INDEX

PHYSICS

CHEMISTRY

BIOLOGY

1 Physical World, Units and Measurements

Fill in the Blanks :

1. The _____ is a measure of how closed the measured value is to the true value of quantity.
2. In the formula $X = 3YZ^2$, X and Z have dimensions of capacitance and magnetic induction respectively. The dimensions of Y in *MKSQ* sytem are ________.
3. The equation of state for real gas is given by $\left(P + \frac{a}{V^2}\right)(V - b) = RT$. The dimensions of the constant a is ________.
4. ____ is the ratio of the mean absolute error to the mean value of the quantity measured.
5. Planck's constant has dimensions ________.
6. The _____ is the error associated with the resolution of the instrument.
7. If $Z = A^3$, then $\frac{\Delta Z}{Z}$ = ______
8. The number of significant figures in 0.00060 m is ________.

True/ False :

1. Every measurement by any measuring instrument has some error.
2. A measurement can have more accuracy but less precision and vice versa.
3. Change of units change the number of significant digits.
4. All the zero between two non-zero digits are significant.
5. Light year and year, both measure time.
6. If l_1= 0.6 cm ; l_2= 0.60 cm and l_3= 0.600 cm, then l_3 is the least accurate measurement.

Conceptual MCQs

1. Which of the following pairs of physical quantities does not have same dimensional formula?
   (a) Work and torque.
   (b) Angular momentum and Planck's constant
   (c) Tension and surface tension.
   (d) Impulse and linear momentum
2. The sum of the numbers 436.32, 227.2 and 0.301 in appropriate significant figures is
   (a) 6663.821 (b) 664
   (c) 663.8 (d) 663.8
3. On the basis of dimensions, decide which of the following relations for the displacement of a particle is not correct.
   (a) $y = a \sin 2\pi t/T - \cos 2\pi t/T$
   (b) $y = a \sin vt$
   (c) $y = \frac{a}{T}\sin\left(\frac{t}{v}\right)$
   (d) $y = a\sqrt{2}\left(\sin\frac{2\pi t}{T} - \cos\frac{2\pi t}{T}\right)$
4. If dimensions of critical velocity υ_c of a liquid flowing through a tube are expressed as $[\eta^x \rho^y r^x]$, where η, ρ and r are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of x, y and z are given by :
   (a) –1, –1, 1 (b) –1, –1, –1
   (c) 1, 1, 1 (d) 1, –1, –1

5. Which of the following quantities has a unit but dimensionless?
(a) Strain
(b) Reynolds number
(c) angular displacement
(d) Poisson's ratio

6. The speed of sound in a gas is given by $V = \sqrt{\frac{\gamma P}{d}}$ where P is pressure and d is density.
The dimensional formula for γ is
(a) $M^{-1} L^{1} T^{2}$ (b) $M^{0} L^{0} T^{0}$
(c) $M^{0} L^{-1} T^{0}$ (d) $M^{0} L^{0} T^{1}$

7. If velocity (V), time (T) and force (F) are fundamental quantities, what is the dimensional formula for mass :
(a) $[F^{-1} TV]$ (b) $[F T V]$
(c) $[FV T^{-1}]$ (d) $[F^{-1} T V^{-1}]$

8. Which of the following sets cannot be taken as fundamental quantities in any system of units :
(a) length, mass, velocity
(b) length, time, velocity
(c) mass, time, acceleration
(d) energy, force, time

9. The dimensional formula for relative density is
(a) $[M L^{-3}]$ (b) $[M^{0} L^{-3}]$
(c) $[M^{0} L^{0} T^{-1}]$ (d) $[M^{0} L^{0} T^{0}]$

10. The percentage error in the measurement of length of a cube is 2%, what will be percentage error in the measurement of its volume
(a) 2% (b) 1%
(c) 4% (d) 6%

11. The solid angle sustended by the total surface area of a sphere, at the centre is
(a) 4π (b) 2π
(c) π (d) 3π

12. Mass of a body is 210 gm and its density is 7.981 g/cm^3. What will be its volume, with regard to significant digits
(a) 26.312 cm^3 (b) 26 cm^3
(c) 27 cm^3 (d) 26.3 cm^3

13. Random error can be eliminated by :
(a) careful observation
(b) eliminating the cause
(c) measuring the quantity with more than one instrument
(d) taking large number of observations and then their mean.

14. If $f = x^2$, then the relative error in f is
(a) $\frac{2\Delta x}{x}$ (b) $\frac{(\Delta x)^2}{x}$
(c) $\frac{\Delta x}{x}$ (d) $(\Delta x)^2$

15. The least count of a stop watch is 0.2 second. The time of 20 oscillations of a pendulum is measured to be 25 second. The percentage error in the measurement of time will be
(a) 8% (b) 1.8%
(c) 0.8% (d) 0.1%

16. Two quantities A and B have different dimensions which mathematical operation given below is physically meaningful?
(a) A/B (b) A + B
(c) A – B (d) A = B

17. The dimensional formula of torque is
(a) $[ML^2T^{-2}]$ (b) $[MLT^{-2}]$
(c) $[ML^{-1}T^{-2}]$ (d) $[ML^{-2}T^{-2}]$

18. In a vernier calliper N divisions of vernier scale coincides with (N – 1) divisions of main scale (in which length of one division is 1 mm). The least count of the instrument should be
(a) N (b) N – 1
(c) 1/10 N (d) 1/N – 1

19. Which of the following is a dimensional constant?
(a) Refractive index
(b) Poissons ratio
(c) Relative density
(d) Gravitational constant

20. The unit of permittivity of free space, ε_o is
(a) Coulomb^2/(Newton-metre)^2
(b) Coulomb/Newton-metre
(c) Newton-meter^2/Coulomb^2
(d) Coulomb^2/Newton-meter^2

21. The ratio of the dimension of Planck′s constant and that of the moment of inertia is the dimension of

(a) time (b) frequency

(c) angular momentum (d) velocity

22. If the dimensions of a physical quantity are given by $M^a L^b T^c$, then the physical quantity will be:

(a) Velocity if a = 1, b = 0, c = – 1

(b) Acceleration if a = 1, b = 1, c = – 2

(c) Force if a = 0, b = – 1, c = – 2

(d) Pressure if a = 1, b = – 1, c = – 2

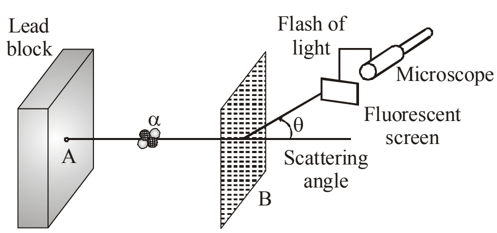
23. The dimensions of $(\mu_0 \epsilon_0)^{\frac{-1}{2}}$ are

(a) $[L^{1/2} T^{-1/2}]$ (b) $[L^{-1} T]$

(c) $[L T^{-1}]$ (d) $[L^{-1/2} T^{1/2}]$

Diagram Based Questions :

1. In Rutherford, alpha particle scattering experiment as shown in given figure, A and B refer to



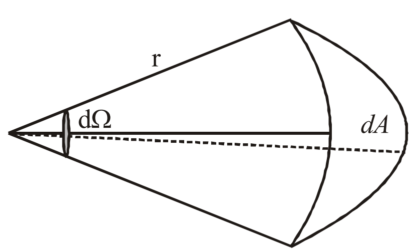
(a) polonium sample and aluminium foil

(b) polonium sample and gold foil

(c) uranium sample and gold foil

(d) uranium sample and aluminium foil

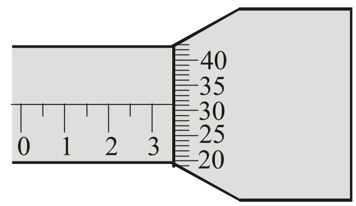
2. For the given figure solid angle, dΩ is equal to



(a) $r^2 dA$ steradian (b) dA/r^2 steradian

(c) $\frac{r^2}{dA}$ steradian (d) dA/r steradian

3. The accompanying diagram represents a screw gauge. The circular scale is divided into 50 divisions and the linear scale is divided into millimeters. If the screw advances by 1 mm when the circular scale makes 2 complete revolutions, the least count of the instrument and the reding of the instrument in figure are respectively.



(a) 0.01 mm and 3.82 mm

(b) 0.02 mm and 3.70 mm

(c) 0.11 mm and 4.57 mm

(d) 1.0 mm and 5.37 mm

4. In a screw gauge, the zero of mainscale coincides with fifth division of circular scale in figure (i). The circular division of screw gauge are 50. It moves 0.5 mm on main scale in one rotation. The diameter of the ball in figure (ii) is

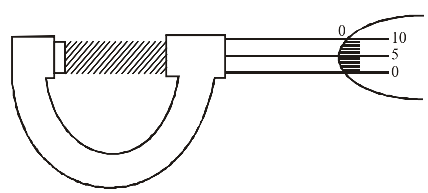


Figure (i)

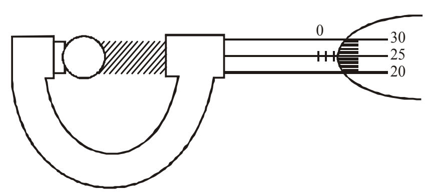


Figure (ii)

(a) 2.25 mm (b) 2.20 mm

(c) 1.20 mm (d) 1.25 mm

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Now a days a standard *metre* is defined in terms of the wavelength of light.
   Reason : Light has no relation with length.
2. **Assertion :** Parallax method cannot be used for measuring distances of stars more than 100 light years away.
   Reason : Because parallax angle reduces so much that it cannot be measured accurately.
3. **Assertion :** A.U. is much bigger than Å.
   Reason : A.U. stands for astronomical unit and A stands for Angstrom.
4. **Assertion :** When we change the unit of measurement of a quantity, its numerical value changes.
   Reason : Smaller the unit of measurement smaller is its numerical value.
5. **Assertion :** Angle and strain are dimensionless.
   Reason : Angle and strain have no unit.
6. **Assertion :** In the equation momentum, P = $\frac{\text{mass}}{\text{area}}x$, the dimensional formula of x is LT^{-2}.
   Reason : Quantities with different dimensions can be multiplied.
7. **Assertion :** Force cannot be added to pressure.
   Reason : The dimensions of force and pressure are different.
8. **Assertion :** The time period of a pendulum is given by the formula, $T = 2\pi\sqrt{g/\ell}$
   Reason : According to the principle of homogeneity of dimensions, only that formula is correct in which the dimensions of L.H.S. is equal to dimensions of R.H.S.
9. **Assertion:** Formula for kinetic energy is $K = \frac{1}{2}mu^2 = ma$
   Reason : Both the equation $K = \frac{1}{2}mv^2$ and $k = ma$ are dimensionally incorrect.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the following Column I and Column II.

Column-I	Column-II
(A) Distance between earth & stars	(1) micron
(B) Inter-atomic distance in a solid	(2) angstrom
(C) Size of the nucleus	(3) light year
(D) Wavelength of infrared laser	(4) fermi
	(5) kilometre

(a) (A)→(1); (B)→(3); C→(4); (D)→(2)
(b) (A)→(3); (B)→(2); C→(4); (D)→(1)
(c) (A)→(5); (B)→(2); C→(3); (D)→(1)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

2.

Column I	Column II
(A) Length	(1) burette
(B) Volume	(2) Vernier callipers
(C) Diameter of a thin wire	(3) screw gauge
(D) Mass	(4) common balance

(a) (A)→(4); (B)→(2); C→(1); (D)→(3)
(b) (A)→(3); (B)→(2); C→(4); (D)→(1)
(c) (A)→(4); (B)→(2); C→(3); (D)→(1)
(d) (A)→(2); (B)→(1); C→(3); (D)→(4)

3.

Column I	Column II
(A) 1 Fermi	(1) 3.08×10^{16} m
(B) 1 Astronomical unit	(2) 9.46×10^{15} m
(C) 1 Light year	(3) 1.496×10^{11} m
(D) 1 Parsec	(4) 10^{-15} m

(a) (A)→(4); (B)→(2); C→(1); (D)→(3)
(b) (A)→(3); (B)→(2); C→(4); (D)→(1)
(c) (A)→(4); (B)→(3); C→(2); (D)→(1)
(d) (A)→(2); (B)→(1); C→(3); (D)→(4)

4.

Column I	Column II
(A) Meter scale	(1) 3.08×10^{16} m
(B) Vernier callipers	(2) 10^{-5} m
(C) Screw gauge	(3) 10^{-3}m to 10^{2}m
(D) Parallax method	(4) 10^{-4} m

(a) (A)→(3); (B)→(4); C→(2); (D)→(3)
(b) (A)→(3); (B)→(2); C→(4); (D)→(1)
(c) (A)→(4); (B)→(3); C→(2); (D)→(1)
(d) (A)→(2); (B)→(1); C→(3); (D)→(4)

5.

Column I	Column II
(A) Size of atomic nucleus	(1) 10^{11} m
(B) Distance of the sun from Earth	(2) 10^{7} m
(C) Radius of Earth	(3) 10^{-15} m
(D) Size of proton	(4) 10^{-14} m

(a) (A)→(3); (B)→(4); C→(1); (D)→(3)
(b) (A)→(4); (B)→(1); C→(2); (D)→(3)
(c) (A)→(4); (B)→(3); C→(2); (D)→(1)
(d) (A)→(2); (B)→(1); C→(3); (D)→(4)

6.

Column I	Column II
(A) Rotation period of Earth	(1) 10^{9}s
(B) Average human life – span	(2) 10^{17}s
(C) Travel time for light from Sun to Earth	(3) 10^{5}s
(D) Age of universe	(4) 10^{2}s

(a) (A)→(3); (B)→(4); C→(1); (D)→(3)
(b) (A)→(4); (B)→(1); C→(2); (D)→(3)
(c) (A)→(3); (B)→(1); C→(4); (D)→(2)
(d) (A)→(2); (B)→(1); C→(3); (D)→(4)

7.

Column I	Column II
(A) Mean absolute error	(1) $\Delta a_{mean} / a_{mean}$
(B) Relative error	(2) $\left(\dfrac{\Delta a_{mean}}{a_{mean}}\right) \times 100$
(C) Percentage error	(3) $\sum_{i=1}^{n} \lvert \Delta a_i \rvert / n$
(D) Absolute error	(4) $a_n - a_{mean}$

(a) (A)→(3); (B)→(1); C→(2); (D)→(4)
(b) (A)→(1); (B)→(2); C→(4); (D)→(3)
(c) (A)→(3); (B)→(2); C→(4); (D)→(1)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

8.

Column - I	Column - II
(A) Force	(1) T^{-1}
(B) Angular velocity	(2) MLT^{-2}
(C) Torque	(3) $ML^{-1}T^{-2}$
(D) Stress	(4) $ML^{-1}T^{-1}$
	(5) ML^2T^{-2}

(a) (A)→(3); (B)→(4); C→(1); (D)→(3)
(b) (A)→(2); B→(1); (C)→(5); (D)→(4)
(c) (A)→(3); (B)→(1); C→(4); (D)→(2)
(d) (A)→(2); (B)→(1); C→(3); (D)→(4)

Critical Thinking Type Questions :

1. In a simple pendulum experiment, the maximum percentage error in the measurement of length is 2% and that in the observation of the time-period is 3%. Then the maximum percentage error in determination of the acceleration due to gravity g is

(a) 5% (b) 6%
(c) 1% (d) 8%

2. Diameter of a steel ball is measured using a Vernier callipers which has divisions of 0.1 cm on its main scale (MS) and 10 divisions of its vernier scale (VS) match 9 divisions on the main scale. Three such measurements for a ball are given below:

S.No.	MS(cm)	VS divisions
1.	0.5	8
2.	0.5	4
3.	0.5	6

If the zero error is – 0.03 cm, then mean corrected diameter is

(a) 0.52 cm (b) 0.59 cm
(c) 0.56 cm (d) 0.53 cm

3. A force is given by $F = at + bt^2$, where t is time, the dimensions of a and b are

(a) $[M L T^{-4}]$ and $[M L T^{-1}]$
(b) $[M L T^{-1}]$ and $[M L T^{0}]$
(c) $[M L T^{-3}]$ and $[M L T^{-4}]$
(d) $[M L T^{-3}]$ and $[M L T^{0}]$

4. If P,Q, R are physical quantities, having different dimensions, which of the following combinations can never be a meaningful quantity?

(a) $(P-Q)/R$ (b) $PQ-R$
(c) PQ/R (d) $(PR-Q^2)/R$

5. The physical quantities not having same dimensions are

(a) torque and work
(b) momentum and Planck's constant
(c) stress and Young's modulus
(d) speed and $(\mu_o \varepsilon_o)^{-1/2}$

6. Which one of the following represents the correct dimensions of the gravitational constant?

(a) $[M^{-1}L^3T^{-2}]$ (b) $[MLT^{-1}]$
(c) $[ML^{-1}T^{-2}]$ (d) $[ML^{-2}T^{-2}]$

7. If the dimensions of a physical quantity are given by $M^a L^b T^c$, then the physical quantity will be

(a) velocity if a = 1, b = 0, c = – 1
(b) acceleration if a = 1, b = 1, c = – 2
(c) force if a = 0, b = – 1, c = – 2
(d) pressure if a = 1, b = – 1, c = – 2

8. If the capacitance of a nanocapacitor is measured in terms of a unit '*u*' made by combining the electric charge '*e*', Bohr radius 'a_0', Planck's constant 'h' and speed of light '*c*' then

(a) $u = \dfrac{e^2h}{a_0}$ (b) $u = \dfrac{hc}{e^2a_0}$

(c) $u = \dfrac{e^2c}{ha_0}$ (d) $u = \dfrac{e^2a_0}{hc}$

2

Motion in a Straight Line

Fill in the Blanks :

1. Area under velocity-time curve over a given interval of time represents _________ .

2. The slope of the tangent drawn on position-time graph at any instant is equal to the instantaneous _________ .

3. Acceleration is described as rate of change of _________ .

4. If a body travels with constant acceleration _________, remains constant.

5. The path of a particle moving under the influence of a force fixed in magnitude and direction is _________ .

6. An object accelerated downward under the influence of force of gravity. The motion of object is said to be _________ .

7. Velocity time curve for a body projected vertically upwards is a _________ .

8. The graph between displacement and time for a particle with uniformly accelerated motion is a/an _________ .

True/ False :

1. In general, speed is equal or greater than the magnitude of the velocity.

2. A particle moving in a given direction with a non-zero velocity can have zero speed.

3. When a body reaches highest point in vertical motion, its velocity becomes zero but acceleration is non -zero.

4. Average velocity of an object is not equal to the instantaneous velocity in uniform motion.

5. Average speed can be zero but average velocity can never be zero.

Conceptual MCQs

1. Which one out of the following statements is false?

(a) A body can have zero velocity and still be accelerated

(b) A body can have a constant velocity and still have a varying speed

(c) A body can have a constant speed and still have a varying velocity

(d) The direction of the velocity of a body can change when its acceleration is constant.

2. The displacement of a particle starting from rest (at $t = 0$) is given by $s = 6t^2 - t^3$. The time in seconds at which the particle will attain zero velocity again, is :

(a) 2 (b) 4

(c) 6 (d) 8

3. The study of motion, without consideration of its cause is studied in :

(a) statistics (b) kinematics

(c) mechanics (d) modern physics

4. The ratio of the numerical values of the average velocity and average speed of a body is always:

(a) unity (b) unity or less

(c) unity or more (d) less than unity

5. A particle has moved from one position to another position

(a) its distance is zero

(b) its displacement is zero

(c) neither distance nor displacement is zero

(d) average velocity is zero

6. A vehicle travels half the distance with speed V_1 and the other half with speed V_2, then its average speed is :

(a) $\frac{V_1+V_2}{2}$ (b) $\frac{2V_1+V_2}{V_1+V_2}$

(c) $\frac{2V_1\ V_2}{V_1+V_2}$ (d) $\frac{2(V_1+V_2)}{V_1\ V_2}$

7. The displacement of a body is zero. The distance covered :
(a) is zero
(b) is not zero
(c) may or may not be zero
(d) depends upon the acceleration

8. Which of the following changes when a particle is moving with uniform velocity?
(a) speed (b) velocity
(c) acceleration (d) position vector

9. A lift is coming from 8th floor and is just about to reach 4th floor. Taking ground floor as origin and positive direction upwards for all quantities, which one of the following is correct?
(a) $X<0, v<0, a>0$ (b) $X>0, v<0, a<0$
(c) $X>0, v<0, a>0$ (d) $X>0, v>0, a<0$.

10. If the velocity of a particle is $v = At + Bt^2$, where A and B are constants, then the distance travelled by it between 1s and 2s is :
(a) $\frac{3}{2}A+4B$ (b) $3A+7B$
(c) $\frac{3}{2}A+\frac{7}{3}B$ (d) $\frac{A}{2}+\frac{B}{3}$

11. The slope of the velocity time graph for retarded motion is
(a) positive
(b) negative
(c) zero
(d) can be +ve, –ve or zero

12. The area of the acceleration-displacement curve of a body gives
(a) impulse
(b) change in momentum per unit mass
(c) change in KE per unit mass
(d) total change in energy

13. At a metro station, a girl walks up a stationary escalator in time t_1. If she ramains stationary on the escalator, then the escalator take her up in time t_2. The time taken by her to walk up on the moving escalator will be
(a) $(t_1+t_2)/2$ (b) $t_1 t_2/(t_2-t_1)$
(c) $t_1 t_2/(t_2+t_1)$ (d) t_1-t_2

14. A body starts from rest, what is the ratio of the distance travelled by the body during the 4th and 3rd seconds ?
(a) $\frac{7}{5}$ (b) $\frac{5}{7}$
(c) $\frac{7}{3}$ (d) $\frac{3}{7}$

15. Three different objects of masses m_1, m_2 and m_3 are allowed to fall from rest and from the same point O along three different frictionless paths. The speeds of the three objects on reaching the ground will be in the ratio of
(a) $m_1 : m_2 : m_3$ (b) $m_1 : 2m_2 : 3m_3$
(c) $1:1:1$ (d) $\frac{1}{m_1}:\frac{1}{m_2}:\frac{1}{m_3}$

16. The displacement of a particle is represented by the following equation : $s = 3t^3+7t^2+5t+8$ where s is in metre and t in second. The acceleration of the particle at t = 1s is
(a) $14\ m/s^2$ (b) $18\ m/s^2$
(c) $32\ m/s^2$ (d) zero

17. What is the relation between displacement, time and acceleration in case of a body having uniform acceleration?
(a) $S = ut+\frac{1}{2}at^2$ (b) $S = (u+a)t$
(c) $S = v^2-2as$ (d) None of these

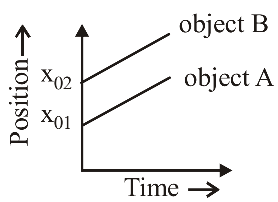
18. Two bodies, A (of mass 1 kg) and B (of mass 3 kg), are dropped from heights of 16m and 25m, respectively. The ratio of the time taken by them to reach the ground is
(a) 12/5 (b) 5/12
(c) 4/5 (d) 5/4

19. A particle moves a distance x in time t according to equation $x = (t+5)^{-1}$. The acceleration of particle is proportional to:
(a) $(\text{velocity})^{3/2}$ (b) $(\text{distance})^2$
(c) $(\text{distance})^{-2}$ (d) $(\text{velocity})^{2/3}$

20. A stone falls freely under gravity. It covers distances h_1, h_2 and h_3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between h_1, h_2 and h_3 is
(a) $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$
(b) $h_2 = 3h_1$ and $h_3 = 3h_2$
(c) $h_1 = h_2 = h_3$
(d) $h_1 = 2h_2 = 3h_3$

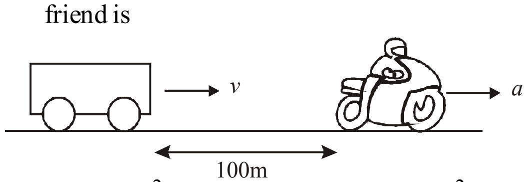
Diagram Based Questions :

1. The graph shown below represents



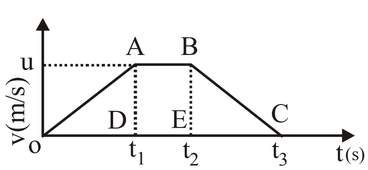
(a) A and B are moving with same velocity in opposite directions
(b) velocity of B is more than A in same direction
(c) velocity of A is more than B in same direction
(d) velocity of A and B is equal in same direction

2. A man travelling in a car with a maximum constant speed of 20m/s watches the friend start off at a distance 100m ahead on a motor cycle with constant acceleration '*a*'. The maximum value of '*a*' for which the man in the car can reach his friend is



(a) 2 m/s^2 (b) 1 m/s^2
(c) 4 m/s^2 (d) None of these

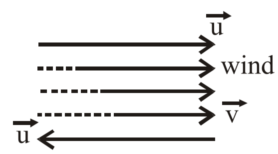
3. The velocity time graph of the motion of the body is as shown below



The total distance travelled by the body during the motion is equal to

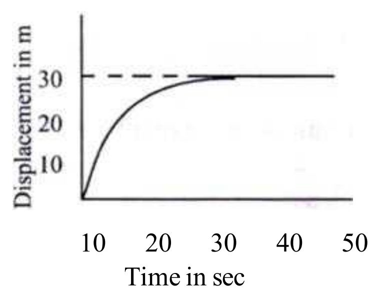
(a) $\frac{1}{2}(AD + BE) \times OC$
(b) $\frac{1}{2}(OA + BC) \times OC$
(c) $\frac{1}{2}(OC + AB) \times AD$
(d) $\frac{1}{2}(OA + AB) \times BC$

4. Wind is blowing west to east along two parallel tracks. Two trains moving with same speed in opposite directions have the relative velocity w.r.t. wind in the ratio 1 : 2. The speed of each train is



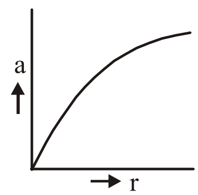
(a) equal to that of wind
(b) double that of wind
(c) three times that of wind
(d) half that of wind

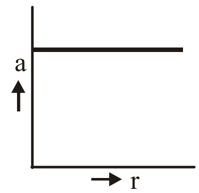
5. The displacement of a particle as a function of time is shown in figure. It indicates that

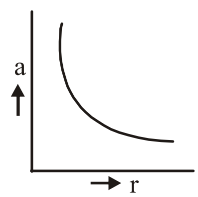


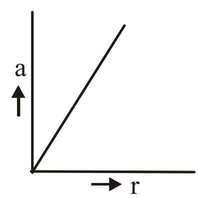
(a) the velocity of the particle is constant throughout
(b) the acceleration of the particle is constant throughout
(c) the particle starts with a constant velocity and is accelerated
(d) the motion is retarded and finally the particle stops

6. If a body moving in circular path maintains constant speed of 10 ms^{-1}, then which of the following correctly describes relation between acceleration and radius ?

(a) 

(b) 

(c) 

(d) 

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The speedometer of an automobile measure the average speed of the automobile.
   Reason : Average velocity is equal to total displacement per total time taken.
2. **Assertion :** An object can have constant speed but variable velocity.
   Reason : Speed is a scalar but velocity is a vector quantity.
3. **Assertion :** The position-time graph of a uniform motion in one dimension of a body can have negative slope.
   Reason : When the speed of body decreases with time, the position-time graph of the moving body has negative slope.
4. **Assertion :** position-time graph of a body moving uniformly in a straight line parallel to position axis. Says body is at rest.
   Reason : The slope of position-time graph in a uniform motion gives the velocity of an object.
5. **Assertion :** The average and instantaneous velocities have same value in a uniform motion.
   Reason : In uniform motion, the velocity of an object increases uniformly.
6. **Assertion :** A body may be accelerated even when it is moving uniformly.
   Reason : When direction of motion of the body is changing, the body must have acceleration.
7. **Assertion :** The equation of motion can be applied only if acceleration is along the direction of velocity and is constant.
   Reason : If the acceleration of a body is zero then its motion is known as uniform motion.
8. **Assertion :** A positive acceleration of a body can be associated with '*slowing down*' of the body.
   Reason : Acceleration is a vector quantity.
9. **Assertion :** A body falling freely may do so with constant velocity.
   Reason : The body falls freely, when acceleration of a body is equal to acceleration due to gravity.
10. **Assertion :** A body, whatever its motion is always at rest in a frame of reference which is fixed to the body itself.
    Reason: The relative velocity of a body with respect to itself is zero.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. For a particle in one dimensional motion, match the following columns :

Column I	Column II
(A) Zero speed but non-zero acceleration.	(1) Body which is about to fall
(B) Zero speed non-zero velocity.	(2) Extreme position of oscillating body
(C) Constant speed non-zero acceleration.	(3) Possible
(D) Positive acceleration must speeding up.	(4) Not possible

(a) (A)→(4); (B)→(2); C→(1); (D)→(3)
(b) (A)→(2); (B)→(1); C→(3); (D)→(4)
(c) (A)→(1, 2, 3); (B)→(3); C→(4); (D)→(1, 3)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

2.

Column I	Column II
(A) Physical quantity whose unit is cm s^{-2} in CGS system	(1) Linear motion
(B) Negative acceleration	(2) Zero
(C) Motion exhibited by body moving in a straight line	(3) Distance
(D) Area under a speed time graph	(4) Acceleration
(E) Velocity of an upward throwing body at the peak point	(5) Retardation

(a) (A)→(4); (B)→(5); C→(1); (D)→(3) ; (E)→(2)
(b) (A)→(2); (B)→(1); C→(3); (D)→(4) ; (E)→(5)
(c) (A)→(5); (B)→(2); C→(3); (D)→(1) ; (E)→(4)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3) ; (E)→(5)

3.

Column I	Column II
(A) Zero acceleration	(1) Retardation
(B) Velocity time graph	(2) Speed
(C) Speed in a direction	(3) Constant motion
(D) Acts in opposite direction of motion	(4) Acceleration
(E) Slope of a distance time graph	(5) Velocity

(a) (A)→(4); (B)→(5); C→(1); (D)→(3) ; (E)→(3)
(b) (A)→(2); (B)→(1); C→(3); (D)→(4) ; (E)→(5)
(c) (A)→(5); (B)→(2); C→(3); (D)→(1) ; (E)→(4)
(d) (A)→(3); (B)→(4); C→(5); (D)→(1) ; (E)→(2)

4.

Column I	Column II
(A) Velocity	(1) m/s^2
(B) Displacement	(2) vector
(C) Speed	(3) m/s
(D) Acceleration	(4) scalar

(a) (A)→(2, 3); (B)→(2); C→(3, 4); (D)→(1)
(b) (A)→(2); (B)→(1); C→(3); (D)→(4)
(c) (A)→(1, 2, 3); (B)→(3); C→(4); (D)→(1, 3)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

5. **Column I** | **Column II**

	Column I		Column II
(A)	Distance travelled by a body	(1)	zero acceleration
(B)	Uniform velocity	(2)	$ut + \frac{1}{2}at^2$
(C)	Speedometer	(3)	instantaneous speed
(D)	Height of a vertically thrown body	(4)	$\frac{u^2}{2g}$

(a) (A)→(2, 3); (B)→(2); C→(3, 4); (D)→(1, 5)
(b) (A)→(1, 2); (B)→(3); C→(5); (D)→(4)
(c) (A)→(1, 5); (B)→(1); C→(3); (D)→(4, 5)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

6.

	Column I		Column II
(A)	s_n	(1)	m/s^2
(B)	$v^2 - u^2$	(2)	$\frac{u+v}{t}$
(C)	Average speed	(3)	$2gh$
(D)	Acceleration	(4)	$u+\frac{a}{2}(2n-1)$

(a) (A)→(4); (B)→(3); C→(2); (D)→(1)
(b) (A)→(4); (B)→(1); C→(2); (D)→(3)
(c) (A)→(3); (B)→(1); C→(4); (D)→(2)
(d) (A)→(2); (B)→(1); C→(3); (D)→(4)

7. Match the Column I and Column II.

	Column I		Column II
(A)	Displacement	(1)	Slope of $x - t$ graph
(B)	Velocity	(2)	Slope of tangent to x – t Curve
(C)	Acceleration	(3)	Area under $v - t$ curve
(D)	Instantaneous velocity	(4)	Slope of $v - t$ graph
			Area. under $x - t$ curve

(a) (A)→(4); (B)→(2); C→(1); (D)→(3)
(b) (A)→(2); (B)→(4); C→(3); (D)→(1)
(c) (A)→(3); (B)→(1); C→(4); (D)→(2)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

Critical Thinking Type Questions :

1. A point traversed half of the distance with a velocity v_0. The half of remaining part of the distance was covered with velocity v_1 & second half of remaining part by v_2 velocity. The mean velocity of the point, averaged over the whole time of motion is

(a) $\frac{v_0 + v_1 + v_2}{3}$ (b) $\frac{2v_0 + v_1 + v_2}{3}$

(c) $\frac{v_0 + .2v_1 + 2v_2}{3}$ (d) $\frac{2v_0(v_1 + v_2)}{(2v_0 + v_1 + v_2)}$

2. A particle moves along a straight line OX. At a time t (in second) the distance x (in metre) of the particle from O is given by $x = 40 + 12t - t^3$. How long would the particle travel before coming to rest?

(a) 24m (b) 40m
(c) 56m (d) 16m

3. The deceleration experienced by a moving motorboat after its engine is cut off, is given by $dv/dt = -kv^3$ where k is constant. If v_0 is the magnitude of the velocity at cut-off, the magnitude of the velocity at a time t after the cut-off is

(a) $\frac{v_0}{\sqrt{(2v_0{}^2kt+1)}}$ (c) $v_0\,e^{-kt}$

(c) $v_0/2$ (d) v_0

4. A particle is moving eastwards with a velocity of 5 ms^{-1}. In 10 seconds the velocity changes to 5 ms^{-1} northwards. The average acceleration in this time is

(a) $\frac{1}{2}ms^{-2}$ towards north

(b) $\frac{1}{\sqrt{2}}ms^{-2}$ towards north - east

(c) $\frac{1}{\sqrt{2}}ms^{-2}$ towards north - west

(d) zero

5. An object, moving with a speed of 6.25 m/s, is decelerated at a rate given by: $\frac{dv}{dt}=-2.5\sqrt{v}$ where v is the instantaneous speed. The time taken by the object, to come to rest, would be

(a) 2 s (b) 4 s

(c) 8 s (d) 1 s

6. A body is projected vertically upwards. If t_1 and t_2 be the times at which it is at height h above the projection while ascending and descending respectively, then h is

(a) $\frac{1}{2}gt_1t_2$ (b) gt_1t_2

(c) $2gt_1t_2$ (d) $2hg$

7. A car accelerates from rest at a constant rate α for some time after which it decelerates at a constant rate β to come to rest. If the total time elapsed is t, the maximum velocity acquired by the car is given by

(a) $\left(\frac{\alpha^2+\beta^2}{\alpha\beta}\right)t$ (b) $\left(\frac{\alpha^2-\beta^2}{\alpha\beta}\right)t$

(c) $\left(\frac{\alpha+\beta}{\alpha\beta}\right)t$ (d) $\left(\frac{\alpha\beta}{\alpha+\beta}\right)t$

8. A particle of unit mass undergoes one-dimensional motion such that its velocity varies according to $v(x) = bx^{-2n}$ where b and n are constants and x is the position of the particle. The acceleration of the particle as d function of x, is given by

(a) $-2nb^2x^{-4n-1}$ (b) $-2b^2x^{-2n+1}$

(c) $-2nb^2e^{-4n+1}$ (d) $-2nb^2x^{-2n-1}$

9. From a tower of height H, a particle is thrown vertically upwards with a speed u. The time taken by the particle, to hit the ground, is n times that taken by it to reach the highest point of its path. The relation between H, u and n is

(a) $2gH = n^2u^2$ (b) $gH = (n-2)^2\,u^2d$

(c) $2gH = nu^2\,(n-2)$ (d) $gH = (n-2)u^2$

3

Motion in a Plane

Fill in the Blanks :

1. _______ number of vectors in different planes can be added to give zero resultant.
2. If t_m is the time taken by a projectile to achieve the maximum height, then the total time of flight T_f related to t_m as _______.
3. In a projectile motion, velocity at maximum height is _______ .
4. At the top of the trajectory of a projectile, the acceleration is _______ .
5. The force required to keep a body in uniform circular motion is _______ .
6. In uniform circular motion, the velocity vector and acceleration vector are ________ .
7. A body of mass m moves in a circular path with uniform angular velocity. The motion of the body has constant ________ .

True/ False :

1. Two balls of different masses are thrown vertically upwards with the same speed. They pass through the point of projection in their downward motion with the same speed (Neglect air resistance).
2. A projectile fired from the ground follows a parabolic path. The speed of the projectile is minimum at the top of its path.
3. Two identical trains are moving on rails along the equator on the earth in opposite directions with the same speed. They will exert the same pressure on the rails.
4. In projectile motion, the range depends on the mass. It is greater for heavier object.
5. In projectile motion, the range is independent of the angle of projection.
6. Magnitude of the centripetal acceleration is $\frac{v^2}{R}$.
7. Centripetal acceleration always pointing towards the centre.

Conceptual MCQs

1. In a two dimensional motion, instantaneous speed v_0 is a positive constant. Then which of the following are necessarily true ?
   (a) The acceleration of the particle is zero.
   (b) The acceleration of the particle is bounded.
   (c) The acceleration of the particle is necessarily in the plane of motion.
   (d) The particle must be undergoing a uniform circular motion
2. Two projectiles are fired from the same point with the same speed at angles of projection 60º and 30º respectively. Which one of the following is true?
   (a) Their maximum height will be same
   (b) Their range will be same
   (c) Their landing velocity will be same
   (d) Their time of flight will be same
3. It is found that $|A+B| = |A|$. This necessarily implies,
   (a) $B = 0$
   (b) A, B are antiparallel
   (c) A, B are perpendicular
   (d) $A.B \leq 0$
4. A stone tied with a string, is rotated in a vertical circle. The minimum speed with which the string has to be rotated
   (a) is independent of the mass of the stone
   (b) is independent of the length of the string
   (c) decreases with increasing mass of the stone
   (d) decreases with increasing length of the string

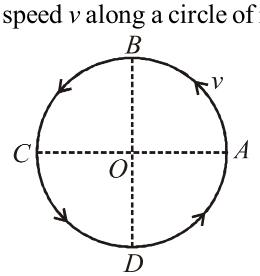
5. Which one of the following statements is true?
(a) A scalar quantity is the one that is conserved in a process.
(b) A scalar quantity is the one that can never take negative values.
(c) A scalar quantity is the one that does not vary from one point to another in space.
(d) A scalar quantity has the same value for observers with different orientations of the axes.

6. The angle between $A = \hat{i} + \hat{j}$ and $B = \hat{i} - \hat{j}$ is
(a) 45° (b) 90°
(c) −45° (d) 180°

7. Which of the following is true regarding projectile motion ?
(a) horizontal velocity of projectile is constant
(b) vertical velocity of projectile is constant
(c) acceleration is not constant
(d) momentum is constant

8. The angular speed of a fly-wheel making 120 revolutions/minute is
(a) π rad/sec (b) 4π rad/sec
(c) 2π rad/sec (d) $4\pi^2$ rad/sec

9. Figure shows a body of mass m moving with a uniform speed v along a circle of radius r.



The change in velocity in going from A to B is
(a) $v\sqrt{2}$ (b) $v/\sqrt{2}$
(c) v (d) zero

10. If a unit vector is represented by $0.5\hat{i} + 0.8\hat{j} + c\hat{k}$, then the value of c is
(a) 1 (b) $\sqrt{0.8}$
(c) $\sqrt{0.11}$ (d) $\sqrt{0.01}$

11. Two vectors are perpendicular if
(a) $\vec{A}.\vec{B} = 1$ (b) $\vec{A} \times \vec{B} = 0$
(c) $\vec{A}.\vec{B} = 0$ (d) $\vec{A}.\vec{B} = AB$

12. A particle A is dropped from a height and another particle B is projected in horizontal direction with speed of 5 m/sec from the same height, then correct statement is
(a) particle A will reach at ground first with respect to particle B
(b) particle B will reach at ground first with respect to particle A.
(c) both particles will reach at ground simultaneously
(d) both particles will reach at ground with same speed

13. The resultant of $\vec{A} \times 0$ will be equal to
(a) zero (b) A
(c) zero vector (d) unit vector

14. If $|\vec{a} + \vec{b}| = |\vec{a} - \vec{b}|$ then angle between $\vec{a}$ and $\vec{b}$ is
(a) 45° (b) 30°
(c) 90° (d) 180°

15. Which of the following is correct :
(a) $\vec{A}\,.\,\vec{B} \neq \vec{B}\,.\,\vec{A}$
(b) $\vec{A}\,.\,(\vec{B} + \vec{C}) = A\,.\,B + \vec{A}\,.\,\vec{C}$
(c) $\vec{A} \times \vec{B} = \vec{B} \times A$
(d) $\vec{A}\,.\,(\vec{B} + \vec{C}) \neq \vec{A}\,.\,\vec{B} + \vec{A}\,.\,\vec{C}$

16. The circular motion of a particle with constant speed is
(a) periodic but not simple harmonic
(b) simple harmonic but not periodic
(c) periodic and simple harmonic
(d) neither periodic nor simple harmonic

17. A boat is sent across a river with a velocity of 8 km h^{-1}. If the resultant velocity of boat is 10 km h^{-1}, then the velocity of the river is
(a) 12.8 km h^{-1} (b) 6 km h^{-1}
(c) 8 km h^{-1} (d) 10 km h^{-1}

18. The magnitude of the vector product of two vectors is $\sqrt{3}$ times then scalar product. The angle between vectors is
(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{6}$
(c) $\frac{\pi}{3}$ (d) $\frac{\pi}{2}$

19. Two vectors $\vec{A}$ and $\vec{B}$ are such that $\vec{A}+\vec{B}=\vec{C}$ and $A^2 + B^2 = C^2$. If θ is the angle between positive direction of $\vec{A}$ and $\vec{B}$, then the correct statement is :

(a) $\theta=\pi$ (b) $\theta=\frac{\pi}{2}$

(c) $\theta=0$ (d) $\theta=\frac{2\pi}{3}$

20. If $\vec{a}$ and $\vec{b}$ are two unit vectors such that $\vec{a}+\vec{b}$ and $\vec{a}-2\vec{b}$ are perpendicular then the angle between $\vec{a}$ and $\vec{b}$ is

(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{3}$

(c) π (d) $\frac{\pi}{6}$

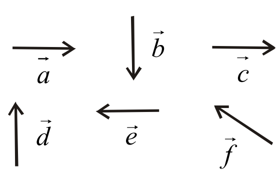
21. For angles of projection of a projectile $(45° - \theta)$ and $(45° + \theta)$, the horizontal ranges described by the projectile are in the ratio of

(a) 1:3 (b) 1 : 2

(c) 2 : 1 (d) 1 : 1

Diagram Based Questions :

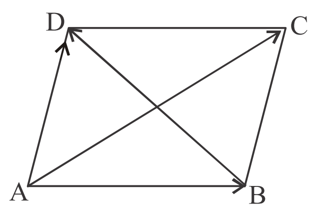
1. Six vectors, $\vec{a}, \vec{b}, \vec{c}, \vec{d}, \vec{e}$ and $\vec{f}$ have the magnitudes and directions indicated in the figure. Which of the following statements is true?



(a) $\vec{b}+\vec{c}=\vec{f}$ (b) $\vec{d}+\vec{c}=\vec{f}$

(c) $\vec{d}+\vec{e}=\vec{f}$ (d) $\vec{b}+\vec{e}=\vec{f}$

2. Which of the following holds true for the given figure?



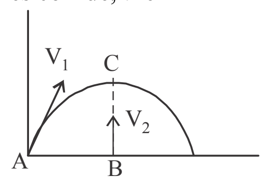
(a) $\overrightarrow{AC}+\overrightarrow{BD}=2\overrightarrow{BC}$

(b) $\overrightarrow{AB}+\overrightarrow{BC}=2\overrightarrow{CD}$

(c) $\overrightarrow{AC}-\overrightarrow{AB}=2\overrightarrow{BD}$

(d) All of these

3. If V_1 is velocity of a body projected from the point A and V_2 is the velocity of a body projected from point B which is vertically below the highest point C. If both the bodies collide, then



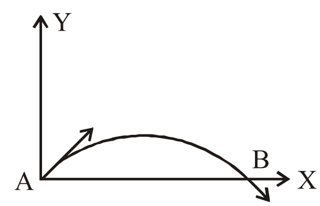
(a) $V_1 = \frac{1}{2}V_2$

(b) $V_2 = \frac{1}{2}V_1$

(c) $V_1 = V_2$

(d) Two bodies can't collide.

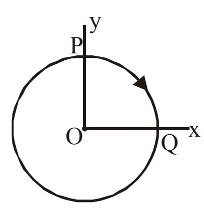
4. The velocity of a projectile at the initial point A is $(2\hat{i}+3\hat{j})$ m/s its velocity (in m/s) at point B is



(a) $-2\hat{i}+3\hat{j}$ (b) $2\hat{i}-3\hat{j}$

(c) $2\hat{i}+3\hat{j}$ (d) $-2\hat{i}-3\hat{j}$

5. A particle moves in a circle of radius 4 cm clockwise at constant speed 2 cm/s. If $\hat{x}$ and $\hat{y}$ are unit acceleration vectors along X and Y-axis respectively (in cm/s^2), the acceleration of the particle at the instant half way between P and Q is given by



(a) $-4(\hat{x}+\hat{y})$ (b) $4(\hat{x}+\hat{y})$

(c) $-(\hat{x}+\hat{y})/\sqrt{2}$ (d) $(\hat{x}-\hat{y})/4$

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The magnitude of velocity of two boats relative to river is same. Both boats start simultaneously from same point on one bank may reach opposite bank simultaneously moving along different paths.
Reason : For boats to cross the river in same time. The component of their velocity relative to river in direction normal to flow should be same.

2. **Assertion :** Two balls of different masses are thrown vertically upward with same speed. They will pass through their point of projection in the downward direction with the same speed.
Reason : The maximum height and downward velocity attained at the point of projection are independent of the mass of the ball.

3. **Assertion :** If a body of mass m is projected upwards with a speed V making an angle θ with the vertical, than the change in the momentum of the body along X–axis is zero.
Reason : Mass of the body remains constant along X–axis

4. **Assertion :** The horizontal range is same when the angle of projection is greater than 45° by certain value and less than 45° by the same value.
Reason: If $\theta = 45° + \alpha$, then

$$R_1 = \frac{u^2 \sin 2(45° + \alpha)}{g} = \frac{u^2 \cos 2\alpha}{g}$$

If $\theta = 45° - \alpha$, then $R_2 = \dfrac{u^2 \sin 2(45° - \alpha)}{g}$

$$= \frac{u^2 \cos 2\alpha}{g}$$

5. **Assertion :** If there were no gravitational force, the path of the projected body always be a straight line.
Reason : Gravitational force makes the path of projected body always parabolic.

6. **Assertion:** The maximum possible height attained by the projected body is $\dfrac{u^2}{2g}$, where u is the velocity of projection.
Reason : To attain the maximum height, body is thrown vertically upwards.

7. **Assertion :** When the range of projectile is maximum, the time of flight is the largest.
Reason : Range is maximum when angle of projection is 45^0.

8. **Assertion :** A shell fired from a gun is moving along the parabolic path. If it explodes at the top of the trajectory, then no part of the shell can fly vertically.
Reason : The vertical momentum of the shell at the top of the trajectory is zero.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Vector $\vec{A}$ has components $A_x = 2, A_y = 3$ and vector $\vec{B}$ has components $B_x = 4, B_y = 5$, then match the columns :

Column I	Column II
(A) The components of vector sum $(\vec{A} + \vec{B})$	(1) 8
(B) The magnitude of $\vec{A} + \vec{B}$	(2) –2
(C) The componet of vector difference $\vec{A} - \vec{B}$	(3) $2\sqrt{2}$
(D) The magnitude of $(\vec{A} - \vec{B})$	(4) 10

(a) (A)→(1); (B)→(4); C→(2); (D)→(3)
(b) (A)→(2); (B)→(4); C→(3); (D)→(1)
(c) (A)→(3); (B)→(2); C→(4); (D)→(1)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

2. Given two vectors $\vec{\mathbf{A}} = 3\hat{\mathbf{i}} + 4\hat{\mathbf{j}}$ and $\vec{\mathbf{B}} = \hat{\mathbf{i}} - 2\hat{\mathbf{j}}$. Then match the following columns :

Column I	Column II
(A) Magnitude of vector $\vec{\mathbf{A}}$ or $\vec{\mathbf{B}}$	(1) 5
(B) Unit vector of $\vec{\mathbf{A}}$	(2) $\left(0.6\hat{\mathbf{i}} + 0.8\hat{\mathbf{j}}\right)$
(C) The magnitude of $\vec{\mathbf{A}} + \vec{\mathbf{B}}$	(3) $\left(2\hat{\mathbf{i}} + 6\hat{\mathbf{j}}\right)$
(D) The difference of vector, $\vec{\mathbf{A}} - \vec{\mathbf{B}}$	(4) $\sqrt{20}$

(a) (A)→(4); (B)→(1); C→(2); (D)→(3)
(b) (A)→(1); (B)→(2); C→(4); (D)→(3)
(c) (A)→(3); (B)→(2); C→(4); (D)→(1)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

3. The velocity $\vec{\mathbf{v}}$ of a particle moving in the xy – plane is given by $\vec{\mathbf{v}} = \left(6t - 4t^2\right)\hat{\mathbf{i}} + 8\hat{\mathbf{j}}$, with $\vec{\mathbf{v}}$ in m/s and t(>0) in second.

Column - I	Column - II
(A) Acceleration magnitude is 10 m/s^2 at a time	(1) ¾ s
(B) Acceleration zero at time	(2) never
(C) velocity zero at time	(3) 1 s
(D) The speed 10 m/s at a time	(4) 2 s

(a) (A)→(4); (B)→(1); C→(2); (D)→(3)
(b) (A)→(2); (B)→(4); C→(3); (D)→(1)
(c) (A)→(3); (B)→(2); C→(4); (D)→(1)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

4. The equation of trajectory of a particle projected from the surface of the planet is given by the equation $y = x - x^2$. (suppose, $g = 2$ m/s^2)

Column - I	Column - II
(A) angle of projection tan θ	(1) $\frac{1}{4}$
(B) time of flight, T	(2) 1
(C) maximum height attained, H	(3) 2
(D) horizontal range, R	(4) 4

(a) (A)→(4); (B)→(1); C→(2); (D)→(2)
(b) (A)→(2); (B)→(3); C→(1); (D)→(4)
(c) (A)→(3); (B)→(2); C→(4); (D)→(1)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

5. A particle is projected with some angle from the surface of the planet. The motion of the particle is described by the equation; $x = t$, $y = t - t^2$. Then match the following columns:

Column - I (quantity)	Column - II (magnitude only)
(A) velocity of projection	(1) 1
(B) acceleration	(2) $\sqrt{2}$
(C) time of flight	(3) 2
(D) maximum height attained	(4) $\frac{1}{4}$

(a) (A)→(4); (B)→(1); C→(2); (D)→(2)
(b) (A)→(2); (B)→(3); C→(1); (D)→(2)
(c) (A)→(2); (B)→(3); C→(1); (D)→(4)
(d) (A)→(3); (B)→(4); C→(3); (D)→(2)

6. A ball is thrown at an angle 75° with the horizontal at a speed of 20 m/s towards a high wall at a distance d. If the ball strikes the wall, its horizontal velocity component reverses the direction without change in magnitude and the vertical velocity component remains same. Ball stops after hitting the ground. Match the statement of column I with the distance of the wall from the point of throw in column II .

Column I	Column II
(A) Ball strikes the wall directly	(1) 8m
(B) Ball strikes the ground at x = 12 m from the wall	(2) 10m
(C) Ball strikes the ground at x = 10m from the wall	(3) 0m
(D) Ball strikes the ground at x = 5 m from the wall	(4) 25m

(a) (A)→(1,2); (B)→(1); C→(2); (D)→ (4)
(b) (A)→(2); (B)→(3); C→(1); (D)→(2)
(c) (A)→(2); (B)→(3); C→(1); (D)→(4)
(d) (A)→(3); (B)→(4); C→(3); (D)→(2)

Critical Thinking Type Questions :

1. The sum of magnitudes of two forces acting at a point is 16 N and their resultant $8\sqrt{3}$ N is at 90° with the force of smaller magnitude. The two forces (in N) are
(a) 11, 5 (b) 9, 7
(c) 6, 10 (d) 2, 14

2. A particle crossing the origin of co-ordinates at time t = 0, moves in the xy-plane with a constant acceleration a in the y-direction. If its equation of motion is $y = bx^2$ (b is a constant), its velocity component in the x-direction is
(a) $\sqrt{\frac{2b}{a}}$ (b) $\sqrt{\frac{a}{2b}}$
(c) $\sqrt{\frac{a}{b}}$ (d) $\sqrt{\frac{b}{a}}$

3. Two projectiles A and B thrown with speeds in the ratio $1 : \sqrt{2}$ acquired the same heights. If A is thrown at an angle of 45° with the horizontal, the angle of projection of B will be
(a) 0° (b) 60°
(c) 30° (d) 45°

4. A projectile is fired from the surface of the earth with a velocity of 5 ms^{-1} and angle θ with the horizontal. Another projectile fired from another planet with a velocity of 3 ms^{-1} at the same angle follows a trajectory which is identical with the trajectory of the projectile fired from the earth. The value of the acceleration due to gravity on the planet is (in ms^{-2}) given g = 9.8 m/s^2
(a) 3.5 (b) 5.9
(c) 16.3 (d) 110.8

5. For a particle in uniform circular motion, the acceleration $\vec{a}$ at a point P(R,θ) on the circle of radius R is (Here θ is measured from the x-axis)

(a) $-\frac{v^2}{R}\cos\theta\ \hat{i} + \frac{v^2}{R}\sin\theta\ \hat{j}$

(b) $-\frac{v^2}{R}\sin\theta\ \hat{i} + \frac{v^2}{R}\cos\theta\ \hat{j}$

(c) $-\frac{v^2}{R}\cos\theta\ \hat{i} - \frac{v^2}{R}\sin\theta\ \hat{j}$

(d) $\frac{v^2}{R}\hat{i} + \frac{v^2}{R}\hat{j}$

6. A stone tied to the end of a string of 1 m long is whirled in a horizontal circle with a constant speed. If the stone makes 22 revolution in 44 seconds, what is the magnitude and direction of acceleration of the stone?
(a) π^2 m s^{-2} and direction along the radius towards the centre.
(b) π^2 m s^{-2} and direction along the radius away from the centre.
(c) π^2 m s^{-2} and direction along the tangent to the circle.
(d) $\pi^2/4$ m s^{-2} and direction along the radius towards the centre.

4 LAWS OF MOTION

Fill in the Blanks :

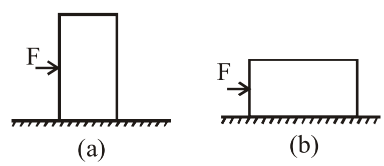
1. Impulse equals _______ .
2. China wares are wraped in straw of paper before packing. This is the application of concept of _______ .
3. Swimming is possible on account of _______ .
4. A body whose momentum is constant must have constant _______ .
5. A jet engine works on the principle of _______.
6. The coefficient of static friction between two surfaces depends upon _______ and _______.
7. If the normal force is doubled, then coefficient of friction is _______ .
8. When a car moves on a level road, then the centripetal force required for circular motion is provided by _______ .

True/ False :

1. Newton's laws of motion hold good for both inertial and non-inertial frames.
2. During explosion, linear momentum is conserved.
3. Force of friction is zero when no driving force is applied.
4. Recoiling of a gun is an application of principle of conservation of linear momentum.
5. The second law of motion relates the net external force to the acceleration of the body.
6. A rocket moves forward by pushing the surrounding air backwards.
7. When a person walks on a rough surface, the frictional force exerted by the surface on the person is opposite to the direction of his motion.
8. A simple pendulum with a bob of mass m swings with an angular amplitude of 40°. When its angular displacement is 20°, the tension in the string is greater than $mg \cos 20°$.

Conceptual MCQs

1. A block of mass 2 kg is resting on a rough inclined plane of inclination 30º. The coefficient of friction is 0.8, the contact force between incline and the block is ($g = 10\ ms^{-2}$)
   (a) 20 N (b) 10 N
   (c) $10\sqrt{3}$ N (d) none of these
2. Centrifugal force
   (a) is a real force
   (b) balances centripetal force
   (c) always acts away from centre
   (d) all of these
3. A rectangular block is placed on a rough horizontal surface in two different ways as shown, then

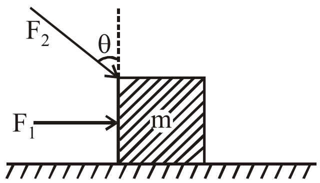


   (a) friction will be more in case (a)
   (b) friction will be more in case (b)
   (c) friction will be equal in both the cases.
   (d) depends on the relations among its dimensions.
4. If the force on a rocket moving with a velocity of 300 m/sec is 345 N, then the rate of combustion of the fuel, is
   (a) 0.55 kg/sec (b) 0.75 kg/sec
   (c) 1.15 kg/sec (d) 2.25 kg/sec
5. On increasing the smoothness of surfaces in contact,
   (a) frictional force b/w them must decrease.
   (b) frictional force b/w them must increase.
   (c) frictional force b/w them may increase or decrease
   (d) frictional force does not change as it does not depend on area of contact.

6. Centripetal force :
   (a) can change speed of the body.
   (b) is always perpendicular to direction of motion
   (c) is constant for uniform circular motion.
   (d) all of these
7. When a horse pulls a cart, the horse moves down to the force exerted by
   (a) the horse on the cart.
   (b) the cart on the horse.
   (c) the horse on the earth.
   (d) the earth on the horse.
8. Forces of action and reaction do not balance each other because.
   (a) they act in same direction
   (b) their magnitudes are not equal
   (c) they act on different bodies
   (d) act perpendicular to each other
9. The force of action and reaction
   (a) must be of same nature
   (b) must be of different nature
   (c) may be of different nature
   (d) may not have equal magnitude
10. Which of the following is self-adjusting ?
   (a) Static friction (b) Kinetic friction
   (c) Limiting friction (d) Rolling friction
11. Frictional force
   (a) always acts opposite to direction of motion.
   (b) always acts in the direction of motion
   (c) may act in the direction of motion
   (d) always acts perpendicular to the direction of motion
12. A body is moving with uniform velocity, then
   (a) no force must be acting on the body.
   (b) exactly two forces must be acting on the body
   (c) body is not acted upon by a single force.
   (d) the number of forces acting on the body must be even.
13. The direction of impulse is
   (a) same as that of the net force
   (b) opposite to that of the net force
   (c) same as that of the final velocity
   (d) same as that of the initial velocity
14. A monkey is climbing up a rope, then the tension in the rope
   (a) must be equal to the force applied by the monkey on the rope.
   (b) must be less than the force applied by the monkey on the rope.
   (c) must be greater than the force applied by the monkey on the rope.
   (d) may be equal to, less than or greater the force applied by the monkey on the rope.
15. A coin is placed on a rotating disc and is stationary w.r.t. the disc, then the direction of friction is
   (a) along the direction of motion of the coin w.r.t. ground
   (b) opposite to the direction of motion of the coin w.r.t. ground
   (c) towards the centre of the disc
   (d) away from the centre of the disc
16. If *a* cricketer catches a ball of mass 150 gm moving with a velocity of 20 m/s, then he experiences a force of (Time taken to complete the catch is 0.1 sec.)
   (a) 300 N (b) 30 N
   (c) 3 N (d) 0.3 N
17. A 100 N force acts horizontally on a block of 10 kg placed on a horizontal rough surface of coefficient of friction $\mu = 0.5$. If the acceleration due to gravity (g) is taken as 10 ms^{-2}, the acceleration of the block (in ms^{-2}) is
   (a) 2.5 (b) 10
   (c) 5 (d) 7.5
18. The mass of a lift is 2000 kg. When the tension in the supporting cable is 28000 N, then its acceleration is:
   (a) 4 ms^{-2} upwards
   (b) 4 ms^{-2} downwards
   (c) 14 ms^{-2} upwards
   (d) 30 ms^{-2} downwards
19. A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m/s. A bob is suspended from the roof of the car by a light wire of length 1.0 m. The angle made by the wire with the vertical is
   (a) 0° (b) $\frac{\pi}{3}$
   (c) $\frac{\pi}{6}$ (d) $\frac{\pi}{4}$
20. Sand is being dropped on a conveyor belt at the rate of M kg/s. The force necessary to keep the belt moving with a constant velocity of v m/s will be:
   (a) Mv newton (b) 2 Mv newton
   (c) $\frac{Mv}{2}$ newton (d) zero

Diagram Based Questions :

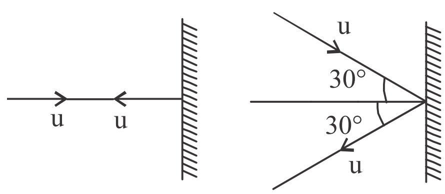
1. A block of mass m on a rough horizontal surface is acted upon by two forces as shown in figure. For equilibrium of block the coefficient of friction between block and surface is



(a) $\dfrac{F_1 + F_2 \sin\theta}{mg + F_2 \cos\theta}$ (b) $\dfrac{F_1 \cos\theta + F_2}{mg - F_2 \sin\theta}$

(c) $\dfrac{F_1 + F_2 \cos\theta}{mg + F_2 \sin\theta}$ (d) $\dfrac{F_1 \sin\theta - F_2}{mg - F_2 \cos\theta}$

2. What is the direction of force on the wall due to the ball in two cases shown in the figures?



(a) (b)

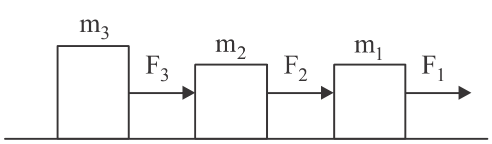
(a) In (a) force is normal to the wall and in (b) force is inclined at 30° to the normal.

(b) In (a) force is normal to the wall and in (b) force is inclined at 60° to the normal.

(c) In (a) the force is along the wall and in (b) force is normal to the wall.

(d) In (a) and (b) both the force is normal to the wall.

3. For the system shown in figure, the correct expression is



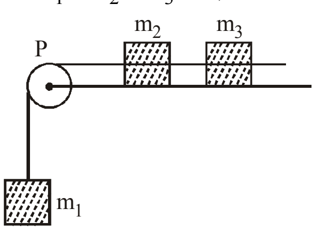
(a) $F_3 = F_1 + F_2$

(b) $F_3 = \dfrac{m_3 F}{F_1 + F_2 + F_3}$

(c) $F_3 = \dfrac{m_3 F}{m_1 + m_2 + m_3}$

(d) $F_3 = \dfrac{m_3 F}{m_1 + m_2}$

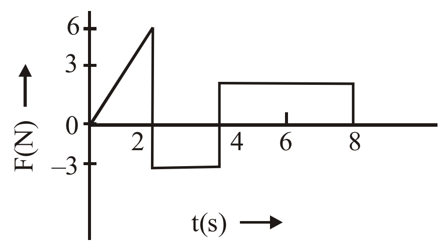
4. A system consists of three masses m_1, m_2 and m_3 connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 and m_3 are on a rough horizontal table (the coefficient of friction = μ). The pulley is frictionless and of negligible mass. The downward acceleration of mass m_1 is :
(Assume $m_1 = m_2 = m_3 = m$)



(a) $\dfrac{g(1 - g\mu)}{g}$ (b) $\dfrac{2g\mu}{3}$

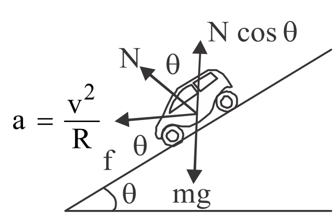
(c) $\dfrac{g(1 - 2\mu)}{3}$ (d) $\dfrac{g(1 - 2\mu)}{2}$

5. The force 'F' acting on a particle of mass 'm' is indicated by the force-time graph shown below. The change in momentum of the particle over the time interval from zero to 8 s is :



(a) 24 Ns (b) 20 Ns
(c) 12 Ns (d) 6 Ns

6. The motion of a car on a banked road is shown in the figure. The centripetal force equation will be given by



(a) $N\sin\theta + f\cos\theta = \frac{mv^2}{R}$

(b) $f = \frac{mv^2}{R}$

(c) $N\cos\theta + f = \frac{mv^2}{R}$

(d) $N\sin\theta + f = \frac{mv^2}{R}$

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The two bodies of masses M and m ($M > m$) are allowed to fall from the same height if the air resistance for each be the same then both the bodies will reach the earth simultaneously.
   Reason : For same air resistance, acceleration of both the bodies will be same.
2. **Assertion :** On a rainy day, it is difficult to drive a car or bus at high speed.
   Reason : The value of coefficient of friction is lowered due to wetting of the surface.
3. **Assertion:** Friction is a necessary evil
   Reason: Though friction dissipates power, but without friction we cannot walk.
4. **Assertion:** There is a stage when frictional force is not needed at all to provide the necessary centripetal force on a banked road.
   Reason: On a banked road, due to its inclination the vehicle tends to remain inwards without any chances of skidding.
5. **Assertion :** Force is required to move a body uniformly along a circle.
   Reason : When the motion is uniform, acceleration is zero.
6. **Assertion :** Linear momentum of a body changes even when it is moving uniformly in a circle.
   Reason : In uniform circular motion, velocity remains constant.
7. **Assertion :** A cyclist always bends inwards while negotiating a curve.
   Reason : By bending, cyclist lowers his centre of gravity.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column I	Column II
(A) Inertia	(1) 10^5 $gcms^{-1}$
(B) Recoil of gun	(2) kg f
(C) 1 kg ms^{-1}	(3) Newton's third law of motion
(D) Weight	(4) Newton's first law of motion

(a) (A)→(4); (B)→(1); C→(2); (D)→(3)
(b) (A)→(4); (B)→(3); C→(1); (D)→(2)
(c) (A)→(3); (B)→(2); C→(4); (D)→(1)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

2. **Column I** | **Column II**

	Column I		Column II
(A)	Unbalanced	(1)	Acts on two different bodies
(B)	Action & Reaction	(2)	Inability to change the state
(C)	Inertia	(3)	*mv*
(D)	Momentum	(4)	Variable velocity

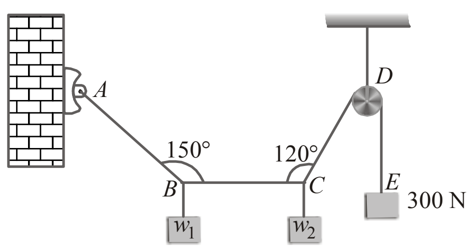
(a) (A)→(4); (B)→(1); C→(2); (D)→(3)
(b) (A)→(1); (B)→(2); C→(4); (D)→(3)
(c) (A)→(3); (B)→(2); C→(4); (D)→(1)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

3.

	Column I		Column II
(A)	Accelerated motion	(1)	Newton's 1st law
(B)	Impulse	(2)	Mass
(C)	Law of inertia	(3)	Force×time
(D)	Measure of inertia	(4)	Change in speed and direction

(a) (A)→(4); (B)→(1); C→(2); (D)→(3)
(b) (A)→(4); (B)→(2); C→(1); (D)→(3)
(c) (A)→(3); (B)→(4); C→(1); (D)→(2)
(d) (A)→(4); (B)→(3); C→(1); (D)→(2)

4. A light string *ABCDE* whose extremity *A* is fixed, has weights W_1 and W_2 attached to it at *B* and *C*. It passes round a small smooth peg at *D* carrying a weight of 300 N at the free end *E* as shown in figure. If in the equilibrium position, *BC* is horizontal and *AB* and *CD* make 150° and 120° with *CB*. Match the columns :



	Column I		Column II
(A)	Tension in portion *AB*, T_{AB}	(1)	150 N
(B)	Tension in portion *BC*, T_{BC}	(2)	173 N
(C)	Weight, W_1	(3)	260 N
(D)	Weight, W_2	(4)	87 N

(a) (A)→(4); (B)→(1); C→(2); (D)→(3)
(b) (A)→(2); (B)→(1); C→(4); (D)→(3)
(c) (A)→(3); (B)→(4); C→(1); (D)→(3)
(d) (A)→(4); (B)→(3); C→(1); (D)→(2)

5.

	Column I		Column II
(A)	Rocket's work	(1)	Momentum
(B)	$F = ma$	(2)	Uniform motion
(C)	Quantity of motion	(3)	Conservation of momentum
(D)	Constant force	(4)	Newton's second law

(a) (A)→(4); (B)→(1); C→(2); (D)→(3)
(b) (A)→(4); (B)→(3); C→(1); (D)→(2)
(c) (A)→(3); (B)→(4); C→(1); (D)→(2)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

Critical Thinking Type Questions :

1. A car moves at a speed of 20 ms^{-1} on a banked track and describes an arc of a circle of radius $40\sqrt{3}$ m. The angle of banking is ($g = 10\ ms^{-2}$)

(a) 25° (b) 60°
(c) 45° (d) 30°

2. A block A of mass m_1 rests on a horizontal table. A light string connected to it passes over a frictionless pulley at the edge of table and from its other end another block B of mass m_2 is suspended. The coefficient of kinetic friction between the block and the table is μ_k. When the block A is sliding on the table, the tension in the string is

(a) $\frac{(m_2 - \mu k\, m_1)g}{(m_1 + m_2)}$ (b) $\frac{m_1 m_2(1+\mu_k)g}{(m_1+m_2)}$

(c) $\frac{m_1 m_2(1-\mu_k)g}{(m_1+m_2)}$ (d) $\frac{(m_2 + \mu_k\, m_1)g}{(m_1+m_2)}$

3. The upper half of an inclined plane of inclination θ is perfectly smooth while lower half is rough. A block starting from rest at the top of the plane will again come to rest at the bottom, if the coefficient of friction between the block and lower half of the plane is given by

(a) $\mu = \frac{2}{\tan\theta}$ (b) $\mu = 2\tan\theta$

(c) $\mu = \tan\theta$ (d) $\mu = \frac{1}{\tan\theta}$

4. A ball is thrown up at an angle with the horizontal. Then the total change of momentum by the instant it returns to ground is

(a) acceleration due to gravity × total time of flight
(b) weight of the ball × half the time of flight
(c) weight of the ball × total time of flight
(d) weight of the ball × horizontal range

5. A block of mass m is placed on a surface with a vertical cross section given by $y = \frac{x^3}{6}$. If the coefficient of friction is 0.5, the maximum height above the ground at which the block can be placed without slipping is:

(a) $\frac{1}{6}$m (b) $\frac{2}{3}$m

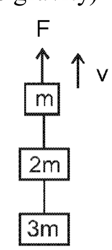
(c) $\frac{1}{3}$m (d) $\frac{1}{2}$m

6. A particle tied to a string describes a vertical circular motion of radius r continually. If it has a velocity $\sqrt{3\,gr}$ at the highest point, then the ratio of the respective tensions in the string holding it at the highest and lowest points is

(a) 4 : 3 (b) 5 : 4
(c) 1 : 4 (d) 3 : 2

7. Three blocks with masses m, 2 m and 3 m are connected by strings as shown in the figure. After an upward force F is applied on block m, the masses move upward at constant speed v. What is the net force on the block of mass 2m? (g is the acceleration due to gravity)

(a) 2 mg
(b) 3 mg
(c) 6 mg
(d) zero



5 Work, Energy And Power

Fill in the Blanks :

1. The change in _______ of a particle is equal to the work done on it by the net force.
2. When the force retards the motion of a body, the work done is _______ .
3. For a conservative force in one dimension, potential energy function V(x) is related to the force F(x) as _______ .
4. The energy stored in wounded spring watch is _______ .
5. If a force F is applied on a body and it moves with a velocity V, the power will be _______ .
6. The coefficient of restitution e for a perfectly elastic collision is _______ .
7. When two bodies stick together after collision, the collision is said to be _______ .
8. When two spheres of equal masses undergo glancing elastic collision with one of them at rest, after collision they will move _______ .

True/ False :

1. If there were no friction, moving vehicles could not be stopped even by locking the brakes.
2. As the angle of inclination is increased, the normal reaction on the body placed on it increases.
3. Momentum of a system can be changed without changing its K.E.
4. In elastic collision, initial kinetic energy is equal to the final kinetic energy.
5. Work energy theorem is a scalar form of Newton's second law.
6. Conservation of mechanical energy is a consequence of work energy theorem for conservative forces.

Conceptual MCQs

1. The magnitude of work done by a force :
   (a) depends on frame of reference
   (b) does not depend on frame of reference
   (c) cannot be calculated in non-inertial frames.
   (d) both (a) and (b)
2. A position dependent force, $F = (7 - 2x + 3x^2)$ N acts on a small body of mass 2 kg and displaces it from x = 0 to $x = 5\ m$. Work done in joule is
   (a) 35 (b) 70
   (c) 135 (d) 270
3. Work done by a conservative force is positive if
   (a) P.E. of the body increases
   (b) P.E. of the body decreases
   (c) K.E. of the body increases
   (d) K.E. of the body decreases
4. A vehicle is moving with a uniform velocity on a smooth horizontal road, then power delivered by its engine must be :
   (a) uniform (b) increasing
   (c) decreasing (d) zero
5. Which of the following forces is/are non-conservative?
   (a) Frictional force (b) Spring force
   (c) Elastic force (d) All of these
6. Work done by frictional force in a round trip
   (a) must be positive (b) must be negative
   (c) may be zero (d) must be none zero
7. A car and a truck moving with equal kinetic energies are stopped by applying equal retarding forces, then :
   (a) car will cover more distance before coming to rest
   (b) truck will cover more distance before coming to rest.
   (c) both will cover equal distance before coming to rest.
   (d) data insufficient.

8. A ball of mass m and a ball B of mass $2m$ are projected with equal kinetic energies. Then at the highest point of their respective trajectories.
(a) P.E. of A will be more than that of B
(b) P.E of B will be more than that of B
(c) P.E of A will be equal to that of B
(d) can't be predicted.

9. In case of elastic collision, at the time of impact.
(a) total K.E. of colliding bodies is conserved.
(b) total K.E. of colliding bodies increases
(c) total K.E. of colliding bodies decreases
(d) total momentum of colliding bodies decreases.

10. A ball A of mass m_A collide with a stationary ball B of mass m_B. The ball A can come to rest after collision *if*
(a) $m_A = m_B$ (b) $m_A < m_B$
(c) $m_A > m_B$ (d) either (a) or (b)

11. A ball is projected from ground at a certain angle. After striking the ground, horizontal component of its velocity
(a) must change
(b) must remain same
(c) will change if surface is smooth.
(d) will change if surface is rough.

12. In case of perfectly inelastic collision in two dimensions
(a) Total K.E. remains conserved.
(b) Both the bodies stick together after the collision.
(c) Total momentum remains conserved
(d) All of these

13. The engine of a vehicle delivers constant power. If the vehicle is moving up the inclined plane then, its velocity,
(a) must remain constant
(b) must increase
(c) must decrease
(d) may increase, decrease or remain same.

14. A ball projected from ground at a certain angle collides a smooth inclined plane at the highest point of its trajectory. If the collision is perfectly inelastic then after the collision.
(a) ball will comes to rest
(b) ball will move along the incline
(c) ball will retrace its path.
(d) ball will bounce back but will strike the ground at a point other than point of projection.

15. Two bodies with kinetic energies in the ratio 4 : 1 aremovingwithequallinearmomentum.Theratio of their masses is
(a) 1 : 2 (b) 1 : 1
(c) 4 : 1 (d) 1 : 4

16. A bomb of mass 30 kg at rest explodes into two pieces of masses 18 kg and 12 kg. The velocity of 18 kg mass is 6 ms^{-1}. The kinetic energy of the other mass is
(a) 324 J (b) 486 J
(c) 256 J (d) 524 J

17. Water falls from a height of 60 m at the rate of 15 kg/s to operate a turbine. The losses due to frictional force are 10% of energy. How much power is generated by the turbine?(g = 10 m/s^2)
(a) 8.1 kW (b) 10.2 kW
(c) 12.3 kW (d) 7.0 kW

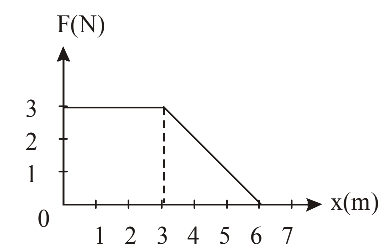
18. A ball moving with velocity 2 m/s collides head on with another stationary ball of double the mass. If the coefficient of restitution is 0.5, then their velocities (in m/s) after collision will be:
(a) 0, 1 (b) 1, 1
(c) 1, 0.5 (d) 0, 2

19. A particle with total energy E is moving in a potential energy region $U(x)$. Motion of the particle is restricted to the region when
(a) $U(x) > E$ (b) $U(x) < E$
(c) $U(x) = O$ (d) $U(x) \le E$

20. A stationary particle explodes into two particles of masses m_1 and m_2 which move in opposite directions with velocities v_1 and v_2. The ratio of their kinetic energies E_1/E_2 is
(a) m_1v_2/m_2v_1 (b) m_2/m_1
(c) m_1/m_2 (d) 1

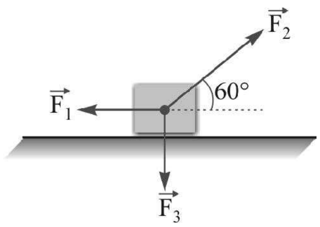
Diagram Based Questions :

1. A force F acting on an object varies with distance x as shown here. The force is in N and x in m. The work done by the force in moving the object from x = 0 to x = 6 m is



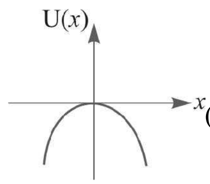
(a) 18.0 J (b) 13.5 J
(c) 9.0 J (d) 4.5 J

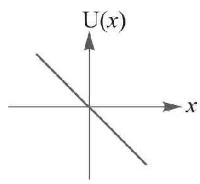
2. Figure shows three forces applied to a trunk that moves leftward by 3 m over a smooth floor. The force magnitudes are $F_1 = 5$N, $F_2 = 9$N, and $F_3 = 3$N. The net work done on the trunk by the three forces

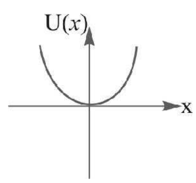


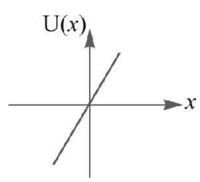
(a) 1.50 J (b) 2.40 J
(c) 3.00 J (d) 6.00 J

3. A particle is placed at the origin and a force $F = kx$ is acting on it (where k is positive constant). If $U(0) = 0$, the graph of $U(x)$ versus x will be (where U is the potential energy function) :

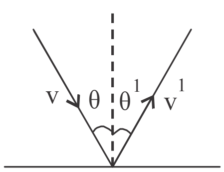
(a) 

(b) 

(c) 

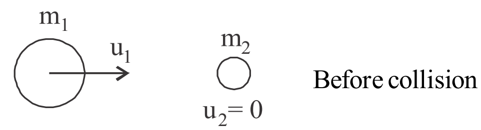
(d) 

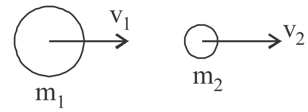
4. A ball of mass m hits the floor making an angle θ as shown in the figure. If e is the coefficient of restitution, then which relation is true, for the velocity component before and after collision?

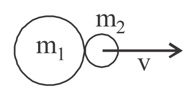


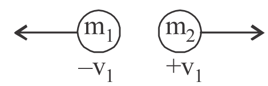
(a) $V^1 \sin\theta = V \sin\theta$
(b) $V^1 \sin\theta' = -\sin\theta$
(c) $V^1 \cos\theta' = V \cos\theta$
(d) $V^1 \cos\theta' = -V \cos\theta$

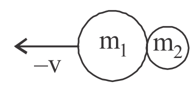
5. For the given case which figure is correctly showing the after inelastic collision situation?



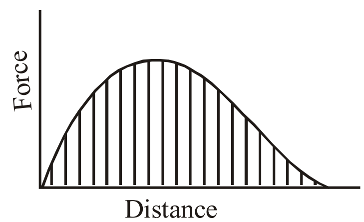
(a) 

(b) 

(c) 

(d) 

6. Which one of the following physical quantities is represented by the shaded area in the given graph?



(a) Torque (b) Impulse
(c) Power (d) Work done

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Mass and energy are not conserved separately, but are conserved as a single entity called mass-energy.
Reason : Mass and energy are inter-convertible in accordance with Einstein's relation.
$$E = mc^2$$
2. **Assertion :** When a machine gun fires n bullets per second each with kinetic energy K, the power of a gun is $P = nK$
Reason : Power P = work done / time
3. **Assertion :** Power developed in circular motion is always zero.
Reason : Work done in case of circular motion is not zero.
4. **Assertion:** Linear momentum is conserved in both elastic and inelastic collisions but total energy is not conserved in inelastic collision.
Reason: Law of conservation of momentum states that momentum has to be conserved in an isolated system.
5. **Assertion :** A point particle of mass m moving with speed υ collides with stationary point particle of mass M. If the maximum energy loss possible is given as $f\left(\frac{1}{2}mv^2\right)$ then $f = \left(\frac{m}{M+m}\right)$.
Reason : Maximum energy loss occurs when the particles get stuck together as a result of the collision.
6. **Assertion :** In an elastic collision of two billiard balls, the total kinetic energy is conserved during the short time of collision of the balls (i.e., when they are in contact).
Reason : Energy spent against friction follow the law of conservation of energy.
7. **Assertion :** Kinetic energy of a system can be increased or decreased without applying any external force on the system.
Reason : This is because K.E. = $\frac{1}{2}mV^2$, so it independent of any external forces.
8. **Assertion :** Graph between potential energy of a spring versus the extension or compression of the spring is a straight line.
Reason : Potential energy of a stretched or compressed spring, proportional to square of extension or compression.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. A small block of mass 200g is kept at the top of a an incline which is 10 m long and 3.2 m high. Match the columns

Column I	Column II
(A) Work done, to lift the block from the ground and put it at the top	(1) 6.4 J
(B) Work done to slide the block up the incline	(2) 7.2 J
(C) The speed of the block at the ground when left from the top of the incline to fall vertically	(3) 4 m/s
(D) The speed of the block at the ground when side along the incline	(4) 8 m/s

(a) (A)→(2); (B)→(3); C→(1); (D)→(4)
(b) (A)→(1); (B)→(1); C→(3); (D)→(3)
(c) (A)→(4); (B)→(3); C→(2); (D)→(2)
(d) (A)→(1); (B)→(3); C→(1); (D)→(2)

2. If W represents the work done, then match the two columns:

	Column I		**Column II**
(A)	Force is always along the velocity	(1)	$W = 0$
(B)	Force is always perpendicular to velocity	(2)	$W < 0$
(C)	Force is always perpendicular to acceleration	(3)	$W > 0$
(D)	The object is stationary but the point of application of the force moves on the object		

(a) (A)→(1); (B)→(2); C→(3); (D)→(2)
(b) (A)→(3); (B)→(1); C→(2,3); (D)→(1)
(c) (A)→(2); (B)→(3); C→(1); (D)→(2)
(d) (A)→(1); (B)→(2); C→(3); (D)→(1)

3. Column I represents work done by forces and column II represents change in kinetic energy Δk, change in potential energy ΔU, change in mechanical energy ΔE. Then match the two columns

	Column I		**Column II (magnitude only)**
(A)	Work done by conservative force	(1)	ΔK
(B)	Work done by non-conservative force	(2)	ΔU
(C)	Work done by internal force	(3)	ΔE
(D)	Work done by external force		

(a) (A)→(1,2); (B)→(1,2); C→(1,2); (D)→(1,3)
(b) (A)→(3); (B)→(1); C→(1,2); (D)→(3)
(c) (A)→(3); (B)→(2); C→(1); (D)→(2,3)
(d) (A)→(1,3); (B)→(2,3); C→(2); (D)→(1)

4.

	Column I		**Column II**
(A)	Kinetic energy	(1)	Drilling anail
(B)	Potential energy	(2)	Water tank on the roof
(C)	Mechanical energy	(3)	Pushing a wall
(D)	Muscular energy	(4)	Motion of a car

(a) (A)→(2); (B)→(3); C→(1); (D)→(4)
(b) (A)→(1); (B)→(1); C→(3); (D)→(3)
(c) (A)→(4); (B)→(2); C→(1); (D)→(3)
(d) (A)→(1); (B)→(3); C→(1); (D)→(2)

5.

	Column I		**Column II**
(A)	Kinetic Energy	(1)	Stretched spring
(B)	Potential Energy	(2)	Watt
(C)	Collision	(3)	Elastic or inelastic
(D)	Power	(4)	A boy running on the roof

(a) (A)→(2); (B)→(3); C→(1); (D)→(4)
(b) (A)→(1); (B)→(1); C→(3); (D)→(3)
(c) (A)→(4); (B)→(3); C→(2); (D)→(2)
(d) (A)→(4); (B)→(1); C→(3); (D)→(2)

Critical Thinking Type Questions :

1. A rod of mass m and length I is made to stand at an angle of 60° with the vertical. Potential energy of the rod in this position is

(a) mgl (b) $\frac{mgl}{2}$

(c) $\frac{mgl}{3}$ (d) $\frac{mgl}{4}$

2. A rubber ball is dropped from a height of 5m on a plane, where the acceleration due to gravity is not shown. On bouncing it rises to 1.8 m. The ball loses its velocity on bouncing by a factor of

(a) $\frac{16}{25}$ (b) $\frac{2}{5}$

(c) $\frac{3}{5}$ (d) $\frac{9}{25}$

3. When a body is projected vertically up from the ground with certain velocity, its potential energy and kinetic energy at a point A are in the ratio 2 : 3. If the same body is projected with double the previous velocity, then at the same point A the ratio of its potential energy to kinetic energy is

(a) 9 : 1 (b) 2 : 9

(c) 1 : 9 (d) 9 : 2

4. When a rubber-band is stretched by a distance x, it exerts restoring force of magnitude $F = ax + bx^2$ where a and b are constants. The work done in stretching the unstretched rubber-band by L is

(a) $aL^2 + bL^3$ (b) $\frac{1}{2}\left(aL^2 + bL^3\right)$

(c) $\frac{aL^2}{2} + \frac{bL^3}{3}$ (d) $\frac{1}{2}\left(\frac{aL^2}{2} + \frac{bL^3}{3}\right)$

5. If two equal masses ($m_1 = m_2$) collide elastically in one dimension, where m_2 is at rest and m_1 moves with a velocity u_1, then the final velocities of two masses are

(a) $V_1 = 0; V_2 = u_1$

(b) $V_1 = V_2 = 0$

(c) $V_1 = 0$ and $V_2 = -u_1$

(d) $V_1 = -u_1; V_2 = 0$

6. A ball moving with velocity 2 m/s collides head on with another stationary ball of double the mass. If the coefficient of restitution is 0.5, then their velocities (in m/s) after collision will be

(a) 0, 1 (b) 1, 1

(c) 1, 0.5 (d) 0, 2

7. A ball of mass m moving with a constant velocity strikes against a ball of same mass at rest. If e = coefficient of restitution, then what will be the ratio of velocity of two balls after collision?

(a) $\frac{1-e}{1+e}$ (b) $\frac{e-1}{e+1}$

(c) $\frac{1+e}{1-e}$ (d) $\frac{2+e}{e-1}$

6 System of Particles and Rotational Motion

Fill in the Blanks :

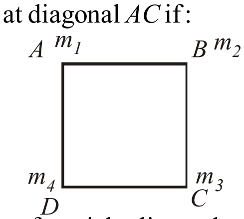
1. The centre of mass of a system of two particles divides the distance between them in _______ ratio of masses of particles.
2. The time rate of change of angular momentum of a particle is equal to _______ .
3. A boy comes running and sits on a rotating plateform _______ is conserved.
4. Rotational analogue of force in linear motion is _______ .
5. Moment of inertia along the diameter of a ring is _______.
6. Radius of gyration of a body depends upon _______ .
7. According to the principle of conservation of angular momentum, if moment of inertia of a rotating body decreases, then its angular velocity _______ .

True/ False :

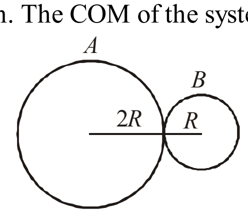
1. Position vector of centre of mass of two particles of equal mass is equal to the position vector of either particle.
2. Centre of mass of a body can lie where there is no mass.
3. Centre of mass depends on the gravity.
4. A body in translatory motion cannot have angular momentum.
5. If $\vec{A}$ points vertically upwards and $\vec{B}$ points towards east then, $\vec{A} \times \vec{B}$ points along South.
6. If earth were to shrink suddenly, length of the day will increase.

Conceptual MCQs

1. Centre of mass of the earth and the moon system lies
   (a) closer to the earth
   (b) closer to the moon
   (c) at the mid-point of line joining the earth and the moon
   (d) cannot be predicted
2. Four particles of masses m_1,m_2,m_3 and m_4 are placed at the vertices A, B, C and D as respectively of a square shown. The COM of the system will lie at diagonal AC if :
   (a) $m_1 = m_3$
   (b) $m_2 = m_4$
   (c) $m_1 = m_2$
   (d) $m_3 = m_4$



3. If COM of a system of particles lies at the origin of the coordinate system then
   (a) x-coordinate of all the particles may be positive.
   (b) x- coordinate of all the particles may be negative.
   (c) x-coordinate of all the particles may be zero.
   (d) y-coordinate of all the particles may be positive.
4. Moment of inertia of a uniform circular disc about a diameter is I. Its moment of inertia about an axis $\perp$ to its plane and passing through a point on its rim will be
   (a) 5 I (b) 3 I
   (c) 6 I (d) 4 I
5. Two spheres A and B of masses m and $2m$ and radii $2R$ and R respectively are placed in contact as shown. The COM of the system lies



(a) inside A (b) inside B
(c) at the point of contact (d) none of these

6. Moment of inertia does not depend upon :
(a) distribution of mass
(b) axis of rotation
(c) point of application of force
(d) none of these

7. Angular momentum of a body is constant if the torque acting on the body is :
(a) constant (b) positive
(c) negative (d) zero

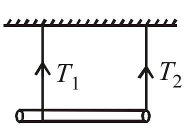
8. A disc is given a linear velocity on a rough horizontal surface then its angular momentum is :
(a) conserved about COM only
(b) conserved about the point of contact only
(c) conserved about all the points
(d) not conserved about any point.

9. A body cannot roll without slipping on a
(a) rough horizontal surface
(b) smooth horizontal surface
(c) rough inclined surface
(d) smooth inclined surface

10. The equation $\tau = I\,\alpha$ is valid about
(a) centre of mass of the body
(b) axis of rotation
(c) all the points
(d) both (a) and (b).

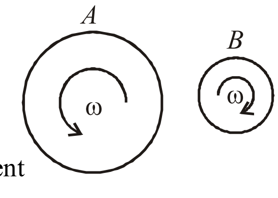
11. A solid sphere of radius R is placed on a smooth horizontal surface. A horizontal force F is applied at height h from the lowest point. For the maximum acceleration of the centre of mass,
(a) $h = R$
(b) $h = 2R$
(c) $h = 0$
(d) The acceleration will be same whatever h may be

12. A uniform rod is hanging with the help of the unintelligible strings as shown. Then:



(a) $T_1 = T_2$
(b) $T_1 > T_2$
(c) $T_1 < T_2$
(c) $T_1 \le T_2$

13. Two discs A and B are in contact and rotating with angular velocity with angular velocities w_1 and w_2 respectively as shown. If there is no shipping between the discs, then



(a) $\omega_1 = \omega_2$
(b) $\omega_1 > \omega_2$
(c) $\omega_1 < \omega_2$
(d) date insufficient

14. If $\vec{F}$ is the force acting on a particle having position vector $\vec{r}$ and $\vec{\tau}$ be the torque of this force about the origin, then:
(a) $\vec{r}\,.\,\vec{\tau} > 0$ and $\vec{F}\,.\,\vec{\tau} < 0$
(b) $\vec{r}\,.\,\vec{\tau} = 0$ and $\vec{F}\,.\,\vec{\tau} = 0$
(c) $\vec{r}\,.\,\vec{\tau} = 0$ and $\vec{F}\,.\,\vec{\tau} \ne 0$
(d) $\vec{r}\,.\,\vec{\tau} \ne 0$ and $\vec{F}\,.\,\vec{\tau} = 0$

15. A solid cylinder is rolling without shipping down an inclined plane. Then its angular momentum is :
(a) conserved about COM of the cylinder.
(b) conserved about point of contact.
(c) conserved about all the points
(d) not conserved about any point

16. In a bicycle, the radius of rear wheel is twice the radius of front wheel. It r_f and r_r are the radii and v_f and v_r are the speeds of topmost points of wheels then
(a) $v_r = 2v_f$ (b) $v_f = 2v_r$
(c) $v_f = v_r$ (d) $v_f = 4v_r$

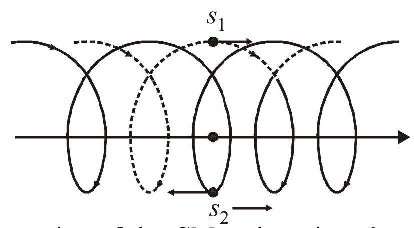
17. If a person standing on a rotating disc stretches out his hands, the angular speed will :
(a) increase (b) decrease
(c) remains same (c) none of these

18. In an orbital motion, the direction of angular momentum vector is :
(a) along the radius vector
(b) parallel to the linear momentum
(c) in the orbital plane
(d) perpendicular to the orbital plane

19. A drum of radius R and mass M, rolls down without slipping along an inclined plane of angle θ. The frictional force
(a) dissipates energy as heat
(b) decreases the rotational motion
(c) decreases the rotational and translational motion
(d) converts translational energy to rotational energy

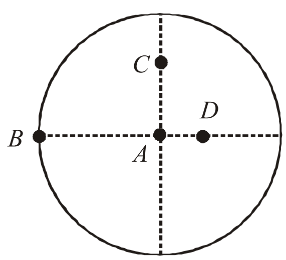
Diagram Based Questions :

1. The motion of binary stars, S_1 and S_2 is the combination of ....*X*.... and ....*Y*.... . Here, *X* and *Y* refer to



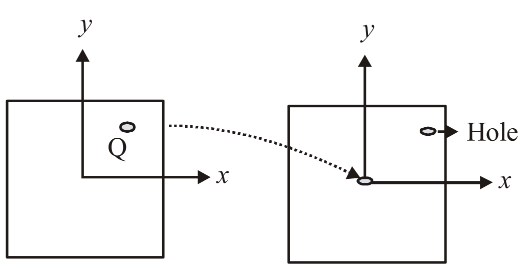
(a) motion of the CM and motion about the CM
(b) motion about the CM and motion of one star
(c) position of the CM and motion of the CM
(d) motion about CM and position of one star

2. The moment of inertia of a uniform circular disc (figure) is maximum about an axis perpendicular to the disc and passing through



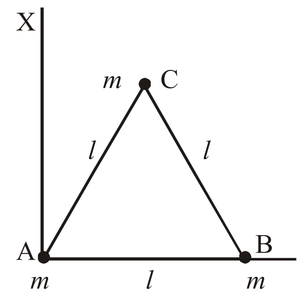
(a) *B* (b) *C*
(c) *D* (d) *A*

3. A uniform square plate has a small piece Q of an irregular shape removed and glued to the centre of the plate leaving a hole behind. Then the moment of inertia about the z-axis



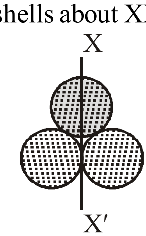
(a) increases
(b) decreases
(c) remains same
(d) changed in unpredicted manner.

4. Three particles, each of mass *m* gram, are situated at the vertices of an equilateral triangle ABC of side ℓ cm (as shown in the figure). The moment of inertia of the system about a line AX perpendicular to AB and in the plane of ABC, in gram-cm^2 units will be



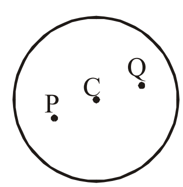
(a) $\frac{3}{2}m\ell^2$
(b) $\frac{3}{4}m\ell^2$
(c) $2\,m\ell^2$
(d) $\frac{5}{4}m\ell^2$

5. Three identical spherical shells, each of mass m and radius r are placed as shown in figure. Consider an axis XX' which is touching to two shells and passing through diameter of third shell. Moment of inertia of the system consisting of these three spherical shells about XX' axis is



(a) $3mr^2$
(b) $\frac{16}{5}mr^2$
(c) $4mr^2$
(d) $\frac{11}{5}mr^2$

6. A disc is rolling (without slipping) on a horizontal surface C is its centre and Q and P are two points equidistant from C. Let V_p, V_q and V_c be the magnitude of velocities of points P, Q and C respectively, then



(a) $V_Q > V_C > V_P$
(b) $V_Q < V_C < V_P$
(c) $V_Q = V_P, V_C = \frac{1}{2}V_P$
(d) $V_Q < V_C > V_P$

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The position of centre of mass of body depend upon shape and size of the body.
Reason : Centre of mass of a body lies always at the centre of the body

2. **Assertion :** A particle is moving on a straight line with a uniform velocity, its angular momentum is always zero.
Reason : The momentum is not zero when particle moves with a uniform velocity.

3. **Assertion :** It is harder to open and shut the door if we apply force near the hinge.
Reason : Torque is maximum at hinge of the door.

4. **Assertion:** When axis of rotation passes through the centre of gravity, then the moment of inertia of a rigid body increases.
Reason: At the centre of gravity mass gets concentrated and moment of inertia increases.

5. **Assertion:** An ice-skater stretches out arms-legs during performance.
Reason: Stretching out arms-legs helps the performer to balance his or her body so that he or she does not fall.

6. **Assertion :** If polar ice melts, days will be longer.
Reason : Moment of inertia decreases and thus angular velocity increases.

7. **Assertion :** Moment of inertia of a particle is same, whatever be the axis of rotation
Reason : Moment of inertia depends on mass and distance of the particles.

8. **Assertion :** Radius of gyration of body is a constant quantity.
Reason : The radius of gyration of a body about an axis of rotation may be defined as the root mean square distance of the particle from the axis of rotation.

9. **Assertion:** A rigid disc rolls without slipping on a fixed rough horizontal surface with uniform angular velocity. Then the acceleration of lowest point on the disc is zero.
Reason : For a rigid disc rolling without slipping on a fixed rough horizontal surface, the velocity of the lowest point on the disc is always zero.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match Column I and Column II

Column I	Column II
(A) Moment of inertia	(1) Twice the product of mass and areal velocity of the particle
(B) Radius of gyration	(2) The product of masses of the various particles and square of their perpendicular distances
(C) Angular momentum	(3) The root mean square distance of the particles from the axis of rotation
(D) Torque	(4) The product of force and its perpendicular distance

(a) (A)→(2); (B)→(3); C→(1); (D)→(4)
(b) (A)→(1); (B)→(2); C→(4); (D)→(3)
(c) (A)→(2); (B)→(1); C→(4); (D)→(3)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

2. **Column I** / **Column II**

(A) Rolling motion — (1) Torque

(B) Rate of change of angular momentum — (2) Rotatory motion

(C) Hollow cylinder about axis — (3) $I_z + Ma^2$

(D) Theorem of parallel axes — (4) MR^2

(a) (A)→(1); (B)→(3); C→(4); (D)→(2)
(b) (A)→(3); (B)→(2); C→(4); (D)→(1)
(c) (A)→(2); (B)→(1); C→(4); (D)→(3)
(d) (A)→(3); (B)→(1); C→(2); (D)→(4)

3. **Column I** / **Column II**

(A) Translational equilibrium — (1) $\Sigma F = 0$

(B) Moment of inertia of disc — (2) MR^2

(C) Rotational equilibrium — (3) $\frac{1}{2} I\omega^2$

(D) Kinetic energy of rolling body — (4) $\frac{1}{2} mV_c m^2 + \frac{1}{2} I\omega^2$

(5) $\Sigma\tau = 0$

(E) Moment of inertia of ring — (6) $MR^2/2$

(a) (A)→(1); (B)→(6); C→(5); (D)→(4); (E)→(2)
(b) (A)→(4); (B)→(3); C→(2); (D)→(1); (E)→(6)
(c) (A)→(6); (B)→(5); C→(3); (D)→(4); (E)→(2)
(d) (A)→(1); (B)→(2); C→(4); (D)→(5); (E)→(6)

4. Match Column I and Column II.

Column I (*Quantity*) / **Column II** (*Expression*)

(A) Angular momentum — (1) $\vec{r} \times (m\vec{v})$

(B) Impulse — (2) $\frac{1}{2} I\omega^2$

(C) Torque — (3) $\vec{r} \times \vec{F}$

(D) Rotational energy — (4) $m\Delta\vec{v}$

(a) (A)→(4); (B)→(2); C→(1); (D)→(3)
(b) (A)→(1); (B)→(2); C→(4); (D)→(3)
(c) (A)→(2,4); (B)→(1); C→(5); (D)→(3)
(d) (A)→(1); (B)→(4); C→(3); (D)→(2)

5. Match Column I (Body rolling on a surface without slipping) with Column II (Ratio of Translational energy to Rotational energy.

Column I / **Column II**

(A) Circular ring — (1) 1/2

(B) Circular disc — (2) 1

(C) Solid sphere — (3) 3/2

(D) Spherical shell — (4) 2

(5) 5/2

(a) (A)→(4); (B)→(2); C→(1); (D)→(3)
(b) (A)→(1); (B)→(2); C→(4); (D)→(3)
(c) (A)→(2); (B)→(1); C→(5); (D)→(3)
(d) (A)→(2); (B)→(4); C→(5); (D)→(3)

6. A rigid body of mass M and radius R rolls without slipping on an inclined plane of inclination θ, under gravity. Match the type of body Column I with magnitude of the force of friction Column II

Column I	**Column II**
(A) For ring	(1) $\frac{Mg\sin\theta}{2.5}$
(B) For solid sphere	(2) $\frac{Mg\sin\theta}{3}$
(C) For solid cylinder	(3) $\frac{Mg\sin\theta}{3.5}$
(D) For hollow spherical shell	(4) $\frac{Mg\sin\theta}{2}$

(a) (A)→(4); (B)→(3); C→(2); (D)→(1)
(b) (A)→(1); (B)→(2); C→(4); (D)→(3)
(c) (A)→(2); (B)→(1); C→(5); (D)→(3)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

Critical Thinking Type Questions :

1. A tube of length L is filled completely with an incompressible liquid of mass M and closed at both ends. The tube is then rotated in a horizontal plane about one of its ends with uniform angular speed ω. What is the force exerted by the liquid at the other end?

(a) $\frac{ML\omega^2}{2}$
(b) $ML\omega^2$
(c) $\frac{ML\omega^2}{4}$
(d) $\frac{ML\omega^2}{8}$

2. The ratio of the radii of gyration of a circular disc about a tangential axis in the plane of the disc and of a circular ring of the same radius about a tangential axis in the plane of the ring is

(a) $1:\sqrt{2}$
(b) $1:3$
(c) $2:1$
(d) $\sqrt{5}:\sqrt{6}$

3. The moment of inertia of a thin uniform rod of mass M and length L about an axis passing through its midpoint and perpendicular to its length is I_0. Its moment of inertia about an axis passing through one of its ends and perpendicular to its length is

(a) $I_0 + ML^2/2$
(b) $I_0 + ML^2/4$
(c) $I_0 + 2ML^2$
(d) $I_0 + ML^2$

4. Two discs rotating about their respective axis of rotation with angular speeds 2 rads^{-1} and 5 rads^{-1} are brought into contact such that their axes of rotation coincide. Now, the angular speed of the system becomes 4 rads^{-1}. If the moment of inertia of the second disc is 1×10^{-3} kg m^2, then the moment of inertia of the first disc (in kg m^2) is

(a) 0.25×10^{-3}
(b) 1.5×10^{-3}
(c) 1.25×10^{-3}
(d) 0.5×10^{-3}

5. If the angular momentum of a particle of mass m rotating along a circular path of radius r with uniform speed is L, the centripetal force acting on the particle is

(a) $\frac{L^2}{mr^3}$
(b) $\frac{L^2}{mr}$
(c) $\frac{L}{mr}$
(d) $\frac{L^2 m}{r}$

6. A bob of mass m attached to an inextensible string of length l is suspended from a vertical support. The bob rotates in a horizontal circle with an angular speed ω rad/s about the vertical. About the point of suspension:

(a) angular momentum is conserved.
(b) angular momentum changes in magnitude but not in direction.
(c) angular momentum changes in direction but not in magnitude.
(d) angular momentum changes both in direction and magnitude.

7

GRAVITATION

Fill in the Blanks :

1. Force of gravitational attraction is least at _______ .
2. There are _______ gravitational lines of force inside a spherically symmetric shell.
3. If the distance of earth is halved from the sun, then the no. days in a year will be _______ .
4. Time period of a simple pendulum inside a satellite orbiting earth is _______ .
5. The height of a Geo-stationary satellite is _______ km.
6. The escape sspeed of a projectile from the earth is approximately _______ .
7. Escape speed on the moon is _______ than escape speed on the earth.
8. If V_e is escape speed from the earth and V_p is that from a planet of half the radius of earth, then V_e = _______ .

True/ False :

1. For a body taken to the moon inertial mass remains the same
2. Under the influence of central force, position vector sweeps out equal areas in equal intervals of time.
3. The orbital velocity is inversely proportional to the square root of the radius of the orbit.
4. Escape velocity of a particle projected from the surface of the earth depends on the speed with which it is fired.
5. The time period of a satellite does not depend on the radius of the orbit.
6. Kepler's second law or, law of area is based on law of conservation of angular momentum.
7. Planets situated at larger distances from the sun take longer time to complete one rotation.

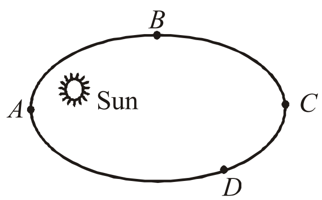
Conceptual MCQs

1. Which of the following is an evidence to show that there must be a force acting on the earth and directed towards the sun?
   (a) Deviation of the falling bodies towards east.
   (b) Revolution of the earth round the sun.
   (c) Phenomenon of day & night.
   (d) Apparent motion of the sun round the earth.
2. A body weighs 72 N on the surface of the earth. What is the gravitational force on it due to earth at a height equal to half the radius of the earth from the surface?
   (a) 32 N (b) 28 N
   (c) 16 N (d) 72 N
3. Kepler's second law is based on :
   (a) Newton's second law of motion
   (b) Newton's law of gravitation
   (c) Special theory of relativity
   (d) Principle of conservation of angular momentum.
4. The orbital speed of Jupiter is :
   (a) greater than the orbital speed of the earth.
   (b) less than the orbital speed of the earth.
   (c) equal to the orbital speed of the earth.
   (d) proportional to distance from the earth.
5. There is no atmosphere on the moon because
   (a) it is closer to the earth and also it has the inactive inert gases in it.
   (b) it is too for from the sun and has very low pressure in its outer surface.
   (c) escape velocity of gas molecules is greater than their root mean square velocity.
   (d) escape velocity of gas molecules is less than their root mean square velocity.

6. Escape velocity of a particle depends upon its mass as :
(a) $v_e \alpha m^2$ (b) $v_e \alpha m$
(c) $v_e \alpha m^0$ (d) $v_e \alpha m^{-1}$

7. A ball is dropped from a spacecraft revolving around the earth at a height of 100 km, then the ball
(a) fall down to the earth gradually
(b) go very far in the space
(c) continue to move with the same speed along the original orbit of the spacecraft.
(d) move with the same speed, tangentially to the spacecraft.

8. The maximum kinetic energy of a planet moving around the sun is at a position :



(a) A (b) B
(c) C (d) D

9. If radius of the earth is reduced, then :
(a) duration of the day reduce.
(b) earth rotates slower
(c) time period of the rotation of earth decreases
(d) duration of the day increases.

10. The value of escape velocity of a certain planet is 2km/s. Then the value of orbital speed for a satellite orbiting closer to its surface is :
(a) 2km/s (b) 1km/s
(c) $\sqrt{2}$km/s (d) $2\sqrt{2}$km/s

11. When a body is taken from poles to equator on the earth, its weight
(a) increases
(b) decreases
(c) remains same
(d) increases at south pole and decreases at north pole.

12. Which of the following does not depend upon the orbital radius of the satellite?
(a) $\frac{T}{R}$ (b) $\frac{T^2}{R}$
(c) $\frac{T^2}{R^2}$ (d) $\frac{T^2}{R^3}$

13. With what minimum velocity a body must be projected from the surface of the earth making an angle 45º with the surface so that it escapes along from the gravitational field of the earth ?
(a) 11.2 kms^{-1} (b) $11.2\sqrt{2}\,kms^{-1}$
(c) $5.6\sqrt{2}\,kms^{-1}$ (d) 22.4 kms^{-1}

14. A man waves his arms while walking. This is to :
(a) keep constant velocity
(b) ease the tension
(c) increase the velocity
(d) balance the effect of earth's gravity

15. A missile is launched with a velocity less than escape velocity. The sum of its kinetic and potential energies is :
(a) Zero
(b) Negative
(c) Positive
(d) May be positive, negative or zero.

16. For a satellite moving in an orbit around the earth, the ratio of kinetic energy to potential energy is
(a) $\frac{1}{2}$ (b) $\frac{1}{\sqrt{2}}$
(c) 2 (d) $\sqrt{2}$

17. A geostationary satellite is orbiting the earth at a height of $5R$ above that surface of the earth, R being the radius of the earth. The time period of another satellite in hours at a height of $2R$ from the surface of the earth is :
(a) 5 (b) 10 (c) $6\sqrt{2}$ (d) $\frac{6}{\sqrt{2}}$

18. The period of revolution of planet A around the Sun is 8 times that of B. The distance of A from the Sun is how many times greater than that of B from the Sun?
(a) 2 (b) 3
(c) 4 (d) 5

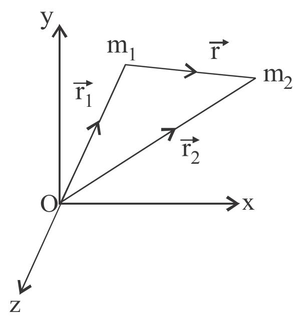
19. Two spheres of masses m and M are situated in air and the gravitational force between them is F. The space around the masses is now filled with a liquid of specific gravity 3. The gravitational force will now be
(a) $\frac{F}{9}$ (b) $3F$
(c) F (d) $\frac{F}{3}$

20. The radius of a planet is twice the radius of earth. Both have almost equal average mass-densities. If V_P and V_E are escape velocities of the planet and the earth, respectively, then

(a) $V_E = 1.5V_P$ (b) $V_P = 1.5V_E$
(c) $V_P = 2V_E$ (d) $V_E = 3V_P$

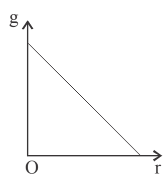
Diagram Based Questions :

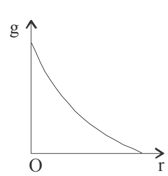
1. In the figure, the direction of gravitational force on m_1 due to m_2 is along

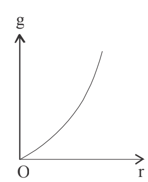


(a) $\vec{r}_1$ (b) $\vec{r}_2$
(c) $\vec{r}$ (d) $-\vec{r}$

2. Which of the following graphs shows the correct variation of acceleration due to gravity with the height above the earth's surface?

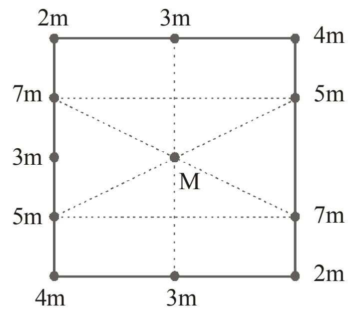
(a) 

(b) 

(c) 

(d) None of these

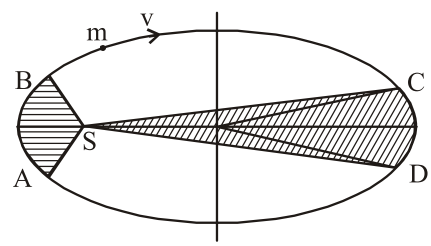
3. A central particle M is surrounded by a square array of other particles, separated by either distance d or distance $d/2$ along the perimeter of the square. The magnitude of the gravitational force on the central particle due to the other particles is



(a) $\frac{9\,GMm}{d^2}$ (b) $\frac{5\,GMm}{d^2}$

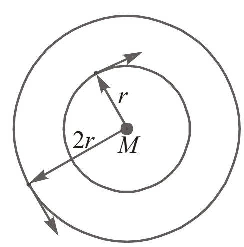
(c) $\frac{3\,GMm}{d^2}$ (d) $\frac{GMm}{d^2}$

4. The figure shows elliptical orbit of a planet m about the sun S. The shaded area SCD is twice the shaded area SAB. If t_1 is the time for the planet to move from C to D and t_2 is the time to move from A to B then



(a) $t_1 = 4t_2$ (b) $t_1 = 2t_2$
(c) $t_1 = t_2$ (d) $t_1 > t_2$

5. Two satellites of masses m and $2m$ are revolving around a planet of mass M with different speeds in orbits of radii r and $2r$ respectively. The ratio of minimum and maximum forces on the planet due to satellites is



(a) $\frac{1}{2}$

(b) $\frac{1}{4}$

(c) $\frac{1}{3}$

(d) None of these

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Gravitational force between two particles is negligibly small compared to the electrical force.
Reason : The electrical force is experienced by charged particles only.

2. **Assertion:** The gain in potential energy of an object of mass m raised to height equal to the radius of earth is $\frac{1}{2}$ mg R
Reason: Kinetic energy at surface = P.E at the top $\frac{1}{2}mv^2$ and at the top $v = \sqrt{gR}$. $\therefore$ PE = $\frac{1}{2}$mgR.

3. **Assertion :** The tidal waves in sea are primarily due to the gravitational effect of earth.
Reason : The intensity of gravitational field of earth is maximum at the surface of earth.

4. **Assertion :** Smaller the orbit of the planet around the sun, shorter is the time it takes to complete one revolution.
Reason : According to Kepler's third law of planetary motion, square of time period is proportional to cube of mean distance from sun.

5. **Assertion :** Gravitational potential of earth at every place on it is negative.
Reason : Every body on earth is bound by the attraction of earth.

6. **Assertion:** The escape velocity on the moon is much higher than that on the earth.
Reason: $V_e = \sqrt{2g / R}$
Thus for lower R, V_e on moon is higher.

7. **Assertion :** Space rocket are usually launched in the equatorial line from west to east
Reason : The acceleration due to gravity is minimum at the equator.

8. **Assertion :** The speed of satellite always remains constant in an orbit.
Reason : The speed of a satellite depends on its path.

9. **Assertion :** A person sitting in an artificial satellite revolving around earth feels weightless.
Reason : There is no gravitational force on the satellite.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column I	Column II
(A) Force between any two bodies	(1) Maximum at the earth's surface
(B) Acceleration due to gravity	(2) Always attractive
(C) Escape velocity	(3) $\sqrt{gR}$
(D) Orbital velocity	(4) $\sqrt{2}.\sqrt{gR}$

(a) (A) → (2) ; (B) → (1) ; (C) → (3) ; (D) → (4)
(b) (A) → (2) ; (B) → (2) ; (C) → (4) ; (D) → (3)
(c) (A) → (4) ; (B) → (3) ; (C) → (2) ; (D) → (1)
(d) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)

2. **Column I** — **Column II**

(A) Gravitational constant — (1) Law of periods

(B) g_h — (2) 24 Hrs

(C) $T^2 \propto R^3$ — (3) 6.67×10^{-11} Nm^2kg^{-2}

(D) Time period of a geostationary satellite — (4) $g_0\left(1-\frac{2h}{R}\right)$

(a) (A)→(2); (B)→(1); (C)→(3); (D)→(4)
(b) (A)→(3); (B)→(4); (C)→(1); (D)→(2)
(c) (A)→(4); (B)→(3); (C)→(2); (D)→(1)
(d) (A)→(3); (B)→(4); (C)→(2); (D)→(1)

3. **Column I** — **Column II**

(A) Weight — (1) Minimum

(B) $g_{equator}$ — (2) Zero

(C) g_{poles} — (3) Vector

(D) g_{centre} — (4) Maximum

(a) (A)→(2); (B)→(1); (C)→(3); (D)→(4)
(b) (A)→(2); (B)→(2); (C)→(4); (D)→(3)
(c) (A)→(3); (B)→(1); (C)→(4); (D)→(2)
(d) (A)→(4); (B)→(3); (C)→(1); (D)→(2)

4. On the surface of earth acceleration due to gravity is g and gravitational potential is V. Match the following:

Column I — **Column -II**

(A) At height $h = R$, value of g — (1) decreases by a factor 1/4

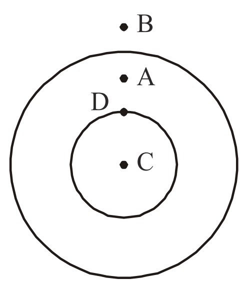
(B) At depth $h = R/2$, value of g — (2) decreases by a factor 1/2

(C) At height $h = R/2$, value of g — (3) decreases by a factor 3/4

(D) At depth $h = R/4$, value of g — (4) decreases by a factor 2/3

(a) (A)→(2); (B)→(1); (C)→(3); (D)→(4)
(b) (A)→(2); (B)→(2); (C)→(4); (D)→(3)
(c) (A)→(4); (B)→(3); (C)→(2); (D)→(1)
(d) (A)→(4); (B)→(3); (C)→(1); (D)→(2)

5. Two concentric spherical shells are as shown in figure. Match the following:



Column I — **Column II**

(A) Potential at A — (1) greater than B

(B) Gravitational field at A — (2) less than B

(C) As one moves from C to D — (3) potential remains constant

(D) As one moves from D to A — (4) gravitational field decreases

(5) None

(a) (A)→(2); (B)→(5); (C)→(3); (D)→(4)
(b) (A)→(3); (B)→(2); (C)→(1); (D)→(4)
(c) (A)→(4); (B)→(3); (C)→(2); (D)→(1)
(d) (A)→(5); (B)→(3); (C)→(1); (D)→(2)

6. | Column I | Column II |
|---|---|
| (A) Potential energy of satellite | (1) Positive |
| (B) Total energy of satellite | (2) Negative |
| (C) kinetic energy of satellite | (3) Zero |
| (D) Gravitational potential energy of satellite at infinity | (4) Infinite |

(a) (A)→(4); (B)→(2); C→(1); (D)→(3)
(b) (A)→(3); (B)→(1); C→(4); (D)→(2)
(c) (A)→(2); (B)→(2); C→(1); (D)→(3)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

Critical Thinking Type Questions :

1. A geostationary satellite is orbiting the earth at a height of $5R$ above that surface of the earth, R being the radius of the earth. The time period of another satellite in hours at a height of $2R$ from the surface of the earth is
(a) 5
(b) 10
(c) $6\sqrt{2}$
(d) $\frac{6}{\sqrt{2}}$

2. The height at which the acceleration due to gravity becomes $\frac{g}{9}$ (where g = the acceleration due to gravity on the surface of the earth) in terms of R, the radius of the earth, is
(a) $\frac{R}{\sqrt{2}}$
(b) $R/2$
(c) $\sqrt{2}R$
(d) $2R$

3. The gravitational potential at the centre of a square of side 'a' and four equal masses (m each) placed at the corners of a square is
(a) Zero
(b) $4\sqrt{2}\frac{Gm}{a}$
(c) $-4\sqrt{2}\frac{Gm}{a}$
(d) $-4\sqrt{2}\frac{Gm^2}{a}$

4. If a person goes to height equal to the radius of the earth, from its surface, then his weight (w′) relative to the weight on earth (w) will be
(a) $W' = \frac{W}{4}$
(b) $W' = 2W$
(c) $W' = \frac{W}{2}$
(d) $W' = W$

5. A particle of mass M is situated at the centre of a spherical shell of same mass and radius a. The gravitational potential at a point situated at $\frac{a}{2}$ distance from the centre, will be
(a) $-\frac{3GM}{a}$
(b) $-\frac{2GM}{a}$
(c) $-\frac{GM}{a}$
(d) $-\frac{4GM}{a}$

6. A particle of mass m is thrown upwards from the surface of the earth, with a velocity u. The mass and the radius of the earth are, respectively, M and R. G is gravitational constant and g is acceleration due to gravity on the surface of the earth. The minimum value of u so that the particle does not return back to earth, is
(a) $\sqrt{\frac{2GM}{R}}$
(b) $\sqrt{\frac{2GM}{R^2}}$
(c) $\sqrt{2gR^2}$
(d) $\sqrt{\frac{2GM}{R^2}}$

7. The radii of circular orbits of two satellites A and B of the earth, are 4R and R, respectively. If the speed of satellite A is 3 V, then the speed of satellite B will be
(a) 3 V/4
(b) 6V
(c) 12 V
(d) 3 V/2

8. What is the minimum energy required to launch a satellite of mass m from the surface of a planet of mass M and radius R in a circular orbit at an altitude of 2R?
(a) $\frac{5GmM}{6R}$
(b) $\frac{2GmM}{3R}$
(c) $\frac{GmM}{2R}$
(d) $\frac{GmM}{2R}$

8 Mechanical Properties of Solids

Fill in the Blanks :

1. The restoring force per unit area is known as _______ .
2. Shearing stress change _______ of the body.
3. If the load is increased beyond the _______ point, the strain increases rapidly for even a small change in the stress.
4. The ratio of stress and strain is called _______ .
5. The ratio of tensile stress to the longitudinal strain is defined as _______ .
6. The only elastic modulus that applies to fluids is ______ .
7. The reciprocal of the bulk modulus is called ______ .
8. Modulus of rigidity of a liquid is _______ .
9. According to Hooke's law of elasticity, if stress is increased, then the ratio of stress to strain _______ .

True/ False :

1. Elastic fatigue is the property by virtue of which behavior becomes less elastic under the action of repeated alternating deforming forces.
2. Plasticity is the property due to which the regain in original shape of a body is delayed after the removal of deforming forces.
3. Modulus of elasticity is more for steel than that of copper.
4. Rubber is more elastic than steel.
5. Bulk modulus is relevant for solids, liquids and gases.
6. The Young's modulus and shear modulus are relevant for fluids.
7. Hollow shaft is much stronger than a solid rod of same length and same mass.
8. It is difficult to twist a long rod as compared to small rod.

Conceptual MCQs

1. A steel wire is stretched to double its length, then its Young's modulus :
   (a) becomes half
   (b) becomes double
   (c) remains same
   (d) becomes one-fourth.
2. Modulus of rigidity of liquids is :
   (a) zero (b) unity
   (c) infinity (d) non-zero but finite.
3. Gases possess
   (a) Young's modulus (b) Bulk modulus
   (c) Shear modulus (d) All of these
4. If the tension in a wire is doubled, the elastic potential energy stored in the wire will :
   (a) become twice (b) become half
   (c) remains same (d) become four times
5. Elastomers are the materials which :
   (a) are not elastic at all
   (b) have very small elastic range.
   (c) do not obey Hooke's law
   (d) none of these
6. Shear modulus of a perfectly rigid body is :
   (a) zero (b) unity
   (c) infinity (d) non-zero but unity

7. Consider four steel wires of dimensions given below (d = diameter and l = length):

(A) $l = 1\text{m}, d = 1\text{mm}$ (B) $l = 2\text{m}, d = 2\text{ mm}$

(C) $l = 2\text{m}, d = 1\text{mm}$ (D) $l = 1\text{m}, d = 2\text{ mm}$

If same force is applied to all the wires then the elastic potential energy stored will be maximum in wire:

(a) A (b) B
(c) C (d) D

8. Which of the following is responsible for change in shape?

(a) Tensile stress (b) Compressive stress
(c) Tangential stress (d) All of these

9. Poisson's ratio is the ratio of :

(a) longitudinal strain to lateral strain
(b) lateral strain to longitudinal strain
(c) longitudinal strain to volumetric strain
(d) volumetric strain to longitudinal strain

10. Steel is :

(a) perfectly elastic
(b) perfectly plastic
(c) partially plastic and partially elastic
(d) depends on applied force

11. Which of the following affects the elasticity of a substance?

(a) Hammering and annealing
(b) Change in temperature
(c) Impurity
(d) All of these

12. Which of the following materials is most elastic?

(a) Rubber (b) Lead
(c) Wood (d) Steel

13. If large deformation takes place between the elastic limit and fracture point then the material is

(a) ductile (b) elastomer
(c) brittle (d) none of these

14. The SI unit of shear stress is

(a) $\frac{\text{N}}{\text{m}^2}$ (b) $\frac{\text{N}}{\text{cm}^2}$

(c) $\frac{dyne}{\text{m}^2}$ (d) $\frac{dyne}{\text{cm}^2}$

15. Two wires A and B are of the same material. Their lengths are in the ratio 1 : 2 and the diameter are in the ratio 2 : 1. If they are pulled by the same force, then increase in length will be in the ratio

(a) 2 : 1 (b) 1 : 4
(c) 1 : 8 (d) 8 : 1

16. When an elastic material with Young's modulus Y is subjected to stretching stress S, elastic energy stored per unit volume of the material is

(a) $YS/2$ (b) $S^2Y/2$
(c) $S^2/2Y$ (d) $S/2Y$

17. The compressibility of water is 4×10^{-5} per unit atmospheric pressure. The decrease in volume of 100 cm^3 of water under a pressure of 100 atmosphere will be

(a) 0.4 cm^3 (b) $4 \times 10^{-5}\text{ cm}^3$
(c) 0.025 cm^3 (d) 0.004 cm^3

18. According to Hook's law of elasticity if stress is increased then within the elastic limits, the ratio of stress to strain

(a) remains contant (b) becomes zero
(c) decrease (d) increases

19. According to Hooke's low, force is proportional to

(a) $\frac{1}{x}$ (b) $\frac{1}{x^2}$

(c) x (d) x^2

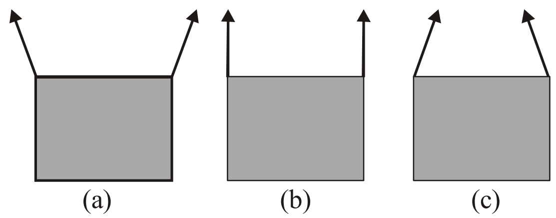
20. Uniform rod of mass m, length l, area of cross-section A has Young's modulus Y. If it is hanged vertically, elongation under its own weight will be

(a) $\frac{mgl}{2AY}$ (b) $\frac{2mgl}{AY}$

(c) $\frac{mgl}{AY}$ (d) $\frac{mgY}{Al}$

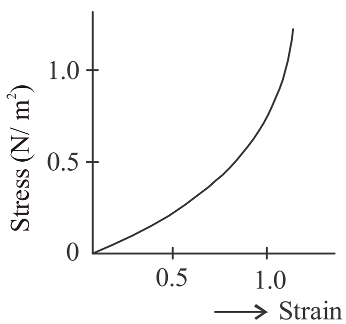
Diagram Based Questions :

1. A rectangular frame is to be suspended symmetrically by two strings of equal length on two supports . It can be done in one of the following three ways



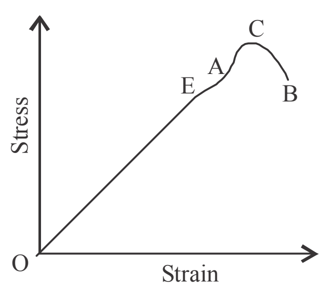
The tension in the strings will be
(a) the same in all cases
(b) least in (a)
(c) least in (b)
(d) least in (c)

2. The graph given is a stress-strain curve for



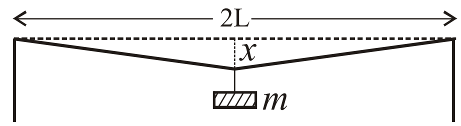
(a) elastic objects (b) plastics
(c) elastomers (d) None of these

3. For the given graph, Hooke's law is obeyed in the region



(a) OA (b) C
(c) OE (d) OB

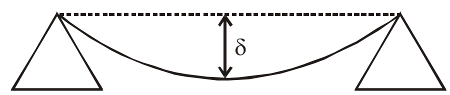
4. A mild steel wire of length 2L and cross-sectional area A is stretched, well within elastic limit, horizontally between two pillars. A mass m is suspended from the mid point of the wire. Strain in the wire is



(a) $\frac{x^2}{2L}$ (b) $\frac{x}{L}$

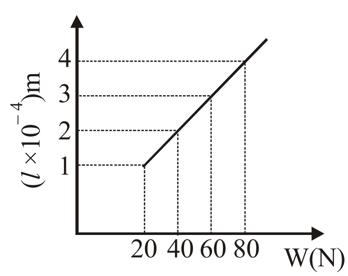
(c) $\frac{x^2}{L}$ (d) $\frac{x^2}{2L}$

5. A beam of metal supported at the two edges is loaded at the centre. The depression at the centre is proportional to



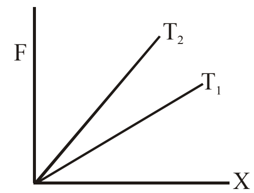
(a) Y^2 (b) Y
(c) 1/Y (d) $1/Y^2$

6. The adjacent graph shows the extension (Δl) of a wire of length 1m suspended from the top of a roof at one end with a load W connected to the other end. if the corss-sectional area of the wire is $10^{-6}m^2$, calculate the Young's modulus of the material of the wire



(a) 2×10^{11} N/m² (b) 2×10^{-11} N/m²
(c) 2×10^{-12} N/m² (d) 2×10^{-13} N/m²

7. The diagram below shows the change in the length X of a thin uniform wire caused by the application of stress F at two different temperatures T_1 and T_2. The variation shown suggests that



(a) $T_1 > T_2$ (b) $T_1 < T_2$
(c) $T_2 > T_1$ (d) $T_1 \geq T_2$

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion:** Solids are least compressible and gases are most compressible.
Reason: solids have definite shape and volume but gases do not have either definite shape or definite volume.

2. **Assertion:** Rubber is more elastic than lead
Reason: If same load is attached to lead and rubber, then the strain produced is much less in rubber than in lead.

3. **Assertion:** Hollow shaft is found to be stronger than a solid shaft made of same equal material.
Reason: Torque required to produce a given twist in hollow cylinder is greater than that required to twist a solid cylinder of same length and material.

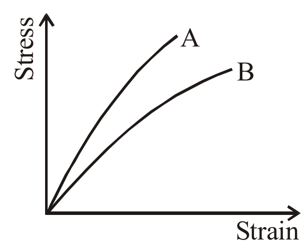
4. **Assertion :** Stress is the internal force per unit area of a body.
Reason : Rubber is less elastic than steel.

5. **Assertion :** Young's modulus for a perfectly plastic body is zero.
Reason : For a perfectly plastic body, restoring force is zero.

6. **Assertion :** Identical springs of steel and copper are equally stretched. More work will be done on the steel spring
Reason : Steel is more elastic than copper.

7. **Assertion:** Girders are given I shape.
Reason: To bear more pressure, depth is increased as per $P = h\rho g$

8. **Assertion :** The stress-strain graphs are shown in the figure for two materials A and B are shown in figure. Young's modulus of A is greater than that of B.



Reason : The Young's modules for small strain is,

$$Y = \frac{\text{stress}}{\text{strain}} = \text{slope of linear portion, of graph;}$$

and slope of A is more than slope that of B.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column I	**Column II**
(A) Mud	(1) Elastic
(B) Steel	(2) Elastomer
(C) Rubber	(3) Plastic
(D) Copper	(4) Compressible

(a) (A)→(2), (B)→(3), (C)→(4), (D)→(1)
(b) (A)→(3), (B)→(1), (C)→(2), (D)→(1)
(c) (A)→(1), (B)→(2), (C)→(3), (D)→(4)
(d) (A)→(2), (B)→ (1), (C)→(3), (D)→(4)

2.

Column I	**Column II**
(A) Young's modulus of elasticity	(1) Rubber
(B) Hooke's law	(2) Solids
(C) Hydraulic stress	(3) Sraight line
(D) Elastomers	(4) Solids, liquids & gases

(a) (A)→(2), (B)→(3), (C)→(4), (D)→(1)
(b) (A)→(4), (B)→(2), (C)→(3), (D)→(1)
(c) (A)→(1), (B)→(2), (C)→(3), (D)→(4)
(d) (A)→(2), (B)→ (1), (C)→(3), (D)→(4)

3.

Column -I	**Column-II**
(A) Equal force acting perpendicular to each point on a spherical surface	(1) Balance the net weight to be supported
(B) Cross-sectional area of the rope used in giant structures	(2) Higher modulus of elasticity
(C) Steel in structural designs	(3) Reduction in volume without change in shape
(D) Stress-strain curve	(4) Inversely depends on the yield strength

(a) (A) → (4); (B) → (1, 3); (C) → (2) ; (D) → (1)
(b) (A) → (3); (B) → (1, 2); (C) → (4) ; (D) → (3, 4)
(c) (A) → (2); (B) → (1) ; (C) → (4) ; (D) → (3)
(d) (A) → (3); B → (1, 4) ; (C) → (2) ; (D) → (2)

4. A copper wire ($Y = 10^{11}$ N/m^2) of length 8 m and steel wire ($Y = 2 \times 10^{11}$ N/m^2) of length 4 m each of 0.5 cm^2 cross-section are fastened end to end and stretched with a tension of 500 N.

Column-I	**Column-II**
(A) Elongation in copper wire in mm	(1) 0.25
(B) Elongation in steel wire in mm	(2) 1.0
(C) Total elongation in mm	(3) 0.8
(D) Elastic potential energy of the system in joules	(4) $\frac{1}{4}$ th the elongation in copper wire

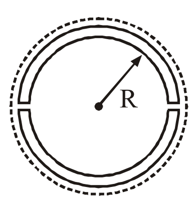
(a) (A)→(3), (B)→(4), (C)→(2), (D)→(1)
(b) (A)→(4), (B)→(2), (C)→(3), (D)→(1)
(c) (A)→(1), (B)→(2), (C)→(3), (D)→(4)
(d) (A)→(2), (B)→ (1), (C)→(3), (D)→(4)

Critical Thinking Type Questions :

1. An iron bar of length ℓ cm and cross section A cm^2 is pulled by a force of F dynes from ends so as to produce an elongation $\Delta\ell$ cm. Which of the following statement is correct ?
(a) Elongation is inversely proportional to length
(b) Elongation is directly proportional to cross section A
(c) Elongation is inversely proportional to cross-section
(d) Elongation is directly proportional to Young's modulus

2. A steel wire of length 'L' at 40°C is suspended from the ceiling and then a mass 'm' is hung from its free end. The wire is cooled down from 40°C to 30°C to regain its original length 'L'. The coefficient of linear thermal expansion of the steel is 10^{-5}/° C, Young's modulus of steel is 10^{11} N/m^2 and radius of the wire is 1 mm. Assume that L diameter of the wire. Then the value of 'm' in kg is nearly
(a) 1 (b) 2
(c) 3 (d) 5

3. A wooden wheel of radius R is made of two semicircular parts (see figure). The two parts are held together by a ring made of a metal strip of cross-sectional area S and length L. L is slightly less than $2\pi R$. To fit the ring on the wheel, it is heated so that its temperature rises by ΔT and it just steps over the wheel. As it cools down to surrounding temperature, it presses the semicircular parts together. If the coefficient of linear expansion of the metal is α and its Young's modulus is Y, the force that one part of the wheel applies on the other part is



(a) $2\pi SY\alpha\Delta T$ (b) $SY\alpha\Delta T$
(c) $\pi SY\alpha\Delta T$ (d) $2SY\alpha\Delta T$

4. A steel wire is suspended vertically from a rigid support. When loaded with a weight in air, it extends by ℓ_a and when the weight is immersed completely in water, the extension is reduced to ℓ_w. Then the relative density of material of the weight is
(a) ℓ_a / ℓ_w (b) $\dfrac{\ell_a}{\ell_a - \ell_w}$
(c) $\ell_w /(\ell_a - \ell_w)$ (d) ℓ_w / ℓ_a

5. A rubber cord catapult has cross-sectional area 25 mm^2 and initial length of rubber cord is 10 cm. It is stretched to 5 cm and then released to project a missile of mass 5 gm. Taking $Y_{rubber} = 5 \times 10^8$ N/m^2. Velocity of projected missile is
(a) 20 ms^{-1} (b) 100 ms^{-1}
(c) 250 ms^{-1} (d) 200 ms^{-1}

6. The length of a metal is ℓ_1 when the tension in it is T_1 and is ℓ_2 when the tension is T_2. The original length of the wire is
(a) $\dfrac{\ell_1 + \ell_2}{2}$ (b) $\dfrac{\ell_1 T_2 + \ell_2 T_1}{T_1 + T_2}$
(c) $\dfrac{\ell_1 T_2 - \ell_2 T_1}{T_2 - T_1}$ (d) $\sqrt{T_1 T_2 \ell_1 \ell_2}$

7. A thick rope of density ρ and length L is hung from a rigid support. The Young's modulus of the material of rope is Y. The increase in length of the rope due to its own weight is
(a) $(1/4)\rho g L^2/Y$ (b) $(1/2)\rho g L^2/Y$
(c) $\rho g L^2/Y$ (d) $\rho g L/Y$

8. If a rubber ball is taken at the depth of 200 m in a pool, its volume decreases by 0.1%. If the density of the water is 1×10^3 kg/m^3 and g = 10m/s^2, then the volume elasticity in N/m^2 will be
(a) 10^8 (b) 2×10^8
(c) 10^9 (d) 2×10^9

9 Mechanical Properties of Fluids

Fill in the Blanks :

1. _________ and _________ play the same role in case of fluids as force and mass play in case of solids.
2. Hydraulic lifts and hydraulic brakes are based on ______ .
3. Specific gravity of a body is also known as ______ .
4. Pressure in a fluid at rest is same at all points which are at the same height. This is known as _______ .
5. A pressure equivalent to 1 mm of Hg is called _______ .
6. The device which measures the flow speed of incompressible fluid is _______ .
7. After terminal velocity is reached, the acceleration of a body falling through a fluid is _______ .
8. Kerosene oil rises up in a wick of a lantern because of _______ .

True/ False :

1. A cricketer, while spinning a ball makes it to experience magnus effect.
2. Viscosity of gases decreases with increase in temperature
3. Viscosity of liquids (except water) decreases with increase in pressure
4. The antiseptics have very low value of surface tension.
5. The value of surface tension of liquid is independent of the temperature
6. A large soap bubble shrinks while a small soap bubble expands when they are connected to each other by a capillary tube, in order to gain equilibrium.
7. A hydrogen filled balloon stops rising after it has attained a certain height.

Conceptual MCQs

1. Consider an iceberg floating in sea water. The density of sea water is 1.03 g/cc and that of ice is 0.92 g/cc. The fraction of total volume of iceberg above the level of sea water is near by
   (a) 1.8% (b) 3%
   (c) 8% (d) 11%
2. The constant velocity attained by a body while falling through a viscous medium is termed as :
   (a) critical velocity (b) terminal velocity
   (c) threshold velocity (d) none of these
3. When a train crosses a platform with high velocity, passenger on the platform tend to fall towards the train. This phenomenon can be explained on the basis of :
   (a) Stoke's law
   (b) Archimede's principle
   (c) Bernoulli's theorem
   (d) Pascal's law
4. The difference in between viscosity and solid friction is/are :
   (a) viscosity depends on area while solid friction does not.
   (b) viscosity depends on nature of material but solid friction does not.
   (c) both (a) and (b)
   (d) neither (a) nor (b)
5. Water is not used in thermometer because.
   (a) it sticks to glass
   (b) its shows anomalous expansion
   (c) both (a) and (b)
   (d) neither (a) nor (b)
6. Angle of contact depends on
   (a) temperature
   (b) presence of impurities
   (c) nature of liquid and the container
   (d) all of these

7. If the terminal speed of a sphere of gold (density = 19.5 kg/m^3) is 0.2 m/s in a viscous liquid (density = 1.5 kg/m^3), find the terminal speed of a sphere of silver (density = 10.5 kg/m^3) of the same size in the same liquid
(a) 0.4 m/s (b) 0.133 m/s
(c) 0.1 m/s (d) 0.2 m/s

8. The wetability of a surface by a liquid depends primarily on
(a) surface tension
(b) density
(c) angle of contact between the surface and the liquid
(d) viscosity

9. If r is the radius of influence of molecules of a certain liquid, then thickness of its surface film is
(a) r (b) $\frac{r}{2}$
(c) $2r$ (d) none of these

10. A certain number of spherical drops of a liquid of radius 'r' coalesce to form a single drop of radius 'R' and volume 'V'. If 'T' is the surface tension of the liquid, then :
(a) energy $= 4VT\left(\frac{1}{r}-\frac{1}{R}\right)$ is released
(b) energy $= 3VT\left(\frac{1}{r}+\frac{1}{R}\right)$ is absorbed
(c) energy $= 3VT\left(\frac{1}{r}-\frac{1}{R}\right)$ is released
(d) energy is neither released nor absorbed

11. Toricelli's theorem is used to find :
(a) the velocity of efflux through an orifice.
(b) the velocity of flow of liquid through a pipe.
(c) terminal velocity
(d) critical velocity.

12. A pin of density greater than that of water can float on the surface of water. It is due to :
(a) viscosity (b) buoyancy
(c) surface tension (d) none of these

13. With increase in temperature, the viscosity of gases :
(a) increases
(b) decrease
(c) remains same
(d) depends on the nature of the gas.

14. In rising from the bottom of a lake, to the top, the temperature of an air bubble remains unchanged, but its diameter gets doubled. If h is the barometric height (expressed in m of mercury of relative density ρ) at the surface of the lake, the depth of the lake is
(a) $8\rho h$ m (b) $7\rho h$ m
(c) $9\rho h$ m (d) $12\rho h$ m

15. Hydraulic lift is based on the principle of
(a) Pascal's law
(b) Bernoulli's theorem
(c) Toricelli's theorem
(d) Stoke's law

16. Paint-gun is based on :
(a) Bernoullis theorem
(b) Archimede's principle
(c) Boyle's law
(d) Pascal's law

17. Water is flowing through a horizontal pipe having a restriction, then
(a) Pressure will be greater at the restriction.
(b) Pressure will be greater in the wider portion.
(c) Pressure will be same throughout the length of the pipe
(d) none of the above

18. The angle of contact between pure water and pure glass, is
(a) 0^o (b) 45^o
(c) 90^o (d) 135^o

19. When a liquid rises in a capillary tube, the gain in P.E. of the liquid is :
(a) less than the work done by force of surface tension
(b) greater than the work done by force of surface tension
(c) equal to the work done by force of surface tension.
(d) may be less than or equal to the force of surface tension.

20. Fevicol is added to paint to be painted on the walls, because.
(a) it increases adhesive force between paint & wall.
(b) it decreases adhesive force between paint & wall molecules.
(c) it decreases cohesive force between paint molecules
(d) none of the above

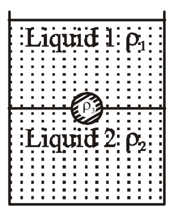
21. The terminal velocity v_T of a small steel ball of radius r falling under gravity through a column of a viscous liquid of coefficient of viscosity η depends on mass of the ball m, acceleration due to gravity g, coefficient of viscosity η and radius r. Which of the following relations is dimensionally correct ?

(a) $v_T \propto \frac{mgr}{\eta}$ (b) $v_T \propto mg\eta r$

(c) $v_T \propto \frac{mg}{r\eta}$ (d) $v_T \propto \frac{\eta mg}{r}$

Diagram Based Questions :

1. A jar is filled with two non-mixing liquids 1 and 2 having densities ρ_1 and, ρ_2 respectively. A solid ball, made of a material of density ρ_3, is dropped in the jar. It comes to equilibrium in the position shown in the figure. Which of the following is true for ρ_1, ρ_1 and ρ_3?



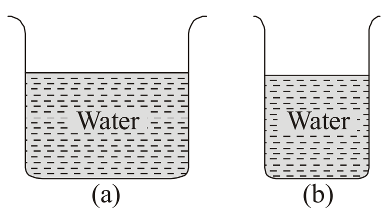
(a) $\rho_3 < \rho_1 < \rho_2$

(b) $\rho_1 > \rho_3 > \rho_2$

(c) $\rho_1 < \rho_2 < \rho_3$

(d) $\rho_1 < \rho_3 < \rho_2$

2. From the figure, the correct observation is



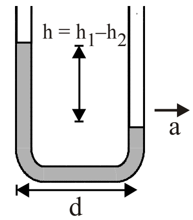
(a) the pressure on the bottom of tank (a) is greater than at the bottom of (b)

(b) the pressure on the botttom of the tank (a) is smaller than at the bottom (b)

(c) the pressure depend on the shape of the container

(d) the pressure on the bottom of (a) and (b) is the same.

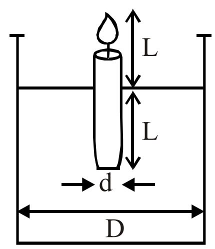
3. Figure shows a U-tube of uniform cross-sectional area A, accelerated with acceleration a as shown. If d is the separation between the limbs, then what is the difference in the levels of the liquid in the U-tube is



(a) $\frac{ad}{g}$ (b) $\frac{ag}{d}$

(c) $\frac{a}{d}$ (d) $\frac{dg}{a}$

4. A candle of diameter d is floating on a liquid in a cylindrical container of diameter D (D >> d) as shown in figure. If it is burning at the rate of 2 cm/hour then the top of the candle will



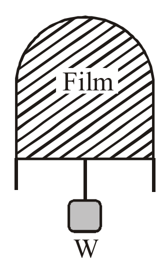
(a) remain at the same height

(b) fall at the rate of 1 cm/hour

(c) fall at the rate of 2 cm/hour

(d) go up at the rate of 1 cm/hour

5. A thin liquid film formed between a U-shaped wire and a light slider supports a weight of 1.5×10^{-2} N (see figure). The length of the slider is 30 cm and its weight negligible. The surface tension of the liquid film is



(a) $0.0125\ Nm^{-1}$ (b) $0.1\ Nm^{-1}$

(c) $0.05\ Nm^{-1}$ (d) $0.025\ Nm^{-1}$

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion:** Mercury is preferred as a barometric substance over water.
Reason: Mercury is opaque and shiny so it is easier to note the observation.

2. **Assertion:** A small iron needle sinks in water while a large iron ship floats.
Reason: The shape of iron needle is like a flat surface while the shape of a ship is that which makes it easier to float.

3. **Assertion :** Pascal's law is the working principle of a hydraulic lift.
Reason : Pressure is equal to the thrust per unit area.

4. **Assertion :** Imagine holding two identical bricks under water. Brick A is completely submerged just below the surface of water, while Brick B is at a greater depth. The magnitude of force exerted by the person (on the brick) to hold brick B in place is the same as magnitude of force exerted by the person (on the brick) to hold brick A in place.
Reason : The magnitude of buoyant force on a brick completely submerged in water is equal to magnitude of weight of water it displaces and does not depend on depth of brick in water.

5. **Assertion :** The blood pressure in humans is greater at the feet than at the brain
Reason : Pressure of liquid at any point is proportional to height, density of liquid and acceleration due to gravity

6. **Assertion :** Hydrostatic pressure is a vector quantity.
Reason : Pressure is force divided by area, and force is vector quantity.

7. **Assertion :** A bubble comes from the bottom of a lake to the top.
Reason : Its radius increases.

8. **Assertion :** When height of a tube is less than liquid rise in the capillary tube, the liquid does not overflow
Reason : Product of radius of meniscus and height of liquid in capillary tube always remains constant.

9. **Assertion:** Surface tension of all lubricating oils and paints is kept high.
Reason: Due to high value of surface tension the fluids don't get damaged.

10. **Assertion :** It is better to wash the clothes in cold soap solution.
Reason : The surface tension of cold solution is more than the surface tension of hot solution.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match column I and column II.

Column I	Column II
(A) Barometer	(1) Law of conservation of energy
(B) Hydrometer	(2) To measure density
(C) Bernoulli's Principle	(3) To measure atmospheric pressure
(D) Archimedes' Principle	(4) upthrust

(a) (A) $\rightarrow$ (3) ; (B) $\rightarrow$ (2) ; (C) $\rightarrow$ (1) ; (D) $\rightarrow$ (4)
(b) (A) $\rightarrow$ (1) ; (B) $\rightarrow$ (2) ; (C) $\rightarrow$ (3) ; (D) $\rightarrow$ (4)
(c) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (1) ; (C) $\rightarrow$ (4) ; (D) $\rightarrow$ (3)
(d) (A) $\rightarrow$ (3) ; (B) $\rightarrow$ (4) ; (C) $\rightarrow$ (2) ; (D) $\rightarrow$ (1)

2.

	Column I		Column II
(A)	Terminal velocity	(1)	Average density becomes less than that of liquid
(B)	Objects of high density can also float	(2)	Upthrust is zero
(C)	A beaker having a solid iron under free fall	(3)	Varies with velocity
(D)	Viscous drag	(4)	Upthrust and viscous force

(a) (A) $\to$ (4) ; (B) $\to$ (2) ; (C) $\to$ (3) ; (D) $\to$ (1)
(b) (A) $\to$ (1) ; (B) $\to$ (2) ; (C) $\to$ (3) ; (D) $\to$ (4)
(c) (A) $\to$ (4) ; (B) $\to$ (1) ; (C) $\to$ (2) ; (D) $\to$ (3)
(d) (A) $\to$ (3) ; (B) $\to$ (4) ; (C) $\to$ (2) ; (D) $\to$ (1)

3.

	Column I		Column II
(A)	Bernoullis theorem	(1)	Narrower pipes have less pressure
(B)	Ball moving with spin	(2)	Paint gun
(C)	Artificial high pressure	(3)	Non-viscous fluids
(D)	Streamline flow	(4)	Conservation of energy
		(5)	Uplift due to pressure difference

(a) (A) $\to$ (3,4) ; (B) $\to$ (5) ; (C) $\to$ (2) ; (D) $\to$ (1,3)
(b) (A) $\to$ (1) ; (B) $\to$ (2) ; (C) $\to$ (3) ; (D) $\to$ (4)
(c) (A) $\to$ (2) ; (B) $\to$ (5) ; (C) $\to$ (4) ; (D) $\to$ (3)
(d) (A) $\to$ (3) ; (B) $\to$ (5) ; (C) $\to$ (2) ; (D) $\to$ (1)

4.

	Column I		Column II
(A)	Magnus effect	(1)	Pascal's law
(B)	Loss of energy	(2)	Archimede's principle
(C)	Pressure is same at the same level in a liquid	(3)	Viscous force
(D)	Hydraulic machines	(4)	Lifting of Asbestos roofs

(a) (A) $\to$ (4) ; (B) $\to$ (2) ; (C) $\to$ (5) ; (D) $\to$ (1)
(b) (A) $\to$ (1) ; (B) $\to$ (2) ; (C) $\to$ (3) ; (D) $\to$ (4)
(c) (A) $\to$ (2) ; (B) $\to$ (5) ; (C) $\to$ (4) ; (D) $\to$ (3)
(d) (A) $\to$ (4) ; (B) $\to$ (3) ; (C) $\to$ (1) ; (D) $\to$ (2)

5.

	Column I		Column II
(A)	Water proofing agents	(1)	Increase in terminal velocity
(B)	Sphygmomanometer	(2)	Gauge pressure
(C)	More than gauge pressure	(3)	Actual pressure
(D)	Mixing of drops of smaller dimension	(4)	Increase the angle of contact

(a) (A) $\to$ (4) ; (B) $\to$ (2) ; (C) $\to$ (5) ; (D) $\to$ (1)
(b) (A) $\to$ (1) ; (B) $\to$ (2) ; (C) $\to$ (3) ; (D) $\to$ (4)
(c) (A) $\to$ (4) ; (B) $\to$ (2) ; (C) $\to$ (3) ; (D) $\to$ (1)
(d) (A) $\to$ (3) ; (B) $\to$ (5) ; (C) $\to$ (2) ; (D) $\to$ (1)

6.

	Column I		Column II
(A)	Capillaries of smaller radii	(1)	Flat meniscus
(B)	$F_c > \sqrt{2}F_a$ where F_c and F_a are cohesive and adhesive force	(2)	Greater height difference
(C)	Angle of contact is zero	(3)	Drop in level
(D)	Lower angle of contact	(4)	Welding agents

(a) (A) $\to$ (4) ; (B) $\to$ (2) ; (C) $\to$ (3) ; (D) $\to$ (1)
(b) (A) $\to$ (3) ; (B) $\to$ (4) ; (C) $\to$ (1) ; (D) $\to$ (2,3)
(c) (A) $\to$ (2) ; (B) $\to$ (1) ; (C) $\to$ (4) ; (D) $\to$ (3)
(d) (A) $\to$ (3) ; (B) $\to$ (4) ; (C) $\to$ (2) ; (D) $\to$ (1)

7. Match the column I and column II

Column I	Column II
(A) Floating bodies	(1) Torricelli's law
(B) Capillarity	(2) Bernoulli's principle
(C) Energy conservation	(3) Archimedes principle
(D) Speed of efflux	(4) Pascal's law

(a) (A) $\rightarrow$ (4) ; (B) $\rightarrow$ (2) ; (C) $\rightarrow$ (3) ; (D) $\rightarrow$ (1)
(b) (A) $\rightarrow$ (3) ; (B) $\rightarrow$ (4) ; (C) $\rightarrow$ (2) ; (D) $\rightarrow$ (1)
(c) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (1) ; (C) $\rightarrow$ (4) ; (D) $\rightarrow$ (3)
(d) (A) $\rightarrow$ (3) ; (B) $\rightarrow$ (4) ; (C) $\rightarrow$ (2) ; (D) $\rightarrow$ (1)

Critical Thinking Type Questions :

1. A block of ice floats on a liquid of density 1.2 in a beaker then level of liquid when ice completely melt
(a) remains same (b) rises
(c) lowers (d) either (b) or (c)

2. A spherical solid ball of volume V is made of a material of density ρ_1. It is falling through a liquid of density ρ_2 ($\rho_2 < \rho_1$). Assume that the liquid applies a viscous force on the ball that is proportional to the square of its speed v, i.e., $F_{viscous} = -kv^2$ ($k > 0$). The terminal speed of the ball is
(a) $\sqrt{\dfrac{Vg(\rho_1 - \rho_2)}{k}}$ (b) $\dfrac{Vg\rho_1}{k}$
(c) $\sqrt{\dfrac{Vg\rho_1}{k}}$ (d) $\dfrac{Vg(\rho_1 - \rho_2)}{k}$

3. When a ball is released from rest in a very long column of viscous liquid, its downward acceleration is 'a' (just after release). Its acceleration when it has acquired two third of the maximum velocity is a/X. Find the value of X.
(a) 2 (b) 3
(c) 4 (d) 5

4. An air bubble of radius 1 cm rises with terminal velocity 0.21 cm/s in liquid column. If the density of liquid is 1.47×10^3 kg/m^3. Then the value of coefficient of viscosity of liquid ignoring the density of air, will be
(a) 1.71×10^4 poise (b) 1.82×10^4 poise
(c) 1.78×10^4 poise (d) 1.52×10^4 poise

5. A solid ball of volume V experiences a viscous force F when falling with a speed v in a liquid. If another ball of volume 8 V with the same velocity v is allowed to fall in the same liquid, it experiences a force
(a) F (b) 16 F
(c) 4 F (d) 2 F

6. In a capillary tube, water rises to 3 mm. The height of water that will rise in another capillary tube having one-third radius of the first is
(a) 1 mm (b) 3 mm
(c) 6 mm (d) 9 mm

7. Two capillary tubes A and B of diameter 1 mm and 2 mm respectively are dipped vertically in a liquid. If the capillary rise in A is 6 cm, then the capillary rise in B is
(a) 2 cm (b) 3 cm
(c) 4 cm (d) 6 cm

8. A certain number of spherical drops of a liquid of radius 'r' coalesce to form a single drop of radius 'R' and volume 'V'. If 'T' is the surface tension of the liquid, then :
(a) energy $= 4VT\left(\dfrac{1}{r} - \dfrac{1}{R}\right)$ is released
(b) energy $= 3VT\left(\dfrac{1}{r} + \dfrac{1}{R}\right)$ is absorbed
(c) energy $= 3VT\left(\dfrac{1}{r} - \dfrac{1}{R}\right)$ is released
(d) energy is neither released nor absorbed

10 Thermal Properties of Matter

Fill in the Blanks :

1. Triple point of water is _______ k.
2. If α, β and γ are coefficient of linear, area and volume expansion respectively, then γ = _______ α.
3. The phenomenon of refreezing the water into ice on removing the increased pressure is called _______ .
4. The value of molar heat capacity at constant temperature is _______ .
5. A quantity of heat required to change the unit mass of a solid substance, from solid state to liquid state, while the temperature remains constant, is known as _______ .
6. _______ is used as a coolent in automobile radiator as well as a heater in hot water bags.
7. Heat is transmitted from higher to lower temperature through actual mass motion of the molecules in _______ .
8. Lamp black absorbs radiant heat which is near about _______ .
9. At temperature T, the emissive power and absorption power of a body for certain wavelength are e_λ and a_λ respectively, then e_λ = _______ .

True/ False :

1. Copper is a better conductor of heat than glass.
2. Thermal conductivity of steel is greater than that of copper.
3. Liquids have conductivities intermediate between solids and gases
4. Radiation is the fastest mode of heat transfer.
5. Steam causes more severe burns than boiling water.
6. Conduction is a mode of heat transfer by actual motion of matter.

Conceptual MCQs

1. The coefficient of thermal conductivity depends upon:
   (a) temperature difference between the two surfaces.
   (b) area of the plate
   (c) material of the plate
   (d) all of these
2. The value of coefficient of volume expansion of glycerine is 5×10^{-4} K^{-1}. The fractional change in the density of glycerine for a rise of 40°C in its temperature, is:
   (a) 0.020 (b) 0.025
   (c) 0.010 (d) 0.015
3. Woollen clothes are used in winter season because woolen clothes :
   (a) are good sources for producing heat.
   (b) absorb heat from surrounding.
   (c) are bad conductors of heat
   (d) none of these
4. If a liquid is heated in weightlessness, the heat is transmitted through:
   (a) conduction
   (b) convection
   (c) radiation
   (d) the liquid cannot be heated in weightlessness.

5. Which of the following qualities are useful for a cooking utensil?
(a) High specific heat and low thermal conductivity.
(b) High specific heat and high thermal conductivity.
(c) Low specific heat and low thermal conductivity.
(d) Low specific heat and high thermal conductivity.

6. The coefficient of thermal expansion of water at 4ºc is :
(a) zero (b) maximum
(c) minimum (d) infinity

7. Certain quantity of water cools from 70°C to 60°C in the first 5 minutes and to 54°C in the next 5 minutes. The temperature of the surroundings is:
(a) 45ºC (b) 20ºC
(c) 42ºC (d) 10ºC

8. The wavelength of radiation emitted by a body depends upon:
(a) the nature of its surface
(b) the area of its surface
(c) the temperature of its surface
(d) all of the above

9. Two metal rods 1 and 2 of same lengths have same temperature difference between their ends. Their thermal conductivities are K_1 and K_2 and cross sectional areas A_1 and A_2, respectively. If the rate of heat conduction in rod 1 is four times that in rod 2, then
(a) $K_1A_1 = K_2A_2$ (b) $K_1A_1 = 4K_2A_2$
(c) $K_1A_1 = 2K_2A_2$ (d) $4K_1A_1 = K_2A_2$

10. The rate of flow of heat through a rod depends on:
(a) thermal conductivity of the rod.
(b) length of the rod.
(c) temperature difference across the rod.
(d) all of the above

11. A piece of iron is heated in a flame. It first becomes dull red then becomes reddish yellow and finally turns to white hot. The correct explanation for the above observation is possible by using
(a) Wien's displacement law
(b) Kirchoff's law
(c) Newton's law of cooling
(d) Stefan's law

12. A vessel completely filled with a liquid is heated. If α and γ represent coefficient of linear expansion of material of vessel and coefficient of cubical expansion of liquid respectively, then the liquid will not overflow if:
(a) $\gamma = 3\alpha$ (b) $\gamma > 3\alpha$
(c) $\gamma < 3\alpha$ (d) $\gamma \leq 3\alpha$

13. Some ice is added to a glass of water, then
(a) the equilibrium temperature must be positive
(b) the equilibrium temperature may be negative
(c) the equilibrium temperature may be zero.
(d) both (b) and (c)

14. Triple point is the temperature at which :
(a) matter may simultaneously exist in liquid and gaseous state.
(b) matter may simultaneously exist in liquid and solid state.
(c) matter may simultaneously exist in solid and gaseous state.
(d) matter may simultaneously exist in all the three forms.

15. If λ_m denotes the wavelength at which the radiative emission from a black body at a temperature T K is maximum, then
(a) $\lambda_m \propto T^{-1}$
(b) $\lambda_m \propto T^4$
(c) λ_m is independent of T
(d) $\lambda_m \propto T$

16. A perfectly black body when heated to extremely high temperature, it appears:
(a) black (b) red
(c) white (d) blue

17. At which temperature, the centrigrade and Fahrenheit scales are equal?
(a) 40° (b) – 40°
(c) 37° (d) – 80°

18. In order that the heat flows from one part of a solid to another part, what is required?
(a) Uniform density
(b) Temperature gradient
(c) Density gradient
(d) Uniform temperature

19. At a common temperature, a block of wood and a block of metal feel equally cold or hot. The temperatures of block and wood are
(a) equal to the temperature of the body
(b) less than the temperature of the body
(c) greater than temperature of the body
(d) either (b) or (c)

20. Steam at 100°C is passed into 20 g of water at 10°C. When water acquires a temperature of 80°C, the mass of water present will be:
[Take specific heat of water = 1 cal g^{-1} °C^{-1} and latent heat of steam = 540 cal g^{-1}]
(a) 24 g (b) 31.5 g
(c) 42.5 g (d) 22.5 g

21. The sprinkling of water slightly reduces the temperature of a closed room because
(a) temperature of water is less than that of the room
(b) specific heat of water is high
(c) water has large latent heat of vaporisation
(d) water is a bad conductor of heat

22. The total radiant energy per unit area, normal to the direction of incidence, received at a distance R from the centre of a star of radius r, whose outer surface radiates as a black body at a temperature T K is given by:

(a) $\frac{\sigma r^2 T^4}{R^2}$ (b) $\frac{\sigma r^2 T^4}{4\pi r^2}$

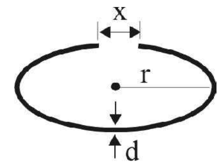
(c) $\frac{\sigma r^4 T^4}{r^4}$ (d) $\frac{4\pi\sigma r^2 T^4}{R^2}$

(where σ is Stefan's constant)

23. According to Newton's law of cooling, the rate of cooling of a body is proportional to $(\Delta\theta)^n$, where $\Delta\theta$ is the difference of the temperature of the body and the surroundings, and n is equal to
(a) two (b) three
(c) four (d) one

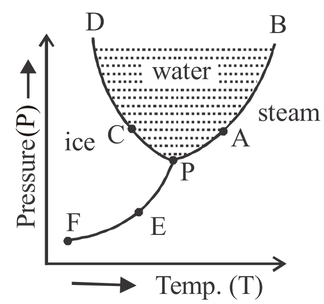
Diagram Based Questions :

1. A cylindrical metal rod is shaped into a ring with a small gap as shown. On heating the system :



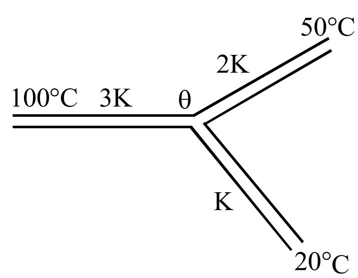
(a) x decreases, r and d increase
(b) x and r increase, d decreases
(c) x, r and d all increase
(d) x and r decreased, d remains constant

2. In the given pressure-temperature diagram, for water, which point indicates triple point ?



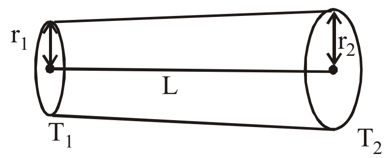
(a) A (b) C
(c) P (d) E

3. There rods of the same dimensions have thermal conductivities 3K, 2K and K. They are arranged as shown in fig. with their ends at 100°C, 50°C and 20°C. The temperature of their junction is



(a) 60° (b) 70°
(c) 50° (d) 35°

4. The rate of heat flow through the cross-section of the rod shown in figure is ($T_2 > T_1$ and thermal conductivity of the material of the rod is K)



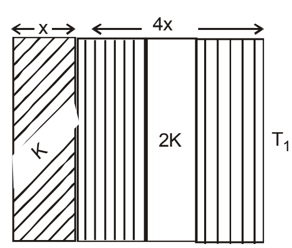
(a) $\dfrac{K\pi r_1 r_2 (T_2 - T_1)}{L}$

(b) $\dfrac{K\pi(r_1 + r_2)^2 (T_2 - T_1)}{4L}$

(c) $\dfrac{K\pi(r_1 + r_1)^2 (T_2 - T_1)}{L}$

(d) $\dfrac{K\pi(r_1 + r_1)^2 (T_2 - T_1)}{2L}$

5. The temperature of the two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity K and $2K$ and thickness x and $4x$, respectively, are T_2 and $T_1 (T_2 > T_1)$. The rate of heat transfer through the slab, in a steady state is $\left(\dfrac{A(T_2 - T_1)K}{x}\right) f$, with f equal to



(a) $\dfrac{2}{3}$

(b) $\dfrac{1}{2}$

(c) 1

(d) $\dfrac{1}{3}$

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion** : Fahrenheit is the smallest unit measuring temperature.
   Reason : Fahrenheit was the first temperature scale used for measuring temperature.
2. **Assertion** : The temperature at which Centigrade and Fahrenheit thermometers read the same is –40°
   Reason : There is no relation between Faherenheit and Centigrade temperature.
3. **Assertion** : It is hotter over the top of a fire than at the same distance on the sides.
   Reason : Air surrounding the fire conducts more heat upwards.
4. **Assertion:** Copper expands five times more than glass for same rise in temperature.
   Reason: Copper is five times far better conductor of heat than glass.
5. **Assertion:** The rate of cooling and the rate of loss of heat are same thing.
   Reason: In both the cases, the material has to cool down and for a given material, rate of cooling and rate of loss of heat will be same.
6. **Assertion** : Specific heat of a body is always greater than its thermal capacity.
   Reason : Specific heat capacity is required for raising temperature of unit mass of the body through unit degree.
7. **Assertion** : Melting of solid causes no change in internal energy.
   Reason : Latent heat is the heat required to melt a unit mass of solid.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the quantities in column-I with the units in column-II.

Column-I	Column-II
(A) Amount of substance	(1) $J\ kg^{-1}\ K^{-1}$
(B) Coefficient of volume expansion	(2) $J\ s^{-1}\ K^{-1}$
(C) Specific heat	(3) K^{-1}
(D) Thermal conductivity	(4) mol

(a) (A) → (4) ; (B) → (2) ; (C) → (3) ; (D) → (1)
(b) (A) → (4) ; (B) → (3) ; (C) → (1) ; (D) → (2)
(c) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)
(d) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)

2.

Column-I	Column-II
(A) Bimetalic strip	(1) Change in length
(B) Steam engine	(2) Energy conversion
(C) Linear expansion	(3) Change in area
(D) Area expansion	(4) Thermal expansion

(a) (A) → (4) ; (B) → (2) ; (C) → (3) ; (D) → (1)
(b) (A) → (4) ; (B) → (2) ; (C) → (1) ; (D) → (3)
(c) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)
(d) (A) → (3) ; (B) → (4) ; (C) → (2) ; (D) → (1)

3. Match the column I and column II.

Column I	Column II
(A) $PV = \mu RT$	(1) Molar specific heat
(B) $\gamma = 3\alpha$	(2) Newton's law of cooling
(C) $C = \frac{1}{\mu}\frac{\Delta Q}{\Delta T}$	(3) Ideal gas equation
(D) $\frac{dQ}{dt} = -k(T_2 - T_1)$	(4) Coefficient of expansion

(a) (A) → (4) ; (B) → (2) ; (C) → (3) ; (D) → (1)
(b) (A) → (1) ; (B) → (2) ; (C) → (3) ; (D) → (4)
(c) (A) → (3) ; (B) → (4) ; (C) → (1) ; (D) → (2)
(d) (A) → (3) ; (B) → (4) ; (C) → (2) ; (D) → (1)

4.

Column I	Column II
(A) Lowest temperature of water in a lake	(1) Less than 4°C
(B) Rate of variation of density (r) is zero	(2) Coexistence of three phases of a substance.
(C) Least volume of water	(3) Surface tension is zero
(D) Triple point	(4) Equal to 4°C

(a) (A) → (4) ; (B) → (2) ; (C) → (3) ; (D) → (1)
(b) (A) → (1) ; (B) → (2) ; (C) → (3) ; (D) → (4)
(c) (A) → (3) ; (B) → (4) ; (C) → (4) ; (D) → (2)
(d) (A) → (3) ; (B) → (4) ; (C) → (4) ; (D) → (2)

5.

Column-I	Column-II
(A) Specific heat capacity S	(1) $l_1 - l_2$ = constant for $l_1\alpha_1 = l_2\alpha_2$
(B) Two metals (l_1, a_1) and (l_2, a_2) are heated	(2) Y is same uniformly
(C) Thermal stress	(3) $S = \infty$ for $\Delta T = 0$
(D) Four wires of same material	(4) $Y \propto \Delta t$

(a) (A) → (3) ; (B) → (1) ; (C) → (4) ; (D) → (2)
(b) (A) → (1) ; (B) → (2) ; (C) → (3) ; (D) → (4)
(c) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)
(d) (A) → (3) ; (B) → (4) ; (C) → (2) ; (D) → (1)

6. Three liquids A, B and C having same specific heat and mass m, 2m and 3m have temperatures 20°C, 40°C and 60°C respectively. Temperature of the mixture when

Column-I	Column-II
(A) A and B are mixed	(1). 33.3°C
(B) A and C are mixed	(2) 52°C
(C) B and C are mixed	(3) 50°C
(D) A, B and C all three are mixed	(4) 46.67°C

(a) (A) → (1) ; (B) → (3) ; (C) → (2) ; (D) → (4)
(b) (A) → (1) ; (B) → (2) ; (C) → (3) ; (D) → (4)
(c) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)
(d) (A) → (3) ; (B) → (4) ; (C) → (2) ; (D) → (1)

Critical Thinking Type Questions :

1. A bar of iron is 10 cm at 20°C. At 19°C it will be (α of iron = 11×10^{-6}/°C)
(a) 11×10^{-6} cm longer
(b) 11×10^{-6} cm shorter
(c) 11×10^{-5} cm shorter
(d) 11×10^{-5} cm longer

2. The coefficient of apparent expansion of mercury in a glass vessel is 153×10^{-6}/°C and in a steel vessel is 144×10^{-6}/°C. If α for steel is 12×10^{-6}/°C , then α of glass is
(a) 9×10^{-6}/°C
(b) 6×10^{-6}/°C
(c) 36×10^{-6}/°C
(d) 27×10^{-6}/°C

3. Two spheres of different materials one with double the radius and one-fourth wall thickness of the other are filled with ice. If the time taken for complete melting of ice in the larger sphere is 25 minute and for smaller one is 16 minute, the ratio of thermal conductivities of the materials of larger spheres to that of smaller sphere is
(a) 4 : 5
(b) 5 : 4
(c) 25 : 8
(d) 8 : 25

4. Three very large plates of same area are kept parallel and close to each other. They are considered as ideal black surfaces and have very high thermal conductivity. The first and third plates are maintained at temperatures 2T and 3T respectively. The temperature of the middle (i.e. second) plate under steady state condition is
(a) $\left(\frac{65}{2}\right)^{1/4} T$
(b) $\left(\frac{97}{4}\right)^{1/4} T$
(c) $\left(\frac{97}{2}\right)^{1/4} T$
(d) $(97)^{1/4}$T

5. A partition wall has two layers of different materials A and B in contact with each other. They have the same thickness but the thermal conductivity of layer A is twice that of layer B. At steady state the temperature difference across the layer B is 50 K, then the corresponding difference across the layer A is
(a) 50 K
(b) 12.5 K
(c) 25 K
(d) 60 K

6. A solid copper cube of edges 1 cm each is suspended in an evacuated enclosure. Its temperture is found to fall from 100°C to 99°C in 100 s. Another solid copper cube of edges 2 cm, with similar surface nature, is suspended in a similar manner. The time required for this cube to cool from 100°C to 99°C will be approximately
(a) 25 s
(b) 50 s
(c) 200 s
(d) 400 s

7. Consider two hot bodies B_1 and B_2 which have temperatures 100°C and 80°C respectively at t = 0. The temperature of the surroundings is 40°C. The ratio of the respective rates of cooling R_1 and R_2 of these two bodies at t = 0 will be
(a) $R_1 : R_2 = 3 : 2$
(b) $R_1 : R_2 = 5 : 4$
(c) $R_1 : R_2 = 2 : 3$
(d) $R_1 : R_2 = 4 : 5$

11

Thermodynamics

Fill in the Blanks :

1. First law of thermodynamics is a special case of ______ .
2. The specific heat of a gas in an isothermal process is _________ .
3. The work done in an adiabatic change in ideal gas depends only upon _______ .
4. In all natural processes, the entropy of the universe ____ .
5. $\Delta u + \Delta w = 0$ is valid for _______ process.
6. No heat flows between the system and surrounding. Then the thermodynamic process is _______ .
7. First operation involved in a car not cycle is _______ .
8. A measure of the degree of disorder of a system is known as _______ .
9. "Heat cannot by itself flow from a body at lower temperature to a body at higher temperature" is a statement or consequence of _______ law of thermodynamics.

True/ False :

1. Adiabatic system is thermally insulated from the surroundings.
2. Internal energy changes in isothermal process.
3. The statement of Second law of thermodynamics, No process is possible whose sole result is the absorption of heat from a reservoir and complete conversion of heat into work.
4. A real engine has efficiency greater than that of Carnot engine.
5. The combustion reaction of a mixture of petrol and air ignited by a spark is irreversible.
6. The leaking of a gas from the kitchen cylinder cannot be reversed by itself.
7. The internal energy of an ideal gas depends upon density.

Conceptual MCQs

1. Which of the following is incorrect regarding first law of thermodynamics?
   (a) It is a restatement of principle of conservation of energy.
   (b) It is applicable to cyclic processes
   (c) It introduces the concept of entropy
   (d) It introduces the concept of internal energy
2. For an isochoric thermodynamic process.
   (a) $\Delta Q = \Delta W$ (b) $\Delta Q = \Delta U$
   (c) $\Delta U = \Delta W$ (d) $\Delta U = 0$
3. An ideal gas heat engine operates in a Carnot cycle between 227ºC and 127ºC. It absorbs 6 kcal at the higher temperature. The amount of heat (in kcal) converted into work is equal to
   (a) 1.2 (b) 4.8
   (c) 3.5 (d) 1.6
4. Choose the incorrect statement related to an isobaric process.
   (a) $\frac{V}{T}$ = constant
   (b) $W = P\Delta V$
   (c) heat given to a system is used up in raising the temperature only.
   (d) $\Delta Q > W$
5. 110 joules of heat is added to a gaseous system, whose internal energy is 40J; then the amount of external work done is
   (a) 150 J (b) 70 J
   (c) 110 J (d) 40 J
6. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its temperature. The ratio of $\frac{C_p}{C_v}$ for the gas is

(a) 2 (b) $\frac{5}{3}$

(c) $\frac{3}{2}$ (d) $\frac{4}{3}$

7. The internal energy of an ideal gas does not depend upon:
(a) temperature of the gas
(b) pressure of the gas
(c) atomicity of the gas
(d) number of moles of the gas.

8. Mark the incorrect statement related to a cyclic process.
(a) the initial and final conditions always coincide
(b) $Q = W$
(c) $W > 0$
(d) none of these

9. When 1 kg of ice at 0°C melts to water at 0°C, the resulting change in its entropy, taking latent heat of ice to be 80 cal/°C, is
(a) 273 cal/K (b) 8 × 104 cal/K
(c) 80 cal/K (d) 293 cal/K

10. During isothermal expansion, the slope of *P-V* graph :
(a) decreases
(b) increases
(c) remains same
(d) may increase or decrease.

11. In an adiabatic process, compressibility of the gas is :
(a) constant
(b) directly proportional to its pressure.
(c) inversly proportional to its pressure
(d) inversly proportiona to p^{γ} where $\gamma = \frac{cp}{G}$

12. If γ be the ratio of specific heats of a perfect gas, the number of degrees of freedom of a molecule of the gas is

(a) $\frac{25}{2}(\gamma-1)$ (b) $\frac{3\gamma-1}{2\gamma-1}$

(c) $\frac{2}{\gamma-1}$ (d) $\frac{9}{2}(\gamma-1)$

13. The internal energy change in a system that has absorbed 2 kcals of heat and done 500 J of work is:
(a) 6400 J (b) 5400 J
(c) 7900 J (d) 8900 J

14. The molar specific heat at constant pressure of an ideal gas is (7/2) *R*. The ratio of specific heat at constant pressure to that at constant volume is
(a) 8/7 (b) 5/7
(c) 9/7 (d) 7/5

15. During melting of ice, its entropy :
(a) increases (b) decreases
(c) remains same (d) cannot increase

16. Which of the following processes is adiabatic ?
(a) Melting of ice
(b) Bursting of tyre
(c) Motion of piston of an engine with constant speed
(d) None of these

17. A Carnot engine whose efficiency is 50% has an exhaust temperature of 500 K. If the efficiency is to be 60% with the same intake temperature, the exhaust temperature must be (in K)
(a) 800 (b) 200
(c) 400 (d) 600

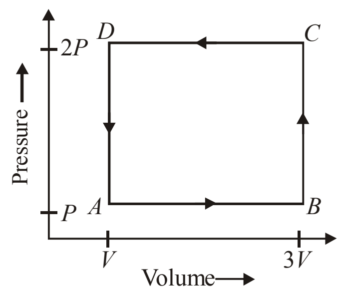
18. At a given temperature the internal energy of a substance
(a) in liquid state is equal to that in gaseous state.
(b) in liquid state is less than that in gaseous state.
(c) in liquid state is more than that in gaseous state.
(d) is equal for the three states of matter.

19. Air conditioner is based on the principle of
(a) Carnot cycle
(b) refrigerator
(c) first low of thermodynamics
(d) none of these

20. An ideal gas undergoing adiabatic change has the following pressure-temperature relationship
(a) $P^{\gamma-1}T^{\gamma}$ = constant
(b) $P^{\gamma}T^{\gamma-1}$ = constant
(c) $P^{\gamma}T^{1-\gamma}$ = constant
(d) $P^{1-\gamma}T^{\gamma}$ = constant

Diagram Based Questions :

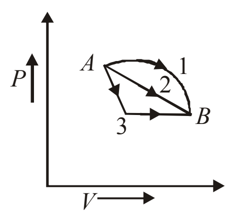
1. A thermodynamic system is taken through the cycle *ABCD* as shown in figure. Heat rejected by the gas during the cycle is



(a) 2PV (b) 4PV

(c) $\frac{1}{2}$ PV (d) PV

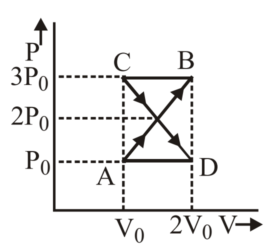
2. An ideal gas goes from state A to state B via three different processes as indicated in the P-V diagram



If Q_1, Q_2, Q_3 indicate the heat absorbed by the gas along the three processes and ΔU_1, ΔU_2, ΔU_3 indicate the change in internal energy along the three processes respectively, then

(a) $Q_1 > Q_2 > Q_3$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$
(b) $Q_3 > Q_2 > Q_1$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$
(c) $Q_1 = Q_2 = Q_3$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$
(d) $Q_3 > Q_2 > Q_1$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$

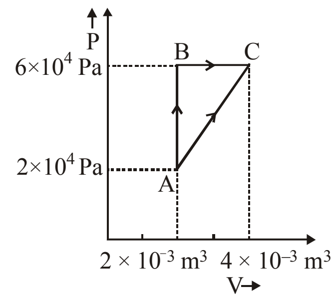
3. A thermodynamic system undergoes cyclic process ABCDA as shown in fig. The work done by the system in the cycle is



(a) P_0V_0 (b) $2P_0V_0$

(c) $\frac{P_0V_0}{2}$ (d) Zero

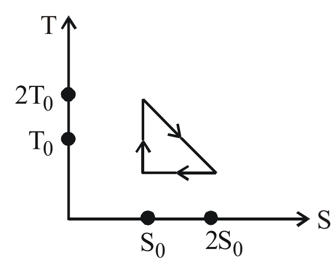
4. Figure below shows two paths that may be taken by a gas to go from a state A to a state C.



In process AB, 400 J of heat is added to the system and in process BC, 100 J of heat is added to the system. The heat absorbed by the system in the process AC will be

(a) 500 J (b) 460 J
(c) 300 J (d) 380 J

5. The temperature-entropy diagram of a reversible engine cycle is given in the figure. Its efficiency is



(a) $\frac{1}{4}$ (b) $\frac{1}{2}$

(c) $\frac{2}{3}$ (d) $\frac{1}{3}$

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Zeroth law of thermodynamics explain the concept of energy.
   Reason : Energy depends on temperature.
2. **Assertion:** Mass of a body will increase when it is heated.
   Reason: The internal energy of a body increases on heating.
3. **Assertion:** Heat cannot be added to a system without increasing its temperature.
   Reason: Adding heat will increase the temperature in every situation.
4. **Assertion :** The heat supplied to a system is always equal to the increase in its internal energy.
   Reason : When a system changes from one thermal equilibrium to another, some heat is absorbed by it.\
5. **Assertion :** In isothermal process whole of the heat energy supplied to the body is converted into internal energy.
   Reason : According to the first law of thermodynamics
   $\Delta Q = \Delta U + W$.
6. **Assertion :** First law of thermodynamics is a restatement of the principle of conservation
   Reason : Energy is fundamental quantity
7. **Assertion :** When a bottle of cold carbonated drink is opened a slight fog forms around the opening.
   Reason : Adiabatic expansion of the gas causes lowering of temperature and condensation of water vapours.
8. **Assertion :** The isothermal curves intersect each other at a certain point.
   Reason : The isothermal change takes place slowly, so the isothermal curves have very little slope
9. **Assertion :** The temperature of the surface of the sun is approximately 6000 K. If we take a bigh lens and focus the sunrays, we can produce a temperature of 8000 K.
   Reason : The highest temperature can be produced according to second law of thermodynamics
10. **Assertion :** When a glass of hot milk is placed in a room and allowed to cool, its entropy decreases
    Reason : Allowing hot object to cool does not violate the second law of thermodynamics.
11. **Assertion :** Efficiency of a Carnot engine increase on reducing the temperature of sink.
    Reason : Efficiency of a Carnot engine is defined as the ratio of net mechanical work done per cycle by the gas to the amount of heat energy absorbed per cycle from the source.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match columns I and II.

Column-I	Column-II
(A) Isothermal	(1) $\Delta Q = 0$
(B) Isobaric	(2) Volume constant
(C) Isochoric	(3) Pressure constant
(D) Adiabatic	(4) Temperature constant

(a) $(A) \to (4), (B) \to (3), (C) \to (2), D \to (1)$
(b) $(A) \to (1), (B) \to (4), (C) \to (3), D \to (2)$
(c) $(A) \to (2), (B) \to (3), (C) \to (1), (D) \to (4)$
(d) $(A) \to (3), (B) \to (1), (C) \to (2), (D) \to (4)$

2.

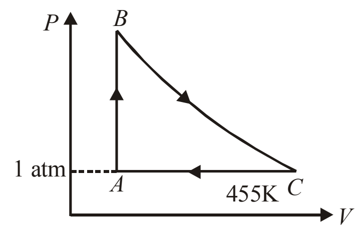
Column-I	Column-II
(A) The coefficient of volume expansion at constant pressure	(1) decrease in pressure
(B) At constant temperature, an increase in volume results in	(2) at all temperature

(C) An ideal gas obeys Boyle's and Charle's law — (3) same for all gases

(D) A real gas behaves as an ideal gas at low pressure — (4) at high temperature

(a) (A) – (3), (B) – (1), (C) – (2), D – (4)
(b) (A) – (4), (B) – (3), (C) – (2), D – (1)
(c) (A) – (1), (B) – (2), (C) – (3), (D) – (4)
(d) (A) – (2), (B) – (4), (C) – (3), (D) – (1)

3. The P-V diagram of 0.2 mol of a diatomic ideal gas is shown in figure. Process BC is adiabatic, $\gamma = 1.4$.



Column I	Column II
(A) ΔQ_{AB} (J)	(1) 602
(B) ΔW_{BC} (J)	(2) – 644
(C) ΔU_{CA} (J)	(3) 1246
(D) ΔU_{BC} (J)	(4) – 602

(a) (A) → (1), (B) → (3), (C) → (4), D → (2)
(b) (A) → (3), (B) → (1), (C) → (2), D → (4)
(c) (A) → (3, 4), (B) → (3), (C) → (2), (D) → (1)
(d) (A) → (1), (B) → (2), (C) → (3), (D) → (4)

Critical Thinking Type Questions :

1. The specific heat at constant pressure of an ideal gas, $C_p = \frac{5R}{2}$. The gas is kept in a closed vessel of volume 0.0083 m^3 at 300 K and a pressure of 1.6×10^6 N/m^2. 2.49×10^4 J of heat energy is supplied to the gas. The final temperature and the pressure respectively are

(a) 567.2 K and 6.3×10^6 N/m^2
(b) 675.2 K and 3.6×10^6 N/m^2
(c) 275.2 K and 2.3×10^6 N/m^2
(d) 465.6 K and 4.2×10^6 N/m^2

2. A mass of diatomic gas ($\gamma = 1.4$) at a pressure of 2 atmospheres is compressed adiabatically so that its temperature rises from 27°C to 927°C. The pressure of the gas in final state is

(a) 28 atm (b) 68.7 atm
(c) 256 atm (d) 8 atm

3. A diatomic gas initially at 18ºC is compressed adiabatically to one eighth of its original volume. The temperature after compression will be

(a) 18ºC (b) 668.4K
(c) 395.4ºC (d) 144ºC

4. A monoatomic gas at a pressure P, having a volume V expands isothermally to a volume 2V and then adiabatically to a volume 16V. The final pressure of the gas is : (take $\gamma = \frac{5}{3}$)

(a) 64P (b) 32P
(c) $\frac{P}{64}$ (d) 16P

5. A spring stores 1 J of energy for a compression of 1 mm. The additional work to be done to compress it further by 1 mm is

(a) 1 J (b) 2 J
(c) 3 J (d) 4 J

6. A diatomic ideal gas is used in a car engine as the working substance. If during the adiabatic expansion part of the cycle, volume of the gas increases from V to 32 V, the efficiency of the engine is

(a) 0.5 (b) 0.75
(c) 0.99 (d) 0.25

7. In a Carnot engine, the temperature of reservoir is 927°C and that of sink is 27°C. If the work done by the engine when it transfers heat from reservoir to sink is 12.6×10^6J, the quantity of heat absorbed by the engine from the reservoir is

(a) 16.8×10^6 J (b) 4×10^6 J
(c) 7.6×10^6 J (d) 4.2×10^6 J

8. If the energy input to a Carnot engine is thrice the work it performs then, the fraction of energy rejected to the sink is

(a) $\frac{1}{3}$ (b) $\frac{1}{4}$
(c) $\frac{2}{5}$ (d) $\frac{2}{3}$

12 Kinetic Theory

Fill in the Blanks :

1. The phenomenon of Browninan movement may be taken as the evidence of _______ .

2. When temperature is constant, the pressure of a given mass of gas varies inversely with volume. This is the statement of _______ .

3. The average kinetic energy per molecule of any ideal gas is always equal to _______ .

4. In kinetic theory of gases, one assumes that the collisions between the molecules are _______ .

5. The ratio of molar specific heat at constant pressure C_P, to molar specific heat at constant volume C_v for a monoatomic gas is _______.

6. The internal energy of an ideal gas is _____ of gas molecules.

7. A fly moving in a room has _______ degree of freedom.

8. If the pressure in a closed vessel is reduced by drawing out some gas, the mean-free path of the molecules _______ .

True/ False :

1. On colliding in a closed container the gas molecules transfer momentum to the walls.

2. The average translational kinetic energy per molecule of oxygen gas is 3 KT (K being Boltzmann constant).

3. The mean free path of molecules of gas is given by $\lambda = \dfrac{kT}{\sqrt{2}\pi d^2 p}$

4. For a gas there is distribution of velocities of the gas molecules.

5. The root mean square speed of the molecules in a fixed mass of an ideal gas is increased by increasing the pressure while keeping the volume constant.

6 $C_P - C_V = R$ is true for monoatomic gases only.

7. Regarding the law of equipartition of energy, the gas possess equal energies in all the three directions x,y and z-axis.

Conceptual MCQs

1. The kinetic theory of gases :
(a) explains the behaviour of an ideal gas.
(b) describes the motion of a single atom or molecule.
(c) relates the temperature of the gas with K.E. of atoms of the gas
(d) all of the above

2. The ratio of principal molar heat capacities of a gas is maximum for :
(a) a diatomic gas
(b) a monoatomic gas
(c) a polyatomic gas having linear molecules.
(d) a polyatomic gas having non-linear molecules.

3. The correct statement of the law of equipartition of energy is
(a) the total energy of a gas is equally divided among all the molecules.
(b) The gas possess equal energies in all the three directions x,y and z-axis.
(c) the total energy of a gas is equally divided between kinetic and potential energies.
(d) the total kinetic energy of a gas molecules is equally divided among translational and rotational kinetic energies.

4. The internal energy of an ideal gas is :
(a) The sum of total kinetic and potential energies.
(b) The total translational kinetic energy.
(c) The total kinetic energy of randomly moving molecules.
(d) The total kinetic energy of gas molecules.

5. The total degree of freedom of a CO_2 gas molecule is
(a) 3 (b) 6
(c) 5 (d) 4

6. If C_s be the velocity of sound in air and C be the r.m.s velocity, then
(a) $C_s < C$ (b) $C_s = C$
(c) $C_s = C(\gamma/3)^{1/2}$ (d) none of these

7. The pressure of a gas is raised from 27°C to 927°C. The root mean square speed
(a) becomes $\sqrt{(927/27)}$ times the earlier value
(b) remains the same
(c) gets halved
(d) get doubled

8. For a certain gas the ratio of specific heats is given to be $\gamma = 1.5$. For this gas
(a) $C_V = 3R/J$ (b) $C_P = 3R/J$
(c) $C_P = 5R/J$ (d) $C_V = 5R/J$

9. The correct relations is/are
(a) $C_v = \frac{1}{2} f R$ (b) $C_v = \frac{R}{\gamma - 1}$
(c) $C_v = \frac{C_p}{\gamma}$ (d) all of these

10. In kinetic theory of gases, it is assumed that molecules
(a) have same mass but can have different volume
(b) have same volume but mass can be different
(c) have different mass as well as volume
(d) have same mass but negligible volume.

11. The amount of heat energy required to raise the temperature of 1g of Helium at NTP, from T_1K to T_2K is
(a) $\frac{3}{2} N_a k_B (T_2 - T_1)$ (b) $\frac{3}{4} N_a k_B (T_2 - T_1)$
(c) $\frac{3}{4} N_a k_B \frac{T_2}{T_1}$ (d) $\frac{3}{8} N_a k_B (T_2 - T_1)$

12. In a vessel, the gas is at a pressure P. If the mass of all the molecules is halved and their speed is doubled, then the resultant pressure will be
(a) $4P$ (b) $2P$
(c) P (d) $P/2$

13. Relation between pressure (P) and energy (E) of a gas is
(a) $P = \frac{2}{3} E$ (b) $P = \frac{1}{3} E$
(c) $P = \frac{1}{2} E$ (d) $P = 3E$

14. The average velocity of molecules of gas is given by:
(a) $\sqrt{\frac{3RT}{M}}$ (b) $\sqrt{\frac{2RT}{M}}$
(c) $\sqrt{\frac{8RT}{\pi M}}$ (d) Zero

15. Hydrogen gas and oxygen gas have volume $1 cm^3$ each at NTP
(i) Number of molecules is same in both the gases
(ii) The rms velocity of molecules of both the gases is same.
(iii) The internal energy of each gas is same.
(iv) The average velocity of molecules of each gas is same
The correct options are :
(a) (i) & (ii) (b) (i), (iii) & (iv)
(c) (ii) & (iii) (d) (i), (ii) & (iii)

16. The equation of state for 5 g of oxygen at a pressure P and temperature T, when occupying a volume V, will be
(a) PV = (5/16) RT (b) PV = (5/32) RT
(c) PV = 5 RT (d) PV = (5/2) RT
where R is the gas constant.

17. At 10° C the value of the density of a fixed mass of an ideal gas divided by its pressure is x. At 110°C this ratio is:
(a) x (b) $\frac{383}{283} x$
(c) $\frac{10}{110} x$ (d) $\frac{283}{383} x$

18. The molar heat capacities of a mixture of two gases at constant volume is 13R/6. The ratio of number of moles of the first gas to the second is 1 : 2. The respective gases may be
(a) O_2 and N_2 (b) He and Ne
(c) He and N_2 (d) N_2 and He

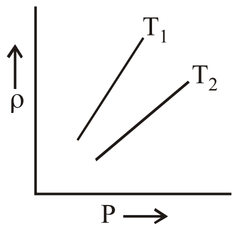
19. One mole of an ideal monoatomic gas requires 207 J heat to raise the temperature by 10 K when heated at constant pressure. If the same gas is heated at constant volume to raise the temperature by the same 10 K, the heat required is [Given the gas constant $R = 8.3$ J/ mol. K]
(a) 198.7 J (b) 29 J
(c) 215.3 J (d) 124 J

20. Let v denote the rms speed of the molecules in an ideal diatomic gas at absolute temperature T. The mass of a molecule is 'm' Neglecting vibrational energy terms, the false statement is :

(a) A molecule can have a speed greater than $\sqrt{2}v$
(b) v is proportional to $\sqrt{T}$
(c) The average rotational K.E. of a molecule is $\frac{1}{4}mv^2$
(d) The average K.E. of a molecule is $\frac{5}{6}mv^2$

Diagram Based Questions :

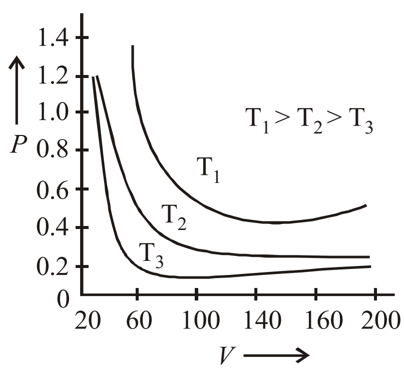
1. The density (ρ)versus pressuure (P) of a given mass of an ideal gas is shown at two temperatures T_1 and T_2



Then relation between T_1 and T_2 may be

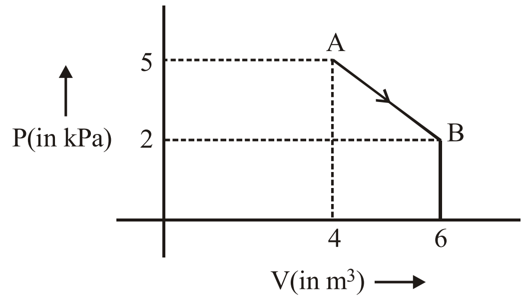
(a) $T_1 > T_2$
(b) $T_2 > T_1$
(c) $T_1 = T_2$
(d) All the three are possible

2. The given *P-V* curve is predicted by



(a) Boyle's law (b) Charle's law
(c) Avogadro's law (d) Gaylussac's law

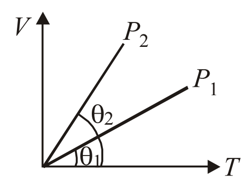
3. One mole of an ideal diatomic gas undergoes a transition from A to B along a path AB as shown in the figure.



The change in internal energy of the gas during the transition is

(a) – 20 kJ (b) 20 J
(c) –12 kJ (d) 20 kJ

4. The figure shows the volume *V* versus temperature *T* graphs for a certain mass of a perfect gas at two constant pressures of P_1 and P_2. What inference can you draw from the graphs?



(a) $P_1 > P_2$
(b) $P_1 < P_2$
(c) $P_1 = P_2$
(d) No inference can be drawn due to insufficient information.

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion:** At low temperature and high pressure, the real gases obey more strictly the gas equation $PV = RT$

Reason: At low temperature, the molecular motion ceases and due to high pressure, volume decreases and *PV* becomes constant.

2. **Assertion:** One mole of any substance at any temperature or volume always contains 6.02×10^{23} molecules.

Reason: One mole of a substance always refers to S.T.P. conditions.

3. **Assertion :** The total translational kinetic energy of all the molecules of a given mass of an ideal gas is 1.5 times the product of its pressure and its volume.

Reason : The molecules of a gas collide with each other and the velocities of the molecules change due to the collision.

4. **Assertion :** When we place a gas cylinder on a moving train, its internal kinetic energy increases.

Reason : Its temperature remains constant.

5. **Assertion :** If a gas container in motion is suddenly stopped, the temperature of the gas rises.

Reason : The kinetic energy of ordered mechanical motion is converted in to the kinetic energy of random motion of gas molecules.

6. **Assertion :** Each vibrational mode gives two degrees of freedom

Reason : By law of equipartition of energy, the energy for each degree of freedom in thermal equilibrium is $2k_B T$.

7. **Assertion :** Maxwell speed distribution graph is symmetric about most probable speed

Reason : rms speed of ideal gas, depends upon it's type (monoatomic, diatomic and polyatomic)

8. **Assertion :** Mean free path of a gas molecules varies inversely as density of the gas.

Reason : Mean free path varies inversely as pressure of the gas.

9. **Assertion :** A gas can be liquified at any temperature by increase of pressure alone.

Reason : On increasing pressure the temperature of gas decreases.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the Column I and II.

	Column I		**Column II**
(A)	$P \propto T$	(1)	Ideal gas equation
(B)	$V \propto T$	(2)	Boyle's law
(C)	$PV = K_B NT$	(3)	Charle's law
(D)	$P = nRT / M$	(4)	V - Constant

(a) (A) → (4) ; (B) → (2) ; (C) → (3) ; (D) → (1)
(b) (A) → (1) ; (B) → (2) ; (C) → (3) ; (D) → (4)
(c) (A) → (4) ; (B) → (3) ; (C) → (1) ; (D) → (2)
(d) (A) → (3) ; (B) → (4) ; (C) → (2) ; (D) → (2)

2. Match **Column I** (Physical Variables) with **Column II** (Expressions) . (n = number of gas molecules present per unit volume, k = Boltzmann constant, T = absolute temperature, m = mass of the particle) :

	Column I		**Column II**
(A)	Most probable velocity	(1)	nkT
(B)	Energy per degree of freedom	(2)	$\sqrt{(3kT/m)}$
(C)	Pressure	(3)	$\sqrt{(2kT/m)}$
(D)	R.M.S. velocity	(4)	$kT/2$

(a) (A) → (3) ; (B) → (4) ; (C) → (1) ; (D) → (2)
(b) (A) → (1) ; (B) → (2) ; (C) → (3) ; (D) → (4)
(c) (A) → (4) ; (B) → (3) ; (C) → (1) ; (D) → (2)
(d) (A) → (3) ; (B) → (4) ; (C) → (2) ; (D) → (2)

3. **Column I** **Column II**

Column I	Column II
(A) Average speed v_{av}	(1) $\sqrt{\frac{3RT}{M}}$
(B) Root mean square speed v_{rms}	(2) $\sqrt{\frac{8RT}{\pi M}}$
(C) Most probable speed v_{mp}	(3) $\frac{\sqrt{\gamma Rt}}{M}$
(D) Speed of sound v_{sound}	(4) $\sqrt{\frac{2RT}{M}}$

(a) (A)$\to$(4) ; (B)$\to$ (2) ; (C)$\to$(3) ; (D)$\to$(1)
(b) (A)$\to$(1) ; (B)$\to$ (2) ; (C)$\to$(3) ; (D)$\to$ (4)
(c) (A)$\to$(2) ; (B)$\to$(1) ; (C)$\to$(4) ; (D)$\to$ (3)
(d) (A)$\to$(3) ; (B)$\to$(4) ; (C)$\to$(2) ; (D)$\to$(1)

4. **Column I** **Column II**

Column I	Column II
(A) An ideal gas obeys gas equation	(1) with decrease in pressure
(B) A real gas behaves as an ideal gas at low	(2) at all temperature pressure
(C) Mean free path of molecules increases	(3) at high temperature
(D) Charle's law	(4) pressure constant

(a) (A)$\to$(3) ; (B)$\to$ (4) ; (C)$\to$(1) ; (D)$\to$ (2)
(b) (A)$\to$(1) ; (B)$\to$ (2) ; (C)$\to$(3) ; (D)$\to$ (4)
(c) (A)$\to$(4) ; (B)$\to$(3) ; (C)$\to$(1) ; (D)$\to$ (4)
(d) (A)$\to$(2) ; (B)$\to$(3) ; (C)$\to$(1) ; (D)$\to$(4)

Critical Thinking Type Questions :

1. If two vessels A and B contain the same gas but the volume of vessel A is twice that of B and temperature and pressure of gas A is twice that of gas in B, then the ratio of gas molecules in A and B is
(a) 1 : 2 (b) 1 : 4
(c) 4 : 1 (d) 2 : 1

2. *P, V, T* respectively denote pressure, volume and temperature of two gases. On mixing, new temperature and volume are respectively *T and V*. Final pressure of the mixture is
(a) *P* (b) 2*P*
(c) zero (d) 3*P*

3. 4.0 g of a gas occupies 22.4 litres at NTP. The specific heat capacity of the gas at constant volume is $5.0 JK^{-1}$. If the speed of sound in this gas at NTP is 952 ms^{-1}, then the heat capacity at constant pressure is
(Take gas constant R = 8.3 $JK^{-1} mol^{-1}$)
(a) 7.5 $JK^{-1} mol^{-1}$ (b) 7.0 $JK^{-1} mol^{-1}$
(c) 8.5 $JK^{-1} mol^{-1}$ (d) 8.0 $JK^{-1} mol^{-1}$

4. The temperature at which oxygen molecules have the same root mean square speed as that of hydrogen molecules at 300 K is
(a) 600 K (b) 2400 K
(c) 4800 K (d) 300 K

5. If one mole of monoatomic gas $\left(\gamma = \frac{5}{3}\right)$ is mixed with one mole of diatomic gas $\left(\gamma = \frac{7}{5}\right)$, the value of γ for the mixture is
(a) 1.40 (b) 1.50
(c) 1.53 (d) 3.07

6. The molar specific heats of an ideal gas at constant pressure and volume are denoted by C_p and C_v, respectively. If $\gamma = \frac{C_p}{C_v}$ and R is the universal gas constant, then C_v is equal to
(a) $\frac{R}{(\gamma-1)}$ (b) $\frac{(\gamma-1)}{R}$
(c) γR (d) $\frac{1+\gamma}{1-\gamma}$

7. A thermally insulated vessel contains an ideal gas of molecular mass *M* and ratio of specific heats γ. It is moving with speed *v* and it suddenly brought to rest. Assuming no heat is lost to the surroundings, its temperature increases by
(a) $\frac{(\gamma-1)}{2\gamma R}Mv^2K$ (b) $\frac{\gamma Mv^2}{2R}K$
(c) $\frac{(\gamma-1)}{2R}Mv^2K$ (d) $\frac{(\gamma-1)}{2(\gamma+1)R}Mv^2K$

13 Oscillations

Fill in the Blanks :

1. A periodic to-and-fro motion is called _______ motion.
2. A simple harmonic motion is represented by $y(t) = 10 \sin(20t + 0.5)$. The frequency is _______ .
3. A child swinging on swing in sitting position, stands up. The time period of the swing will _______ .
4. The graph plotted between the velocity and displacement from mean position of a particle executing SHM is a/an _____.
5. The ratio of energies of oscillations of two exactly identical pendulums oscillating with amplitudes 5 cm and 10 cm is _______ .
6. The tension in the string of a simple pendulum is __________ at the mean position.
7. If a body oscillates at angular frequency ω_d of the driving force, then the oscillations are called _______ .
8. The acceleration of a particle is S.H.M. is ______ at the extreme position.

True/ False :

1. In SHM, the acceleration of the body is in the direction of velocity of the body.
2. KE becomes maximum twice and PE becomes maximum once in one vibration.
3. In sitar, guitar the strings vibrate and produce sound.
4. In solids, atoms oscillate to produce the temperature sensation.
5. Time period of a spring mass system depends on spring constant.
6. A system exhibiting S.H.M. must possess elasticity as well as inertia.

Conceptual MCQs

1. A child swinging on swing in sitting position stands up. The time period of the swing will :
   (a) increase
   (b) decrease
   (c) remain same
   (d) increase if the child is tall and decrease if the child is short.
2. In case of forced vibrations, the resonance wave become very sharp when the
   (a) applied periodic force is small
   (b) quality factor is small
   (c) damping force is small
   (d) restoring force is small
3. What is the time period of a pendulum hanged in a satellite?
   (T is time period of the pendulum on the earth)
   (a) Zero (b) T
   (c) $\frac{T}{\sqrt{6}}$ (d) Infinity
4. A particle executing S.H.M. has amplitude 0.01m and frequency 60 Hz. The maximum acceleration of the particle is
   (a) $144\pi^2$ m/s^2 (b) $120\pi^2$ m/s^2
   (c) $80\pi^2$ m/s^2 (d) $60\pi^2$ m/s^2
5. For a particle executing simple harmonic motion, which of the following statements is not correct?
   (a) Total energy of the particle always remains same
   (b) Restoring force is always directed towards a fixed point
   (c) Restoring force is maximum at the extreme position.
   (d) Acceleration of the particle is maximum at the equilibrium position.
6. If the metal bob of a simple pendulum is replaced by wooden bob of same size, then its time period will
   (a) increase
   (b) decrease
   (c) remains same
   (d) may increase or decrease

7. Two simple harmonic motions act on a particle. These harmonic motions are $x = A\cos(\omega t + \delta)$, $y = A\cos(\omega t + \alpha)$ when $\delta = \alpha + \frac{\pi}{2}$, the resulting motion is
(a) a circle and the actual motion is clockwise
(b) an ellipse and the actual motion is counterclockwise
(c) an elllipse and the actual motion is clockwise
(d) a circle and the actual motion is counter clockwise

8. The time period of a simple pendulum is 2 seconds. If its length is increased by 4-times, then its period becomes
(a) 16 s (b) 12 s
(c) 8 s (d) 4 s

9. The equation of a simple harmonic wave is given by $y = 3\sin\frac{\pi}{2}(50t - x)$
Where x and y are in meters and t is in seconds. The ratio of maximum particle velocity to the wave velocity is
(a) 2π (b) $\frac{3}{2}\pi$
(c) 3π (d) $\frac{2}{3}\pi$

10. The particle executing simple harmonic motion has a kinetic energy $K_0\cos^2\omega t$. The maximum values of the potential energy and the total energy are respectively
(a) $K_0/2$ and K_0 (b) K_0 and $2K_0$
(c) K_0 and K_0 (d) 0 and $2K_0$.

11. Which of the following is a simple harmonic motion?
(a) particle moving through a string fixed at both ends.
(b) wave moving through a string fixed at both ends.
(c) earth spinning about its axis.
(d) ball bouncing between two rigid vertical walls.

12. A mass m is vertically suspended from a spring of negligible mass; the system oscillates with a frequency n. What will be the frequency of the system, if a mass 4 m is suspended from the same spring?
(a) $\frac{n}{4}$ (b) $4n$
(c) $\frac{n}{2}$ (d) $2n$

13. The time period of second's pendulum is :
(a) 1s (b) 2s
(c) 4s (d) 8s

14. The potential energy of a long spring when stretched by 2 cm is U. If the spring is stretched by 8 cm, the potential energy stored in it is
(a) 8U (b) 16U
(c) U/4 (d) 4U

15. A simple pendulumn oscillates with a frequency f. The frequency with which its K.E. varies is :
(a) f (b) $\frac{f}{2}$
(c) $2f$ (d) $4f$

16. At resonance, the frequency of periodic force :
(a) must be equal to the frequency of oscillations.
(b) must be less than the frequency of oscillations
(c) must be greater than the frequency of oscillations.
(d) may be equal to the frequency of oscillations.

17. A rod is hinged vertically at one end and is forced to oscillate in a vertical plane with hinged end at the top, the motion of the rod:
(a) is simple harmonic
(b) is oscillatory but not simple harmonic
(c) is pericolic but not oscillatory
(d) may be simple harmonic

18. The superposition of two mutually perpendicular simple harmonic motions having same amplitude and a phase difference of $\frac{\pi}{2}$ results into :
(a) a circle
(b) an ellipse
(c) simple harmonic motion
(d) none of these

19. The necessary and sufficient condition for simple harmonic motion is :
(a) constant acceleration
(b) constant time period
(c) constant amplitude
(d) restoring force directly proportional to displacement

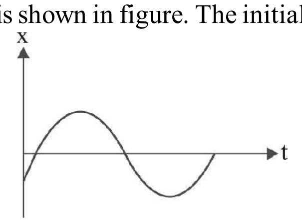
20. The phase difference between the instantaneous velocity and acceleration of a particle executing simple harmonic motion is

(a) π (b) $0.707\,\pi$

(c) zero (d) $0.5\,\pi$

Diagram Based Questions :

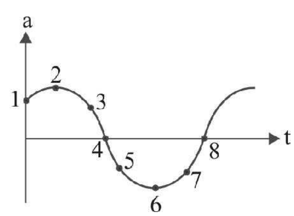
1. The displacement vs time of a particle executing SHM is shown in figure. The initial phase ϕ is



(a) $-\pi < \phi < -\frac{\pi}{2}$ (b) $\pi < \phi < \frac{3\pi}{2}$

(c) $-\frac{3\pi}{2} < \phi < -\pi$ (d) $\frac{\pi}{2} < \phi < \pi$

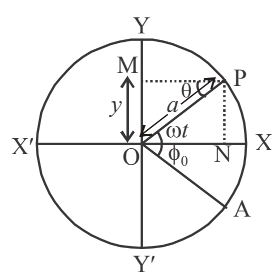
2. The acceleration of a particle undergoing SHM is graphed in figure. At point 2 the velocity of the particle is



(a) zero (b) negative

(c) positive (d) None of these

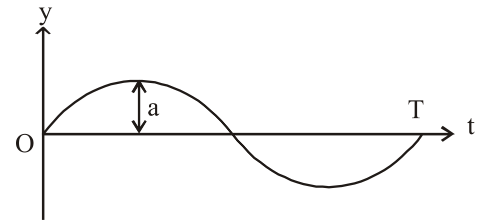
3. For the given figure



(a) $y = a \sin \omega t$ (b) $y = a \sin (\omega t - \phi_0)$

(c) $y = a \cos \omega t$ (d) $y = a \cos (\omega t - \phi_0)$

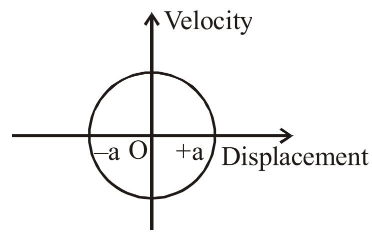
4. In the given displacement time curve for SHM at what value of t is the amplitude negative?



(a) $\frac{T}{2}$ (b) $\frac{T}{4}$

(c) $\frac{3T}{4}$ (d) $\frac{3T}{2}$

5. The graph shown in figure represents



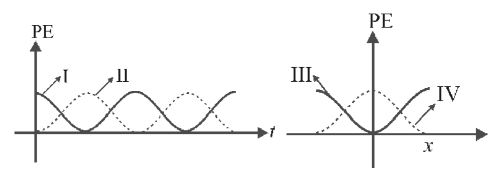
(a) S.H.M.

(b) circular motion

(c) rectillinear motion

(d) uniform circular motion

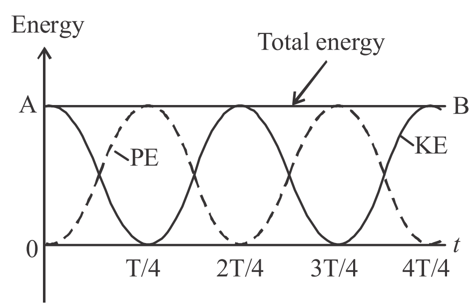
6. For a particle executing SHM the displacement x is given by $x = A\cos\omega t.$ Identify the graph which represents the variation of potential energy (P.E.) as a function of time t and displacement x.



(a) I, III (b) II, IV

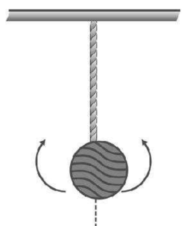
(c) II, III (d) I, IV

7. What do you conclude from the graph about the frequency of KE, PE and SHM ?



(a) Frequency of KE and PE is double the frequency of SHM
(b) Frequency of KE and PE is four times the frequency SHM.
(c) Frequency of PE is double the frequency of K.E.
(d) Frequency of KE and PE is equal to the frequency of SHM.

8. A simple pendulum is made of a body which is a hollow sphere containing mercury suspended by means of a wire. If a little mercury is drained off, the period of pendulum will



(a) remain unchanged (b) increase
(c) decrease (d) become erratic

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** *Sine* and *cosine* functions are periodic functions.
Reason : Sinusoidal functions repeats its values after a difinite interval of time

2. **Assertion :** In simple harmonic motion, the motion is to and fro and periodic
Reason : Velocity of the particle $(v) = \omega\sqrt{k^2 - x^2}$ (where x is the displacement).

3. **Assertion :** The graph of total energy of a particle in SHM w.r.t. position is a straight line with zero slope.
Reason : Total energy of particle in SHM remains constant throughout its motion.

4. **Assertion :** In a S.H.M. kinetic and potential energies become equal when the displacement is $1/\sqrt{2}$ times the amplitude.
Reason : In SHM, kinetic energy is zero when potential energy is maximum.

5. **Assertion :** The periodic time of a hard spring is less as compared to that of a soft spring.
Reason : The periodic time depends upon the spring constant, and spring constant is large for hard spring.

6. **Assertion :** Damped oscillation indicates loss of energy.
Reason : The energy loss in damped oscillation may be due to friction, air resistance etc.

7. **Assertion :** Resonance is special case of forced vibration in which the natural frequency of vibration of the body is the same as the impressed frequency of external periodic force and the amplitude of forced vibration is maximum
Reason : The amplitude of forced vibrations of a body increases with an increase in the frequency of the externally impressed periodic force.

8. **Assertion:** Pendulum clock will gain time on the mountain top.
Reason: On the mountain top the length of the pendulum will decrease and $T \propto \sqrt{l}$, so it will also decrease.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the column I and column II.

Column I		Column II	
(A)	Max. positive displacement	(1)	0
(B)	Max. positive velocity	(2)	$\frac{T}{2}$
(C)	Min. acceleration	(3)	$\frac{T}{4}$
(D)	Max. positive acceleration	(4)	T
(E)	Min. displacement	(5)	$\frac{3T}{4}$

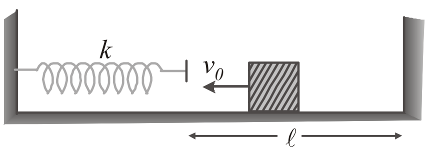
(a) (A) $\rightarrow$ (2), (B) $\rightarrow$ (4), (C) $\rightarrow$ (3), (D) $\rightarrow$ (5), (E) $\rightarrow$ (1)
(b) (A) $\rightarrow$ (1), (B) $\rightarrow$ (4), (C) $\rightarrow$ (5), (D) $\rightarrow$ (3), (E) $\rightarrow$ (2)
(c) (A) $\rightarrow$ (5), (B) $\rightarrow$ (1, 4), (C) $\rightarrow$ (3), (D) $\rightarrow$ (5), (E) $\rightarrow$ (1, 2, 4)
(d) (A) $\rightarrow$ (1, 3), (B) $\rightarrow$ (3, 4), (C) $\rightarrow$ (5), (D) $\rightarrow$ (1, 2), (E) $\rightarrow$ (5, 4)

2. A particle of mass 2 kg is moving on a straight line under the action of force $F = (8 - 2x)$ N. The particle is released at rest from $x = 6$m. For the subsequent motion match the following (All the values in the column II are in their S.I. units)

Column I		Column II	
(A)	Equilibrium position at x	(1)	$\pi/4$
(B)	Amplitude of SHM is	(2)	$\pi/2$
(C)	Time taken to go directly from $x = 2$ to $x = 4$	(3)	4
(D)	Energy of SHM is	(4)	2

(a) (A) $\rightarrow$ (3), (B) $\rightarrow$ (4), (C) $\rightarrow$ (2), (D) $\rightarrow$ (3)
(b) (A) $\rightarrow$ (4), (B) $\rightarrow$ (3), (C) $\rightarrow$ (2), (D) $\rightarrow$ (1)
(c) (A) $\rightarrow$ (1), (B) $\rightarrow$ (2), (C) $\rightarrow$ (3), (D) $\rightarrow$ (4)
(d) (A) $\rightarrow$ (2), (B) $\rightarrow$ (4), (C) $\rightarrow$ (1), (D) $\rightarrow$ (3)

3. A block of mass m is projected towards a spring with velocity v_0. The force constant of the spring is k. The block is projected from a distance ℓ from the free end of the spring. The collision between block and the wall is completely elastic. Match the following columns :



Column-I		Column-II	
(A)	Maximum compression of the spring	(1)	$-\sqrt{\frac{kv_0^2}{m}}$
(B)	Energy of oscillations of block	(2)	$\sqrt{\frac{mv_0^2}{k}}$
(C)	Time period of oscillations	(3)	$\frac{1}{2}mv_0^2$
(D)	Maximum acceleration of the block	(4)	$\left[\frac{2\ell}{v_0} + \pi\sqrt{\frac{m}{k}}\right]$

(a) (A) $\rightarrow$ (2), (B) $\rightarrow$ (3), (C) $\rightarrow$ (1), (D) $\rightarrow$ (4)
(b) (A) $\rightarrow$ (2), (B) $\rightarrow$ (3), (C) $\rightarrow$ (4), (D) $\rightarrow$ (1)
(c) (A) $\rightarrow$ (1), (B) $\rightarrow$ (4), (C) $\rightarrow$ (3), (D) $\rightarrow$ (2)
(d) (A) $\rightarrow$ (1), (B) $\rightarrow$ (2), (C) $\rightarrow$ (3), (D) $\rightarrow$ (4)

4. **Column I** | **Column II**

Column I	Column II
(A) $\frac{d^2y}{dt^2} = v^2 \frac{d^2y}{dx^2}$	(1) Resonant vibration
(B) $\frac{d^2y}{dt^2} + \omega^2 y = 0$	(2) Free vibration
(C) $\frac{d^2y}{dt^2} + 2k\frac{dy}{dt} + \omega^2 y = 0$	(3) Damped vibration
(D) $\frac{d^2y}{dt^2} + 2k\frac{dy}{dt} + \omega^2 y = F \sin pt$	(4) Forced vibration
	(5) Progressive wave

(a) (A) → (1), (B) → (3), (C) → (2, 4), (D) → (5)
(b) (A) → (1, 3), (B) → (2, 5), (C) → (3), (D) → (4, 5)
(c) (A) → (5), (B) → (2), (C) → (3), (D) → (1, 4)
(d) (A) → (1), (B) → (2), (C) → (3), (D) → (4)

5.

Column I	Column II
(A) Motion of a satellite	(1) Damped oscillations
(B) Motion of a simple pendulum	(2) Resonant oscillations
(C) Oscillation of stretched string in air	(3) Periodic motion
(D) Flying off of a paper rider placed on the stretched string	(4) Simple harmonic motion

(a) (A) → (2), (B) → (3), (C) → (4), (D) → (1)
(b) (A) → (3), (B) → (2), (C) → (4), (D) → (1)
(c) (A) → (1), (B) → (3), (C) → (2), (D) → (4)
(d) (A) → (3), (B) → (4), (C) → (1), (D) → (2)

Critical Thinking Type Questions :

1. A point mass oscillates along the x-axis according to the law $x = x_0 \cos(\omega t - \pi/4)$. If the acceleration of the particle is written as $a = A\cos(\omega t + \delta)$, then
(a) $A = x_0\omega^2, \delta = 3\pi/4$
(b) $A = x_0, \delta = -\pi/4$
(c) $A = x_0\omega^2, \delta = \pi/4$
(d) $A = x_0\omega^2, \delta = -\pi/4$

2. A particle at the end of a spring executes S.H.M with a period t_1, while the corresponding period for another spring is t_2. If the period of oscillation with the two springs in series is T then
(a) $T^{-1} = t_1^{-1} + t_2^{-1}$
(b) $T^2 = t_1^2 + t_2^2$
(c) $T = t_1 + t_2$
(d) $T^{-2} = t_1^{-2} + t_2^{-2}$

3. The length of a simple pendulum executing simple harmonic motion is increased by 21%. The percentage increase in the time period of the pendulum of increased length is
(a) 11%
(b) 21%
(c) 42%
(d) 10%

4. The amplitude of a damped oscillator becomes $\left(\frac{1}{3}\right)^{rd}$ in 2 seconds. If its amplitude after 6 seconds is $\frac{1}{n}$ times the original amplitude, the value of *n* is
(a) 3^2
(b) 3^3
(c) $\sqrt[3]{3}$
(d) 2^3

5. A pendulum of time period 2 s on earth is taken to another planet whose mass and diameter are twice that of earth. Then its time period on the planet is (in second)
(a) $\frac{1}{2}$
(b) $2\sqrt{2}$
(c) $\frac{1}{\sqrt{2}}$
(d) 2

6. A pendulum with time period of 1s is losing energy due to damping. At certain time its energy is 45 J. If after completing 15 oscillations, its energy has become 15 J, its damping constant (in s^{-1}) is :
(a) $\frac{1}{2}$
(b) $\frac{1}{30}\ln 3$
(c) 2
(d) $\frac{1}{15}\ln 3$

14 WAVES

Fill in the Blanks :

1. The waves associated with the moving fundamental particles are called _______ waves.
2. The ratio of the speed of a body to the speed of sound is called _______ .
3. Standing waves in a string are due to _______ of waves.
4. Two waves are said to be coherent, if they have _______ .
5. The notes of frequencies which are integral multiple of the fundamental frequencies are called _______ .
6. Doppler's effect in sound takes place when source and observer are in _______ motion.
7. Two sound waves of slightly different frequencies propagating in the same direction produce beats due to _______ .
8. Frequencies of sound produced from an organ pipe closed at one end are _______ harmonics only.

True/ False :

1. Waves are patterns of disturbance which move without the actual physical transfer of flow of matter as a whole.
2. Waves cannot transport energy.
3. Mechanical waves transfer energy and matter both from one point to another.
4. A series of wave pulse is called wave train.
5. In a closed organ pipe, closed at one end, longitudinal standing waves are present.
6. The harmonics which are present in a pipe, open at both ends are odd harmonics only.
7. Change in frequency due to Doppler effect will be positive if the distance between source and listener increases.

Conceptual MCQs :

1. Frequencies of sound produced from an organ pipe open at both ends are
   (a) only fundamental note
   (b) only even harmonics
   (c) only odd harmonics
   (d) even and odd harmonics
2. The fundamental frequency of an organ pipe is 512Hz. If its length is increased, then frequency will :
   (a) decrease (b) increase
   (c) remains same (d) cannot be predicted
3. Two sound waves having a phase difference of 60º have path difference of
   (a) 2λ (b) $\frac{\lambda}{2}$
   (c) $\frac{\lambda}{3}$ (d) $\frac{\lambda}{6}$
4. A sounding horn is rotating rapidly in a horizontal circle, the apparent frequency of the horn observed at the centre of the circle will be :
   (a) same as the actual frequency
   (b) less than the actual frequency
   (c) more than the actual frequency
   (d) sometimes more than and sometimes less than the actual frequency.
5. A star emitting light of green colour is approaching the earth with a uniform acceleration, its colour as seen from earth will :
   (a) appear green
   (b) turn gradually yellow
   (c) turn gradually blue
   (d) turn gradually red.
6. The property of a medium necessary for wave propagation is :
   (a) inertia (b) elasticity
   (c) low resistance (d) all of these

7. An observer moves towards a stationary source of sound with a speed 1/5th of the speed of sound. The wavelength and frequency of the sound emitted are λ and f respectively. The apparent frequency and wavelength recorded by the observer are respectively.

(a) 0.8f, 0.8λ (b) 1.2f, 1.2λ
(c) 1.2f, λ (d) f, 1.2λ

8. A transverse wave propagating along x-axis is represented by $y(x,t) = 8.0\sin(0.5\pi x - 4\pi t - \frac{\pi}{4})$ where x is in metres and t is in seconds. The speed of the wave is

(a) 0.5 π m/s (b) $\frac{\pi}{4}$ m/s
(c) 8 m/s (d) 4π m/s

9. A wave in a string has an amplitude of 2 cm. The wave travels in the + ve direction of x axis with a speed of 128 m/sec and it is noted that 5 complete waves fit in 4 m length of the string. The equation describing the wave is

(a) y = (0.02) m sin (15.7x – 2010t)
(b) y = (0.02) m sin (15.7x + 2010t)
(c) y = (0.02) m sin (7.85x – 1005t)
(d) y = (0.02) m sin (7.85x + 1005t)

10. Two sources P and Q produce notes of frequency 660 Hz each. A listener moves from P to Q with a speed of 1 ms^{-1}. If the speed of sound is 330 m/s, then the number of beats heard by the listener per second will be

(a) zero (b) 4
(c) 8 (d) 2

11. Two sources of sound placed close to each other are emitting progressive waves given by $y_1 = 4 \sin 600\,\pi t$ and $y_2 = 5 \sin 608\,\pi t$. An observer located near these two sources of sound will hear :

(a) 4 beats per second with intensity ratio 25 : 16 between waxing and waning.
(b) 8 beats per second with intensity ratio 25 : 16 between waxing and waning
(c) 8 beats per second with intensity ratio 81 : 1 between waxing and waning
(d) 4 beats per second with intensity ratio 81 : 1 between waxing and waning

12. The property of liquid which enables transverse wave to propagate on the surface of the liquid is

(a) bulk modulus (b) viscosity
(c) surface tension (d) all of these

13. Doppler's effect is not applicable for:

(a) audio waves
(b) electromagnetic waves
(c) shock waves
(d) none of these

14. A wave $y = a \sin(\omega t - kx)$ on a string meets with another wave producing a node at $x = 0$. Then the equation of the unknown wave is :

(a) $y = a \sin(\omega t + kx)$
(b) $y = -a \sin(\omega t + kx)$
(c) $y = a \sin(\omega t - kx)$
(d) $y = -a \sin(\omega t - kx)$

15. Two sound waves of equal intensity I produce beats. The maximum intensity of sound produced in beats will be :

(a) I (b) 2I
(c) 3I (d) 4I

16. The time taken by a particle in reaching from trough to crest in a transverse wave is :

(a) $\frac{T}{4}$ (b) $\frac{T}{2}$
(c) $\frac{3T}{4}$ (d) T

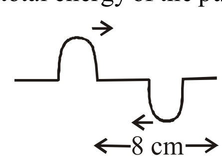
17. Doppler's effect is used for finding :

(a) the rotation of the sun
(b) the double star
(c) the saturn ring
(d) all the above

18. From a wave equation: $y = 0.5\sin\frac{2\pi}{3.2}(64t - x)$, the frequency of the wave is

(a) 5 Hz (b) 15 Hz
(c) 20 Hz (d) 25 Hz

19. Two pulses on a stretched string whose centres are initially 8 cm apart are moving towards each other as shown in the figure. When the pulses overlap, the total energy of the pulses will be :



(a) zero
(b) purely kinetic
(c) purely potential
(d) partly kinetic and partly potential

20. An organ pipe P_1 closed at one end vibrating in its first overtone and another pipe P_2, open at both ends vibrating in its third overtone are in resonance with a given tuning fork. The ratio of lengths of P_1 and P_2 respectively are given by

(a) 1 : 2 (b) 1 : 3
(c) 3 : 8 (d) 3 : 4

21. A standing wave having 3 nodes and 2 antinodes is formed between two atoms having a distance 1.21 Å between them. The wavelength of the standing wave is

(a) 1.21 Å (b) 2.42 Å
(c) 6.05 Å (d) 3.63 Å

22. If we study the vibration of a pipe open at both ends, then which of the following statements is not true ?

(a) Odd harmonics of the fundamental frequency will be generated
(b) All harmonics of the fundamental frequency will be generated
(c) Pressure change will be maximum at both ends
(d) Antinode will be at open end

23. Two sound waves with wavelengths 5.0 m and 5.5m respectively, each propagate in a gas with velocity 330 m/s. We expect the following number of beats per second

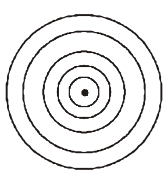
(a) 0 (b) 1
(c) 6 (d) 12

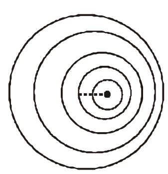
24. A source and an observer move away from each other, with a velocity of 10m/s with respect to ground. If the observer finds the frequency of sound coming from the source as 1950 Hz, then original frequency of source is (velocity of sound in air = 340 m/s)

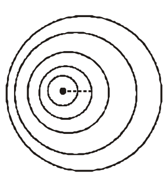
(a) 1950 Hz (b) 2068 Hz
(c) 2132 Hz (d) 2486 Hz

Diagram Based Questions :

1. If the source is moving towards right, wave front of sound waves get modified to

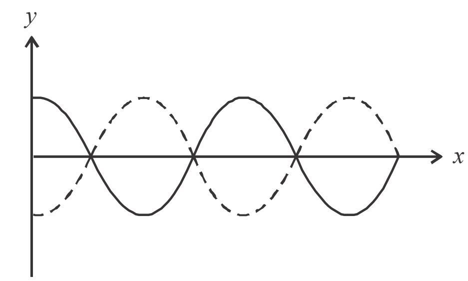
(a) 

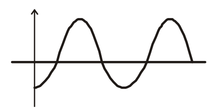
(b) 

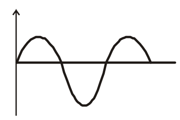
(c) 

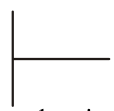
(d) None of these

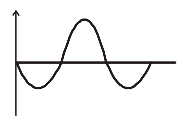
2. For the graph given, the resultant wave will be



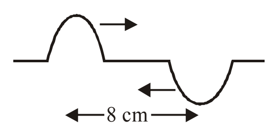
(a) 

(b) 

(c) 

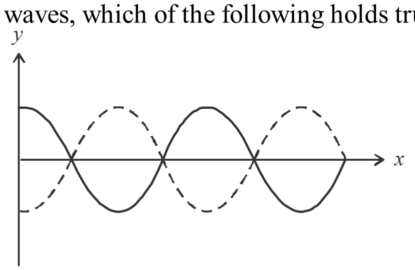
(d) 

3. Two pulses in a stretched string whose centres are initially 8 cm apart are moving towards each other as shown in the figure. The speed of each pulse is 2 cm/s. After 2 s, the total energy of the pulses will be



(a) Zero
(b) Purely kinetic
(c) Purely potential
(d) Partly kinetic and partly potential

4. For the graph given below for superposition of two waves, which of the following holds true?

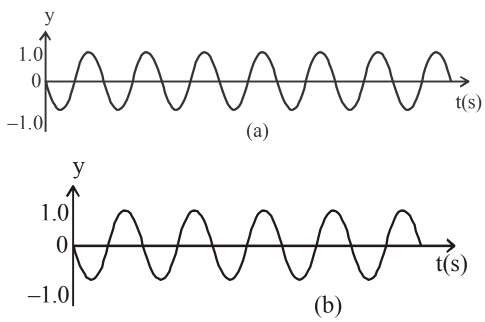


(a) Phase difference, $\phi = 0$
(b) Phase difference, $\phi = \frac{\pi}{2}$
(c) Phase difference, $\phi = \pi$
(d) Phase difference, $\phi = 2\pi$

5. The fifth harmonic for vibrations of a stretched string is shown in figure. How many nodes are present here?

(a) 4 (b) 6
(c) 5 (d) 10

6. What will be the frequency of beats formed from the superposition of two harmonic waves shown below?



(a) 20 Hz (b) 11 Hz
(c) 9 Hz (d) 2 Hz

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Sound wave is an example of longitudinal wave.
Reason : In longitudinal waves, the constituents of the medium oscillate perpendicular to the direction of wave propagation.

2. **Assertion :** Two waves moving in a uniform string having uniform tension cannot have different velocities.
Reason : Elastic and inertial properties of string are same for all waves in same string. Moreover speed of wave in a string depends on its elastic and inertial properties only.

3. **Assertion:** Explosions on other planets are not heard on Earth.
Reason: Sound waves cannot travel to a far off distance

4. **Assertion:** Two astronauts can talk to each other on moon through microphone.
Reason: Microphone can convert their sound signals into transverse waves which can travel even in vacuum.

5. **Assertion :** The base of Laplace correction was that exchange of heat between the region of compression and rarefaction in air is negligible.
Reason : Air is bad conductor of heat and velocity of sound in air is quite large.

6. **Assertion :** On reflection from a rigid boundary there takes place a complete reversal of phase.
Reason: On reflection from a denser medium, both the particle velocity and wave velocity are reversed in sign.

7. **Assertion :** In the case of a stationary wave, a person hear a loud sound at the nodes as compared to the antinodes.
Reason : In a stationary wave all the particles of the medium vibrate in phase.

8. **Assertion :** Speed of mechanical wave in the medium depends on the velocity of source, relative to an observer at rest.
Reason : Speed of mechanical wave is independent of the elastic and other properties such as mass density of the medium.

9. **Assertion :** Doppler formula for sound wave is symmetric with respect to the speed of source and speed of observer.
Reason : Motion of source with respect to stationary observer is not equivalent to the motion of an observer with respect to stationary source.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the Columns I and II.

	Column I		**Column II**
(A)	A region of low pressure and low density	(1)	Particles oscillate at right angle
(B)	A region of high pressure and high density	(2)	Particles oscillate in the same direction
(C)	Longitudinal wave	(3)	Compression
(D)	Transverse wave	(4)	Rarefaction

(a) (A) $\rightarrow$ (3) ; (B) $\rightarrow$ (4) ; (C) $\rightarrow$ (1) ; (D) $\rightarrow$ (2)
(b) (A) $\rightarrow$ (1) ; (B) $\rightarrow$ (2) ; (C) $\rightarrow$ (3) ; (D) $\rightarrow$ (4)
(c) (A) $\rightarrow$ (4) ; (B) $\rightarrow$ (3) ; (C) $\rightarrow$ (2) ; (D) $\rightarrow$ (1)
(d) (A) $\rightarrow$ (3) ; (B) $\rightarrow$ (4) ; (C) $\rightarrow$ (2) ; (D) $\rightarrow$ (2)

2.

	Column I		**Column II**
(A)	Mechanical waves	(1)	Disturbance for short time
(B)	Pulse	(2)	Independent of amplitude of vibrations
(C)	Velocity of sound in air	(3)	SONAR
(D)	Tracking of fish in ocean	(4)	Require a material medium

(a) (A) $\rightarrow$ (3) ; (B) $\rightarrow$ (4) ; (C) $\rightarrow$ (1) ; (D) $\rightarrow$ (2)
(b) (A) $\rightarrow$ (1) ; (B) $\rightarrow$ (2) ; (C) $\rightarrow$ (3) ; (D) $\rightarrow$ (4)
(c) (A) $\rightarrow$ (4) ; (B) $\rightarrow$ (1) ; (C) $\rightarrow$ (2) ; (D) $\rightarrow$ (3)
(d) (A) $\rightarrow$ (3) ; (B) $\rightarrow$ (4) ; (C) $\rightarrow$ (2) ; (D) $\rightarrow$ (2)

3.

	Column I		**Column II**
(A)	$y = 4\sin(5x - 4t) + 3\cos(4t - 5x + \pi/6)$	(1)	Particles at every position are performing SHM
(B)	$y = 10\cos\left(t - \frac{x}{330}\right)\sin(100)\left(t - \frac{x}{330}\right)$	(2)	Equation of travelling wave
(C)	$y = 10\sin(2\pi x - 120t) + 10\cos(120t + 2\pi x)$	(3)	Equation of standing wave
(D)	$y = 10\sin(2\pi x - 120t) + 8\cos(118t - 59/30\pi x)$	(4)	Equation of Beats

(a) (A) $\rightarrow$ (3) ; (B) $\rightarrow$ (4) ; (C) $\rightarrow$ (1) ; (D) $\rightarrow$ (2)
(b) (A) $\rightarrow$ (1) ; (B) $\rightarrow$ (2) ; (C) $\rightarrow$ (3) ; (D) $\rightarrow$ (4)
(c) (A) $\rightarrow$ (4) ; (B) $\rightarrow$ (3) ; (C) $\rightarrow$ (1) ; (D) $\rightarrow$ (2)
(d) (A) $\rightarrow$ (1,2) ; (B) $\rightarrow$ (4) ; (C) $\rightarrow$ (1,3) ; (D) $\rightarrow$ (4)

4.

	Column I		**Column II**
(A)	Sound	(1)	Frequency
(B)	SONAR	(2)	Mechanical wave
(C)	Reflection of sound	(3)	Finding depth of the sea
(D)	Pitch	(4)	Echo

(a) (A) $\rightarrow$ (3) ; (B) $\rightarrow$ (4) ; (C) $\rightarrow$ (1) ; (D) $\rightarrow$ (2)
(b) (A) $\rightarrow$ (1) ; (B) $\rightarrow$ (2) ; (C) $\rightarrow$ (3) ; (D) $\rightarrow$ (4)
(c) (A) $\rightarrow$ (4) ; (B) $\rightarrow$ (3) ; (C) $\rightarrow$ (1) ; (D) $\rightarrow$ (2)
(d) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (3) ; (C) $\rightarrow$ (4) ; (D) $\rightarrow$ (1)

5.

	Column I		**Column II**
(A)	Pitch	(1)	Waveform
(B)	Quality	(2)	Frequency
(C)	Loudness	(3)	Intensity
(D)	Nodes	(4)	Position of zero amplitude

(a) (A) $\rightarrow$ (1) ; (B) $\rightarrow$ (2) ; (C) $\rightarrow$ (3) ; (D) $\rightarrow$ (4)
(b) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (1) ; (C) $\rightarrow$ (3) ; (D) $\rightarrow$ (4)
(c) (A) $\rightarrow$ (3) ; (B) $\rightarrow$ (1) ; (C) $\rightarrow$ (4) ; (D) $\rightarrow$ (2)
(d) (A) $\rightarrow$ (3) ; (B) $\rightarrow$ (4) ; (C) $\rightarrow$ (1) ; (D) $\rightarrow$ (2)

6.

	Column I		**Column II**
(A)	Change in apparent frequency due to the relative motion between source and listner	(1)	Beats
(B)	Intensity of sound varies with	(2)	Transverse Wave
(C)	Sound waves in air	(3)	Doppler's effect
(D)	Light waves	(4)	Longitudinal wave

(a) (A) → (1) ; (B) → (2) ; (C) → (3) ; (D) → (4)
(b) (A) → (2) ; (B) → (3) ; (C) → (4) ; (D) → (1)
(c) (A) → (3) ; (B) → (1) ; (C) → (4) ; (D) → (2)
(d) (A) → (3) ; (B) → (4) ; (C) → (1) ; (D) → (2)

7. Source has frequency f. Source and observer both have same speed. For the apparent frequency observed by observer match the following.

Column-I	**Column-II**
(A) Observer is approaching the source but source is receding from the observer	(1) More than f
(B) Observer and source both approaching towards each other	(2) Less than f
(C) Observer and source both receding from each other	(3) Equal to f
(D) Source is approaching but observer is receding	(4) Infinite

(a) (A) → (3) ; (B) → (4) ; (C) → (1) ; (D) → (2)
(b) (A) → (1) ; (B) → (2) ; (C) → (3) ; (D) → (4)
(c) (A) → (4) ; (B) → (3) ; (C) → (1) ; (D) → (2)
(d) (A) → (3) ; (B) → (1) ; (C) → (2) ; (D) → (3)

Critical Thinking Type Questions :

1. A transverse wave is represented by $y = A \sin(\omega t - kx)$. For what value of the wavelength is the wave velocity equal to the maximum particle velocity?

(a) $\frac{\pi A}{2}$ (b) πA
(c) $2\pi A$ (d) A

2. The displacement y of a particle in a medium can be expressed as, $y = 10^{-6} \sin\left(100t + 20x + \frac{\pi}{4}\right) m$ where t is in second and x in meter. The speed of the wave is

(a) 20 m/s (b) 5 m/s
(c) 2000 m/s (d) 5π m/s

3. A sonometer wire supports a 4 kg load and vibrates in fundamental mode with a tuning fork of frequency 416 Hz. The length of the wire between the bridges is now doubled. In order to maintain fundamental mode, the load should be changed to

(a) 1 kg (b) 2 kg
(c) 4 kg (d) 16 kg

4. A sonometer wire of length 1.5 m is made of steel. The tension in it produces an elastic strain of 1%. What is the fundamental frequency of steel if density and elasticity of steel are 7.7×10^3 kg/m^3 and 2.2×10^{11} N/m^2 respectively ?

(a) 188.5 Hz (b) 178.2 Hz
(c) 200.5 Hz (d) 770 Hz

5. The fundamental frequency of a closed organ pipe of length 20 cm is equal to the second overtone of an organ pipe open at both the ends. The length of organ pipe open at both the ends is

(a) 100 cm (b) 120 cm
(c) 140 cm (d) 80 cm

6. A car is moving towards a high cliff. The car driver sounds a horn of frequency f. The reflected sound heard by the driver has as frequency $2f$. If v be the velocity of sound, then the velocity of the car, in the same velocity units, will be

(a) v /2 (b) v /$\sqrt{2}$
(c) v /3 (d) v /4

7. A train moving at a speed of 220 ms^{-1} towards a stationary object, emits a sound of frequency 1000 Hz. Some of the sound reaching the object gets reflected back to the train as echo. The frequency of the echo as detected by the driver of the train is (speed of sound in air is 330 ms^{-1})

(a) 3500 Hz (b) 4000 Hz
(c) 5000 Hz (d) 3000 Hz

15

Electric Charges and Fields

Fill in the Blanks :

1. A soap bubble is given a negative charge, then its radius _______ .

2. The electric field created by a point charge falls with distance from the point charge as ______ .

3. Quantisation of charge was experimentally demonstrated by _______ .

4. If a dipole of dipole moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$, then torque acting on it is given by _______ .

5. The total electric flux emanating from a closed surface enclosing an α-particle is (e-electronic charge) _______ .

6. The electric field inside a spherical shell of uniform surface charge density is _______ .

7. When an electric dipole $\vec{P}$ is placed in a uniform electric field $\vec{E}$ then at angle _______ between $\vec{P}$ and $\vec{E}$ the value of torque will be maximum.

8. The law, governing the force between electric charges is known as _______ .

True/ False :

1. The work done in carrying a point charge from one point to another in an electrostatic field depends on the path along which the point charge is carried.

2. Two identical metallic spheres of exactly equal masses are taken. One is given a positive charge and the other an equal negative charge. Their masses after charging are different.

3. A small metal ball is suspended in a uniform electric field with the help of an insulated thread. If high energy X-ray beam falls on the ball, the ball will be deflected in the direction of the field.

4. Total flux linked with a closed body, not enclosing any charge will be zero.

5. Electric fields lines start from negative charge and end at positive charge.

6. Electric field lines form closed loops.

7. At the centre of the line joining two equal and opposite charge, electric field E = 0

Conceptual MCQs :

1. An electric charge, + Q is placed on the surface of a solid, conduction sphere of radius a. The distance measured from the centre of the sphere is denoted as r. Then

(a) the charge gets distributed uniformly through the volume of the sphere

(b) The electrostatic potential has the same value for r < a

(c) an equal and opposite charge gets induce in the bottom half of the sphere

(d) the electric field is given by $1/(4\pi \epsilon_0 r^2)$ for r < a

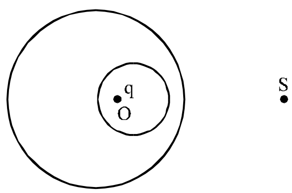
2. An electron is moving round the nucleus of a hydrogen atom in a circular orbit of radius r. The Coulomb force $\vec{F}$ between the two is

$$\left(\text{where } K = \frac{1}{4\pi\varepsilon_0}\right)$$

(a) $K\dfrac{e^2}{r^3}\vec{r}$ (b) $K\dfrac{e^2}{r^2}\hat{r}$

(c) $-K\dfrac{e^2}{r^3}\hat{r}$ (d) $-K\dfrac{e^2}{r^3}\vec{r}$

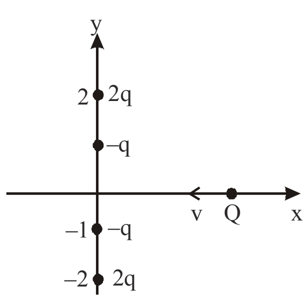
3. A charge q is placed at O in the cavity in a spherical uncharged conductor. Point S is outside the conductor.
If the charge is displaced from O towards S, still remaining



within the cavity, electric field at S will
(a) increase
(b) decrease
(c) first increase and then decrease
(d) not change

4. The electric intensity due to a dipole of length 10 cm and having a charge of 500 μC, at a point on the axis at a distance 20 cm from one of the charges in air, is
(a) 6.25×10^7 N/C (b) 9.28×10^7 N/C
(c) 13.1×10^{11} N/C (d) 20.5×10^7 N/C

5. Four charges are rigidly fixed along the Y-axis as shown. A positive charge approaches the system along the X-axis with initial speed just enough to cross the origin. Then its total energy at the origin is –



(a) zero (b) positive
(c) negative (d) data insufficient

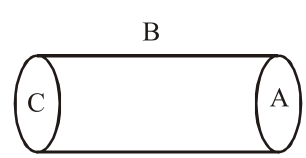
6. A ball of charge + 50e lies at the centre of a hollow spherical metal shell that has a net charge of – 150e. The charge on the inner surface and outer surface of the spherical shell is :
(a) + 50 e, – 200 e (b) – 50 e, – 100 e
(c) – 50 e, – 150 e (d) – 50 e, + 100 e

7. The total positive charge in a glass of water containing 180 g of water is approximately :
(a) 1.0×10^7 coulomb
(b) 6.03×10^7 coulomb
(c) 1.80×10^7 coulomb
(d) 1.20×10^7 coulomb

8. The electric field at a distance $\frac{3R}{2}$ from the centre of a charged conducting spherical shell of radius R is E. The electric field at a distance $\frac{R}{2}$ from the centre of the sphere is
(a) $\frac{E}{2}$ (b) zero
(c) E (d) $\frac{E}{2}$

9. Three point charges +q, –q and +q are placed at points (x = 0, y = a, z = 0), (x = 0, y = 0, z = 0) and (x = a, y = 0, z = 0) respectively. The magnitude and direction of the electric dipole moment vector of this charge assembly are
(a) $\sqrt{2}$qa along the line joining points (x = 0, y = 0, z = 0) and (x = a, y = a, z = 0)
(b) qa along the line joining points (x = 0, y = 0, z = 0) and (x = a, y = a, z = 0)
(c) $\sqrt{2}$qa along +ve x direction
(d) $\sqrt{2}$qa along +ve y direction

10. A hollow cylinder has a charge q coulomb within i. If ϕ is the electric flux in units of voltmeter associated with the curved surface B, the flux linked with the plane surface A in units of voltmeter will be



(a) $\frac{q}{2\varepsilon_0}$ (b) $\frac{\phi}{3}$

(c) $\frac{q}{\varepsilon_0}-\phi$ (d) $\frac{1}{2}\left(\frac{q}{\varepsilon_0}-\phi\right)$

11. An electric dipole of moment $\vec{p}$ is lying along a uniform electric field $\vec{E}$. The work done in rotating the dipole by 90° is

(a) $\frac{pE}{2}$ (b) $2pE$

(c) pE (d) $\sqrt{2}\,pE$

12. A charge q is located at the centre of a cube. The electric flux through any face is

(a) $\frac{q}{6(4\pi\varepsilon_0)}$ (b) $\frac{2\pi q}{6(4\pi\varepsilon_0)}$

(c) $\frac{4\pi q}{6(4\pi\varepsilon_0)}$ (d) $\frac{\pi q}{6(4\pi\varepsilon_0)}$

13. The mean free path of electrons in a metal is 4×10^{-8} m. The electric field which can give on an average 2 eV energy to an electron in the metal will be in units of V/m

(a) 5×10^{-11} (b) 8×10^{-11}

(c) 5×10^{7} (d) 8×10^{7}

14. A particle of mass m and charge q is placed at rest in a uniform electric field E and then released. The kinetic energy attained by the particle after moving a distance *y* is

(a) qEy^2 (b) qE^2y

(c) qEy (d) q^2Ey

15. A point charge +q is placed at mid point of a cube of side 'L'. The electric flux emerging from the cube is

(a) $\frac{q}{\varepsilon_0}$ (b) $\frac{6qL^2}{\varepsilon_0}$

(c) $\frac{q}{6L^2\varepsilon_0}$ (d) zero

16. An electric dipole, consisting of two opposite charges of 2×10^{-6} C each separated by a distance 3 cm is placed in an electric field of 2×10^{5} N/C. Torque acting on the dipole is

(a) 12×10^{-1} N – m (b) 12×10^{-2} N – m

(c) 12×10^{-3} N – m (d) 12×10^{-4} N – m

17. The point charge Q and – 2Q are placed of some distance apart. If the electric field at the location of Q is E. Then the electric field at the location of – 2 Q will be

(a) – 2 E (b) – E

(c) $-\frac{5E}{2}$ (d) $-\frac{E}{2}$

18. Two charges of magnitude q and Q – q are placed at a distance d from each other force between them would be maximum if :

(a) q = Q/3 (b) q = – Q/2d

(c) q = 2Q (d) q = Q/2

19. The electric field strength at a distance r from a charge q is E. What will be electric field strength if the distance of the observation point is increased to 2 r?

(a) E/2 (b) E/4

(c) E/6 (d) none of the above

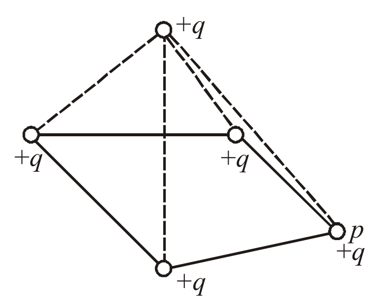
20. The surface density on the copper sphere is s. The electric field strength on the surface of the sphere is

(a) s (b) s/2

(c) $\sigma/2\varepsilon_o$ (d) σ/ε_o

Diagram Based Questions :

1. The figure shows a charge + *q* at point P held in equilibrium in air with the help of four + *q* charges situated at the vertices of a square. The net electrostatic force on *p* is given by

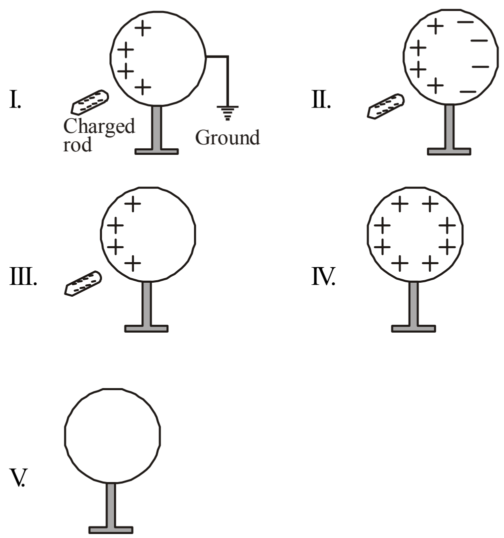


(a) Gauss's law (b) Coulomb's law

(c) Principle of superposition

(d) net electric flux out the position of +*q*.

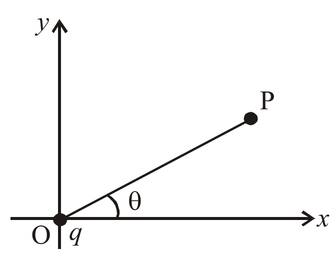
2. A metal sphere is being charged by induction using a charged rod, but the sequence of diagrams showing the process misplaced.



Correct order of charging is

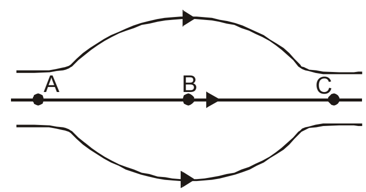
(a) I → II → III → IV → V
(b) V → II → III → I → IV
(c) V → II → I → III → IV
(d) IV → II → III → I → V

3. In the figure, charge q is placed at origin O. When the charge q is displaced from its position the electric field at point P changes



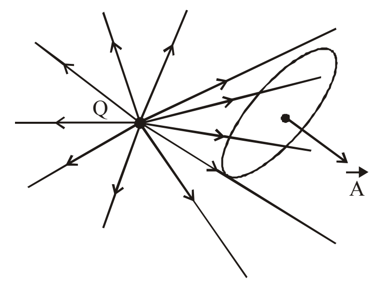
(a) at the same time when q is displaced.
(b) at a time after $\frac{OP}{c}$ where c is the speed of light.
(c) at a time after $\frac{OP\cos\theta}{c}$.
(d) at a time after $\frac{OP\sin\theta}{c}$

4. Figure shows some of the electric field lines corresponding to an electric field. The figure suggests that



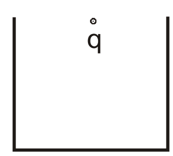
(a) $E_A > E_B > E_C$ (b) $E_A = E_B = E_C$
(c) $E_A = E_C > E_B$ (d) $E_A = E_C < E_B$

5. In the figure the net electric flux through the area A is $\phi = \vec{E} \cdot \vec{A}$ when the system is in air. On immersing the system in water the net electric flux through the area



(a) becomes zero (b) remains same
(c) increases (d) decreases

6. A charge q is placed at the centre of the open end of a cylindrical vessel. The flux of the electric field through the surface of the vessel is



(a) zero (b) q/ε_o
(c) $q/2\varepsilon_o$ (d) $2q/\varepsilon_o$

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** When bodies are charged through friction, there is a transfer of electric charge from one body to another, but no creation or destruction of charge.
Reason : This follows from conservation of electric charges.

2. **Assertion :** Coulomb law and gravitational law follow the same inverse-square law.
Reason : Both laws are same in all aspects.

3. **Assertion :** The coulomb force is the dominating force in the universe.
Reason : The coulomb force is weaker than the gravitational force.

4. **Assertion :** If there exists coulomb attraction between two bodies, both of them may not be charged.
Reason : In coulomb attraction two bodies are oppositely charged.

5. **Assertion :** A deuteron and an α-particle are placed in an electric field. If F_1 and F_2 be the forces acting on them and a_1 and a_2 be their accelerations respectively then, $a_1 = a_2$.
Reason : Forces will be same in electric field.

6. **Assertion :** The property that the force with which two charges attract or repel each other are not affected by the presence of a third charge.
Reason : Force on any charge due to a number of other charge is the vector sum of all the forces on that charge due to other charges, taken one at a time.

7. **Assertion :** On bringing a positively charged rod near the uncharged conductor, the conductor gets attracted towards the rod.
Reason : The electric field lines of the charged rod are perpendicular to the surface of conductor.

8. **Assertion :** On going away from a point charge or a small electric dipole, electric field decreases at the same rate in both the cases.
Reason : Electric field is inversely proportional to square of distance from the charge or an electric dipole.

9. **Assertion :** On moving a distance two times the initial distance away from an infinitely long straight uniformly charged wire the electric field reduces to one third of the initial value.
Reason : The electric field is inversely proportional to the distance from an infinitely long straight uniformly charged wire.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match Column I and Column II.

Column I	**Column II**
(A) Additivity of charge	(1) ${}_0^1n + {}_{92}^{235}U \rightarrow {}_{56}^{144}Ba + {}_{36}^{89}Kr + 3{}_0^1n$
(B) Conservation of charge	(2) $-5\mu C + 15\mu C = 10\mu C$
(C) Quantisation of charge	(3) Gold nucleus repels alpha particle.
(D) Attraction and repulsion	(4) q = ne

(a) $(A)\rightarrow(3), (B)\rightarrow(2), (C)\rightarrow(4), (D)\rightarrow(1)$
(b) $(A)\rightarrow(2), (B)\rightarrow(4), (C)\rightarrow(1), (D)\rightarrow(3)$
(c) $(A)\rightarrow(2), (B)\rightarrow(1), (C)\rightarrow(4), (D)\rightarrow(3)$
(d) $(A)\rightarrow(1), (B)\rightarrow(2), (C)\rightarrow(3), (D)\rightarrow(4)$

2. Match the physical quantities in column I and the information related to them in Column II.

Column I	**Column II**
(A) Electric dipole moment	(1) Vector product
(B) Electric field	(2) Scalar product
(C) Electric flux	(3) Points towards positive charge
(D) Torque	(4) Points away from positive charge

(a) $(A)\rightarrow(3), (B)\rightarrow(2), (C)\rightarrow(4), (D)\rightarrow(1)$
(b) $(A)\rightarrow(1), (B)\rightarrow(3), (C)\rightarrow(4), (D)\rightarrow(2)$
(c) $(A)\rightarrow(3), (B)\rightarrow(4), (C)\rightarrow(2), (D)\rightarrow(1)$
(d) $(A)\rightarrow(1), (B)\rightarrow(2), (C)\rightarrow(3), (D)\rightarrow(4)$

3. **Column I** | **Column II**

Column I	Column II
(A) Linear charge density	(1) $\frac{\text{Charge}}{\text{Volume}}$
(B) Surface charge density	(2) $\frac{\text{Charge}}{\text{Length}}$
(C) Volume charge density	(3) $\frac{\text{Charge}}{\text{Area}}$
(D) Discrete charge distribution	(4) System consisting of ultimate individual charges

(a) $A \to (2), B \to (3), C \to (1), D \to (4)$
(b) $A \to (1), B \to (3), C \to (1), D \to (4)$
(c) $A \to (3), B \to (1), C \to (2), D \to (4)$
(d) $A \to (3), B \to (2), C \to (1), D \to (4)$

4. Match the entries of column I with that of Column II.

Column I	Column II
(A) Coulomb's law	(1) Total electric flux through a closed surface.
(B) Gauss's law	(2) Vector sum of forces.
(C) Principle of superposition	(3) Force is inversely proportional to square of distance
(D) Quantisation of charge	(4) Discrete nature of charge

(a) $(A) \to (2), (B) \to (3), (C) \to (1), (D) \to (4)$
(b) $(A) \to (3), (B) \to (1), (C) \to (2), (D) \to (4)$
(c) $(A) \to (1), (B) \to (4), (C) \to (3), (D) \to (2)$
(d) $(A) \to (1), (B) \to (2), (C) \to (3), (D) \to (4)$

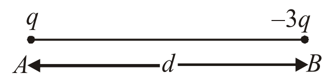
5. Match the source of charge given in Column I with expressions of electric field produced by them in Column II.

Column I	Column II
(A) Point charge	(1) $\frac{\lambda}{2\pi\varepsilon_0 r}$
(B) Infinitely long straight uniformly charged wire	(2) $\frac{\sigma}{2\varepsilon_0}$
(C) Uniformly charged infinite plane sheet	(3) 0
(D) At a point inside a uniformly charged thin spherical shell.	(4) $\frac{q}{4\pi\varepsilon_0 r^2}$

(a) $(A) \to (1), (B) \to (3), (C) \to (4), (D) \to (2)$
(b) $(A) \to (4), (B) \to (3), (C) \to (2), (D) \to (1)$
(c) $(A) \to (4), (B) \to (1), (C) \to (2), (D) \to (3)$
(d) $(A) \to (2), (B) \to (4), (C) \to (1), (D) \to (3)$

Critical Thinking Type Questions :

1. Two charge q and $-3q$ are placed fixed on x–axis separated by distance d. Where should a third charge $2q$ be placed such that it will not experience any force ?



(a) $\frac{d-\sqrt{3}\,d}{2}$ (b) $\frac{d+\sqrt{3}\,d}{2}$

(c) $\frac{d+3d}{2}$ (d) $\frac{d-3d}{2}$

2. Force between two identical charges placed at a distance of r in vacuum is F. Now a slab of dielectric of dielectric contrant 4 is inserted between these two charges. If the thickness of the slab is r/2, then the force between the charges will become

(a) F (b) $\frac{3}{5}$F

(c) $\frac{4}{9}$F (d) $\frac{F}{2}$

3. Two particle of equal mass m and charge q are placed at a distance of 16 cm. They do not experience any force. The value of $\frac{q}{m}$ is

(a) l (b) $\sqrt{\frac{\pi\varepsilon_0}{G}}$

(c) $\sqrt{\frac{G}{4\pi\varepsilon_0}}$ (d) $\sqrt{4\pi\varepsilon_0 G}$

4. The number of electric lines of force that radiate outwards from one coulomb of charge in vacuum is

(a) 1.13×10^{11} (b) 1.13×10^{10}

(c) 0.61×10^{11} (d) 0.61×10^{9}

5. The electric intensity due to a dipole of length 10 cm and having a charge of 500 μC, at a point on the axis at a distance 20 cm from one of the charges in air, is

(a) 6.25×10^{7} N/C (b) 9.28×10^{7} N/C

(c) 13.1×10^{11} N/C (d) 20.5×10^{7} N/C

6. An electric dipole is placed at an angle of 30° with an electric field of intensity 2×10^5 NC^{-1}, It experiences a torque of 4 Nm. Calculate the charge on the dipole if the dipole length is 2 cm.

(a) 8mC (b) 4mC

(c) 8μC (d) 2mC

7. The surface density on the copper sphere is σ. The electric field strength on the surface of the sphere is

(a) σ (b) σ/2

(c) $Q/2\varepsilon_o$ (d) Q/ε_o

8. If a charge q is placed at the centre of the line joining two equal charges Q such that the system is in equilibrium then the value of q is

(a) Q/2 (b) –Q/2

(c) Q/4 (d) –Q/4

16

Electrostatic Potential and Capacitance

Fill in the Blanks :

1. An electric dipole of moment $\vec{p}$ is placed normal to the lines of force of electric intensity $\vec{E}$, then the work done in deflecting it through an angle of 180° is ______ .
2. On decreasing the distance between the plates of a parallel plate capacitor, its capacitance ______ .
3. A capacitor stores ______ in the electrostatic field between the plates.
4. A sheet of aluminium foil of negligible thickness is introduced between the plates of a capacitor. The capacitance of the capacitor ______ .
5. The potential gradient at which the dielectric of a condenser just gets punctured is called ______ .
6. The energy stored in a condenser of capacity C which has been raised to a potential V is given by ______ .
7. An arrangement which consists of two conductors separated by a dielectric medium is called ______ .
8. ______ is a machine that can build up high voltages of the order of a few million volts.

True/ False :

1. In non-polar molecules displacement stops when the external force on the constituent charges of the molecule is balanced by the restoring force.
2. Electric field lines are always perpendicular to equipotential surface.
3. Electric field lines are in the direction of tangent to an equipotential surface.
4. The potential at all the points on an equipotential surface is same.
5. Work done in moving a charge from one point to other on an equipotential surface is zero.
6. Regarding series grouping of capacitors, Potential difference and energy distributes in the reverse ratio of capacitance.
7. Effective capacitance is even les than the least of the individual capacitances.

Conceptual MCQs :

1. A parallel plate capacitor is charged to a certain voltage. Now, if the dielectric material (with dielectric constant k) is removed then the
   (a) capacitance increases by a factor of k
   (b) electric field reduces by a factor k
   (c) voltage across the capacitor decreases by a factor k
   (d) none of these.
2. In a region, the potential is represented by $V(x, y, z) = 6x - 8xy - 8y + 6yz$, where V is in volts and x, y, z are in metres. The electric force experienced by a charge of 2 coulomb situated at point (1, 1, 1) is :
   (a) $6\sqrt{5}$ N (b) 30 N
   (c) 24 N (d) $4\sqrt{35}$ N
3. A point charge q is held at a distance 2a from the centre of an isolated, uncharged conductance sphere of radius a. The potential of the sphere is
   (a) $\frac{q}{8\pi\varepsilon_0 a}$ (b) $\frac{q}{4\pi\varepsilon_0 a}$
   (c) $\frac{q}{2\pi\varepsilon_0 a}$ (d) zero
4. A sphere of radius R has uniform volume charge density. The electric potential at a points (r <R) is
   (a) due to the charge inside a sphere of radius r only
   (b) due to the entire charge of the sphere
   (c) due to the charge in the spherical sheel of inner and outer radii r and R, only
   (d) independent of r

5. A point charge q is held at a distance $\frac{a}{2}$ from the centre of a thin, conducting, uncharged, spherical shell of radius a. The potential of the shell is

(a) $\frac{q}{2\pi\varepsilon_0 a}$ (b) $\frac{q}{4\pi\varepsilon_0 a}$

(c) $\frac{q}{8\pi\varepsilon_0 a}$ (d) zero

6. A parallel plate air capacitor of capacitance C is connected to a cell of emf V and then disconnected from it. A dielectric slab of dielectric constant K, which can just fill the air gap of the capacitor, is now inserted in it. Which of the following is incorrect ?

(a) The energy stored in the capacitor decreases K times.

(b) The chance in energy stored is $\frac{1}{2}CV^2\left(\frac{1}{K}-1\right)$

(c) The charge on the capacitor is not conserved.

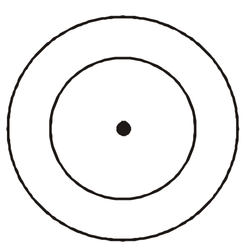
(d) The potential difference between the plates decreases K times.

7. A hollow metal sphere of radius 10 cm is charged such that the potential on its surface is 80 V. The potential at the centre of the sphere is

(a) zero (b) 80 V

(c) 800 V (d) 8 V

8. In the figure two conducting concentric spherical shells are shown.



If the electric potential at the centre is 20V and the electric potential of the outer shell is 5V, then the potential of the inner shell is

(a) 5V (b) 15V

(c) 20V (d) 25V

9. Two point charge of 8 μC and 12 μC are kept in air at a distance of 10 cm from each other. The work required to change the distance between them to 6 cm will be.

(a) 5.8 J (b) 4.8 J

(c) 3.8 J (d) 2.8 J

10. A capacitor is charges by using a battery which is then disconnected. A dielectric slab in then introduced between the plates which results in the:

(a) reduction of charge on the plates and increase of potential difference across the plates.

(b) increase in the potential difference across the plates and reduction in stored energy but no change in the charge on the plates.

(c) decrease in potential difference across the plates and reduction in stored energy but not change in the charge on the plates.

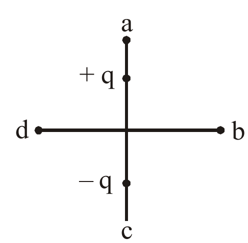
(d) none of these

11. Two conducting spheres of radii 5.0 cm and 10.0 cm are given a charge of 15.0 μC each. After connective the spheres by a copper wire, the charge on the smaller sphere is equal to :

(a) 20.0 μC (b) 5.0μC

(c) 10 μC (d) none of the above

12. Four points a, b, c and d are set at equal distance from thwe centre of a dipole as shown the figure. The electrostatic potential V_a, V_b, V_c, and V_d would satisfy the following relation:



(a) $V_a > V_b > V_c > V_d$ (b) $V_a > V_b = V_d > V_c$

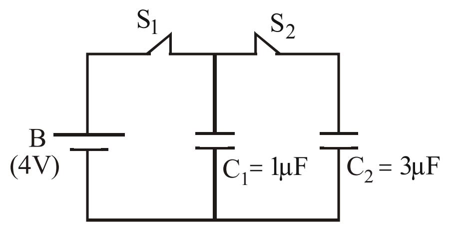
(c) $V_a > V_c = V_b = V_d$ (d) $V_b = V_d > V_a > V_c$

13. N small drops of a liquid each having a charge + q are combined to form a larger drop. The new electrostatic potential V_0 is related to the potential V on each small drop by the equation :

(a) $V_0 = VN^3$ (b) $V_0 = VN^{2/3}$

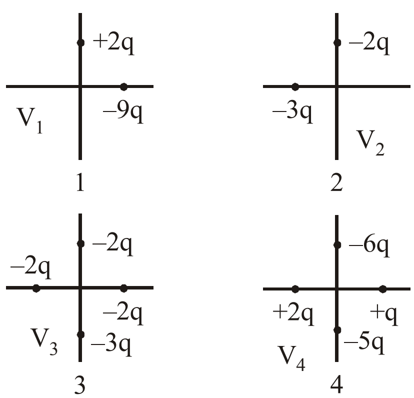
(c) $V_0 = VN^{3/2}$ (d) $V_0 = VN$

14. Consider the network shown here, B is a 4V battery of zero internal resistance; S_1 and S_2 are switches and C_1 and C_2 are ideal capacitors of values shown. Suppose S_1 is closed keeping S_2 open till the capacitor C_1 is fully charged. Then S_1 is opened and S_2 is closed so that C_2 gets charged. The energy stored in the capacitors is equal to :



(a) 2×10^{-6} J (b) 4×10^{-6} J
(c) 8×10^{-6} J (d) 32×10^{-6} J

15. The figure given below shows four arrangements of charged particles, all at the same distance from the origin. Rank the situation according to the net electric potential (V_1, V_2, V_3, V_4) at the origin, most positive first :



(a) $V_1 > V_2 > V_3 > V_4$ (b) $V_2 > V_1 > V_3 > V_4$
(c) $V_2 > V_1 > V_4 > V_3$ (d) $V_4 > V_1 > V_3 > V_2$

16. The electric potentials (in volts) and four points A, B, C and D are depicted in the figure on which of the following parts with the work done on a charge of – 2 C, be maximum

(+2V) (–3V)
D • C •
(+1V) (–1V)
B • A •

(a) BC (b) BAD
(c) AD (d) ABC

17. A parallel plate capacitor has plate area A and separation d. It is charged to a potential difference V_0. The charging battery is disconnected and the plates are pulled apart to three times the initial separation. The work required to separate the plates is

(a) $\dfrac{3\varepsilon_0 A V_0^2}{d}$ (b) $\dfrac{\varepsilon_0 A V_0^2}{2d}$

(c) $\dfrac{\varepsilon_0 A V_0^2}{3d}$ (d) $\dfrac{\varepsilon_0 A V_0^2}{d}$

18. Three concentric spherical shells have radii a, b and c ($a < b < c$) and have surface charge densities σ, $-\sigma$ and σ respectively. If V_A, V_B and V_C denotes the potentials of the three shells, then for $c = a + b$, we have

(a) $V_C = V_B \neq V_A$ (b) $V_C \neq V_B \neq V_A$
(c) $V_C = V_B = V_A$ (d) $V_C = V_A \neq V_B$

19. The electric potential at a point in free space due to a charge Q coulomb is $Q \times 10^{11}$ volts. The electric field at that point is

(a) $4\pi\varepsilon_0 Q \times 10^{22}$ volt/m
(b) $12\pi\varepsilon_0 Q \times 10^{20}$ volt/m
(c) $4\pi\varepsilon_0 Q \times 10^{20}$ volt/m
(d) $12\pi\varepsilon_0 Q \times 10^{22}$ volt/m

20. Consider two points 1 and 3 in a region outside a charged sphere. The two points are not very far away from the sphere. If $\vec{E}$ and V represent the electric field vector and the electric potential, which of the following is not possible :

(a) $|\vec{E}_1| = |\vec{E}_2|, V_1 = V_2$

(b) $\vec{E}_1 \neq \vec{E}_2, V_1 \neq V_2$

(c) $\vec{E}_1 \neq \vec{E}_2, V_1 = V_2$

(d) $|\vec{E}_1| = |\vec{E}_2|, V_1 \neq V_2$

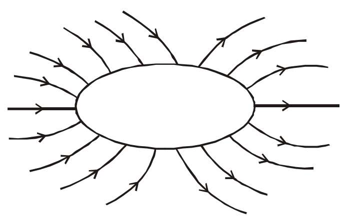
21. A parallel plate capacitor has a uniform electric field *E* in the space between the plates. If the distance between the plates is *d* and area of each plate is *A*, the energy stored in the capacitor is :

(a) $\frac{1}{2}\varepsilon_0 E^2$ (b) $E^2 Ad/\varepsilon_0$

(c) $\frac{1}{2}\varepsilon_0 E^2 Ad$ (d) $\varepsilon_0 EAd$

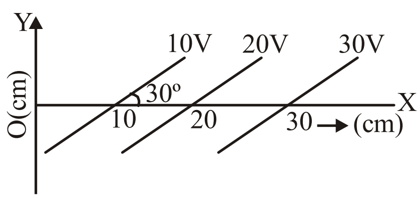
Diagram Based Questions :

1. Figure below shows a hollow conducting body placed in an electric field. Which of the quantities are zero inside the body?



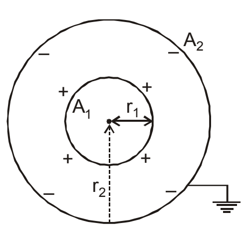
(a) Electric field and potential
(b) Electric field and charge density
(c) Electric potential and charge density.
(d) Electric field, potential and charge density.

2. Equipotential surfaces are shown in figure. Then the electric field strength will be



(a) 100 Vm^{-1} along X-axis
(b) 100 Vm^{-1} along Y-axis
(c) 200 Vm^{-1} at an angle 120° with X-axis
(d) 50 Vm^{-1} at an angle 120° with X-axis

3. Two spherical conductors A_1 and A_2 of radii r_1 and r_2 ($r_2 > r_1$) are placed concentrically in air. A_1 is given a charge +Q while A_2 is earthed. Then the equivalent capacitance of the system is



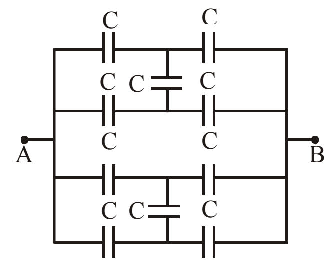
(a) $\frac{4\pi \in_0 r_1 r_2}{r_2 - r_1}$

(b) $4\pi \in_0 (r_1 + r_2)$

(c) $4\pi \in_0 r_2$

(d) $4\pi \in_0 r_1$

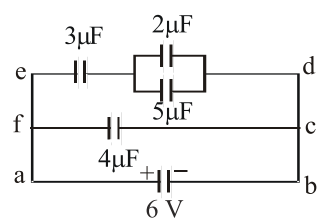
4. The effective capacitance of combination of equal capacitors between points A and B shown in figure is



(a) C (b) 2C

(c) 3C (d) $\frac{C}{2}$

5. In the circuit given below, the charge in μC, on the capacitor having capacitance 5 μF is



(a) 4.5 (b) 9
(c) 7 (d) 15

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Electric potential and electric potential energy are different quantities.

   Reason : For a system of positive test charge and point charge electric potential energy = electric potential.

2. **Assertion :** For a non-uniformly charged thin circular ring with net charge is zero, the electric field at any point on axis of the ring is zero.

   Reason : For a non-uniformly charged thin circular ring with net charge zero, the electric potential at each point on axis of the ring is zero.

3. **Assertion :** Electric energy resides out of the spherical isolated conductor.

   Reason : The electric field at any point inside the conductor is zero.

4. **Assertion :** Two equipotential surfaces cannot cut each other.

   Reason : Two equipotential surfaces are parallel to each other.

5. **Assertion :** A parallel plate capacitor is connected across battery through a key. A dielectric slab of dielectric constant k is introduced between the plates. The energy stored becomes k times.

   Reason : The surface density of charge on the plate remains constant.

6. **Assertion :** When a dielectric slab is gradually inserted between the plates of an isolated parallel-plate capacitor, the energy of the system decreases.

   Reason : The force between the plates decreases.

7. **Assertion :** A dielectric is inserted between the plates of a battery connected capacitor. The energy of the capacitor increases.

   Reason : Energy of the capacitor, $U = \frac{1}{2}CV^2$.

8. **Assertion.** Two equipotential surfaces can be orthogonal.

   Reason: Electric field lines are normal to the equipotential surface.

Matching Based Questions :

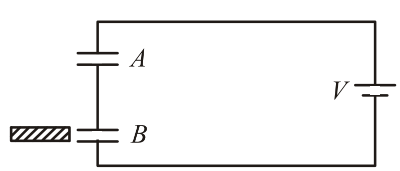
DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the Column I and Column II.

Column-I	Column -II
(A) Electric potential near an isolated positive charge	(1) Negative
(B) Electric potential near an isolated negative charge	(2) Positive
(C) Electric potential due to a charge at its own location is not defined	(3) Varies inversly of radius
(D) Electric potential due to uniformly charged solid non-conducting sphere	(4) Infinite

(a) (A) $\rightarrow$ (2); (B) $\rightarrow$ (1); (C) $\rightarrow$ (4); (D) $\rightarrow$ (3)
(b) (A) $\rightarrow$ (1); (B) $\rightarrow$ (3); (C) $\rightarrow$ (4); (D) $\rightarrow$ (2)
(c) (A) $\rightarrow$ (4); (B) $\rightarrow$ (1); (C) $\rightarrow$ (3); (D) $\rightarrow$ (4)
(d) (A) $\rightarrow$ (3); (B) $\rightarrow$ (2); (C) $\rightarrow$ (1); (D) $\rightarrow$ (4)

2. When a dielectric slab is inserted between the plates of one of the two identical capacitors shown in the figure then match the following:



Column-I	Column-II
(A) Charge on A	(1) Increases
(B) Potential difference across A	(2) Decreases
(C) Potential difference across B	(3) Remains constant
(D) Charge on B	(4) Cannot say

(a) (A) $\to$ (1); (B) $\to$ (2); (C) $\to$ (2); (D) $\to$ (1)
(b) (A) $\to$ (1); (B) $\to$ (1); (C) $\to$ (2); (D) $\to$ (2)
(c) (A) $\to$ (2); (B) $\to$ (2); (C) $\to$ (2); (D) $\to$ (4)
(d) (A) $\to$ (1); (B) $\to$ (2); (C) $\to$ (2); (D) $\to$ (3)

3. Match the entries of Column I and Column II

Column-I	Column-II
(A) Inside a conductor placed in an external electric field.	(1) Potential energy = 0
(B) At the centre of a dipole	(2) Electric field = 0
(C) Dipole in stable equilibrium	(3) Electric potential = 0
(D) Electric dipole perpendicular to uniform electric field.	(4) Torque = 0

(a) (A) $\to$ (2); (B) $\to$ (4); (C) $\to$ (3); (D) $\to$ (1)
(b) (A) $\to$ (2); (B) $\to$ (3); (C) $\to$ (4); (D) $\to$ (1)
(c) (A) $\to$ (2); (B) $\to$ (3); (C) $\to$ (1); (D) $\to$ (4)
(d) (A) $\to$ (1); (B) $\to$ (3); (C) $\to$ (4); (D) $\to$ (2)

4. Match the types of capacitors in Column I and expressions of capacitances in Column II.

Column-I	Column-II
(A) Spherical capacitor	(1) $\dfrac{\varepsilon_0 KA}{d}$
(B) Cylindrical capacitor	(2) $\dfrac{\varepsilon_0 A}{d}$
(C) Parallel plate capacitor air filled	(3) $\dfrac{2\pi\varepsilon_0 \ell}{\ln\left(\dfrac{r_2}{r_1}\right)}$
(D) Parallel plate capacitor with dielectric slab between the plates.	(4) $\dfrac{4\pi\varepsilon_0 r_1 r_2}{r_1 - r_2}$

(a) (A) $\to$ (4); (B) $\to$ (2); (C) $\to$ (3); (D) $\to$ (1)
(b) (A) $\to$ (4); (B) $\to$ (3); (C) $\to$ (1); (D) $\to$ (2)
(c) (A) $\to$ (3); (B) $\to$ (4); (C) $\to$ (2); (D) $\to$ (1)
(d) (A) $\to$ (4); (B) $\to$ (3); (C) $\to$ (2); (D) $\to$ (1)

Critical Thinking Type Questions :

1. Two equally charged spheres of radii a and b are connected together. What will be the ratio of electric field intensity on their surfaces?

(a) $\frac{a}{b}$ (b) $\frac{a^2}{b^2}$

(c) $\frac{b}{a}$ (d) $\frac{b^2}{a^2}$

2. Four point charges $-Q, -q, 2q$ and $2Q$ are placed, one at each corner of the square. The relation between Q and q for which the potential at the centre of the square is zero is

(a) $Q = -q$ (b) $Q = -\frac{1}{q}$

(c) $Q = q$ (d) $Q = \frac{1}{q}$

3. In a region, the potential is represented by $V(x, y, z) = 6x - 8xy - 8y + 6yz$, where V is in volts and x, y, z are in metres. The electric force experienced by a charge of 2 coulomb situated at point (1, 1, 1) is

(a) $6\sqrt{5}$ N (b) 30 N

(c) 24 N (d) $4\sqrt{35}$ N

4. A parallel plate air capacitor of capacitance C is connected to a cell of emf V and then disconnected from it. A dielectric slab of dielectric constant K, which can just fill the air gap of the capacitor, is now inserted in it. Which of the following is incorrect ?

(a) The energy stored in the capacitor decreases K times.

(b) The chance in energy stored is $\frac{1}{2}CV^2\left(\frac{1}{K}-1\right)$

(c) The charge on the capacitor is not conserved.

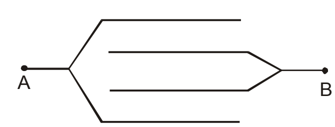
(d) The potential difference between the plates decreases K times.

5. In a Van de Graaff generator, a spherical metal shell is to be 15×10^6 V electrode. The dielectric strength of the gas surrounding the electrode is $5 \times 10^7 V\, m^{-1}$. The minimum radius of the spherical shell required is

(a) 1 m (b) 2 m

(c) 1.5 m (d) 3 m

6. Four metallic plates each with a surface area of one side A, are placed at a distance d from each other. The two outer plates are connected to one point A and the two other inner plates to another point B as shown in the figure. Then the capacitance of the system is



(a) $\frac{\varepsilon_0 A}{d}$ (b) $\frac{2\varepsilon_0 A}{d}$

(c) $\frac{3\varepsilon_0 A}{d}$ (d) $\frac{4\varepsilon_0 A}{d}$

17 CURRENT ELECTRICITY

Fill in the Blanks :

1. When a potential difference V is applied across a conductor at a temperature T, the drift velocity of electrons is proportional to _______ .
2. Macroscopic form of ohm's law's _______ .
3. Constantan wire is used for making standard resistance, because it has _______ .
4. When potential difference is applied across an electrolyte, then Ohm's law is obeyed at _______ potential .
5. A cell of internal resistance r is connected across an external resistance nr. Then the ratio of the terminal voltage to the emf of the cell is ______.
6. Kirchoff's first law, i.e., Σ i = 0 at a junction, deals with the conservation of _______ .
7. If in the experiment of Wheatstone's bridge, the positions of cells and galvanometer are interchanged, then balance point will _______ .
8. The reciprocal of resistance is _______ .
9. Sensitivity of potentiometer can be increased by _______ length of potentiometer .

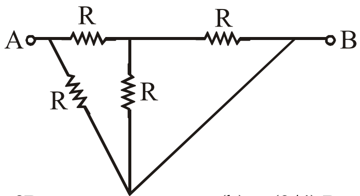
True/False :

1. In household electric circuit, all electric appliances drawing power are joined in parallel
2. A switch may be either in series or in parallel with the appliance which it controls
3. Microscopic form of ohm's law is $R=\frac{V}{I}$
4. When resistances are connected in parallel, current distributes in the inverse ratio of resistances.
5. When resistances are connected in series maximum current flows through the resistance having least value.
6. In series a device of higher power rating consumes less power.
7. The order of magnitude of current in lightening is about one ampere.

Conceptual MCQs

1. If a negligibly small current is passed through a wire of length 15 m and of resistance 5Ω having uniform cross-section of 6×10^{-7} m^2 , then coefficient of resistivity of material, is
   (a) $1\times10^{-7}\,\Omega$-m (b) $2\times10^{-7}\,\Omega$-m
   (c) $3\times10^{-7}\,\Omega$-m (d) $4\times10^{-7}\,\Omega$-m
2. The emf developed by a thermocouple is measured with the help of a potentiometer and not by a moving coil millivoltmeter because
   (a) the potentiometer is more accurate than the voltmeter
   (b) the potentiometer is more sensitive than voltmeter
   (c) the potentiometer makes measurement without drawing any current from the thermocouple
   (d) measurement using a potentiometer is simpler than with a voltmeter
3. You have been provided with four 100 ohm resistors each with a tolerance of 2%. The number of ways in which these can be combined to have different equivalent resistances is
   (a) seven different combinations and seven different equivalents
   (b) eight different combinations and seven different equivalents resistances
   (c) nine different combinations and eight different resistances
   (d) ten different combinations and nine different resistances

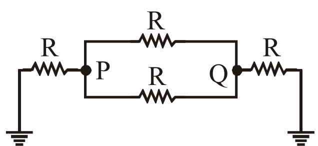
4. The equivalent resistance between points A and B is



(a) 2R (b) (3/4) R
(c) (4/3) R (d) (3/5) R

5. If the resistance of a conductor is 5 Ω at 50ºC and 7Ω at 100ºC, then the mean temperature coefficient of resistance (of the material) is
(a) 0.001/ºC (b) 0.004/ºC
(c) 0.006/ºC (d) 0.008/ºC

6. The net resistance between point P and Q in the circuit shown in figure is

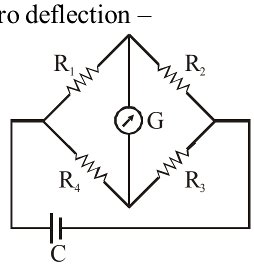


(a) R/2 (b) 2R/5
(c) 3R/5 (d) R/3

7. A cell can be balanced against 110 cm and 100 cm of potentiometer wire, respectively with and without being short circuited through a resistance of 10Ω. Its internal resistance is
(a) 1.0 ohm (b) 0.5 ohm
(c) 2.0 ohm (d) zero

8. A battery of internal resistance 2Ω is connected to a variable resistor whose value can vary from 4Ω to 10Ω. The resistance is initially set at 4Ω. If the resistance is now increased then –
(a) power consumed by it will decrease
(b) power consumed by it will increase
(c) power consumed by it may increase or may decrease
(d) power consumed will first increase then decrease.

9. The Wheatstone bridge shown in the figure is balanced. If the positions of the cell C and the galvanometer G are now interchanged, G will show zero deflection –



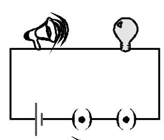
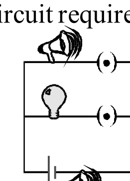
(a) in all cases
(b) only if all the resistances are equal
(c) only if $R_1 = R_3$ and $R_2 = R_4$
(d) only if $R_1/R_3/R_2/R_4$

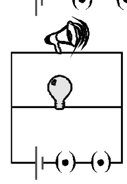
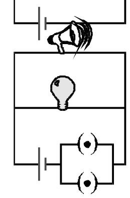
10. Three resistances R, 2R and 3R are connected in parallel to a battery. Then
(a) the potential drop across 3R is maximum
(b) the current through each resistance is same
(c) the heat developed in 3R is maximum
(d) the heat developed in R is maximum.

11. A milli voltmeter of 25 milli volt range is to be converted into an ammeter of 25 ampere range. The value (in ohm) of necessary shunt will be :
(a) 0.001 (b) 0.01 (c) 1 (d) 0.05

12. A piece of copper and another of germanium are cooled from room temperature to 80 K. The resistance of
(a) each of them increases
(b) each of them decreases
(c) copper increases and germanium decreases
(d) copper decreases and germanium increases

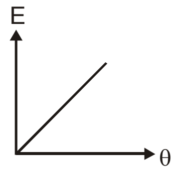
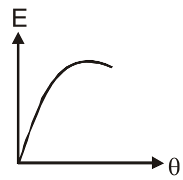
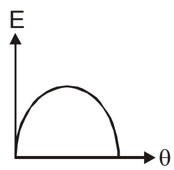
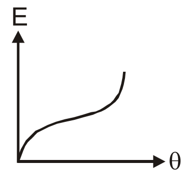
13. In the house of a person who is weak of hearing, a light bulb is also lit when somebody rings the door bell. The ring can be operated both from the garden gate and from the door of the house. Select the correct possible circuit required.

(a)  (b) 

(c)  (d) 

14. If two bulbs of power 25 W and 100 W respectively each rated at 220 V are connected in series with the supply of 440 V. Which bulb will fuse ?
(a) 25 W bulb (b) 40 watts
(c) none of these (d) both 1 & 2

15. Which of the following graphs represent the variation of thermo emf (E) of a thermocouple with temperature θ of hot junction (the cold junction being kept at 0ºC)

(a) 
(b) 
(c) 
(d) 

16. Consider the following devices :
I Copper voltameter
II Water voltameter
III Semi conductor diode
Which of these obey Ohm's law :
(a) I only (b) I and II
(c) III only (d) I, II and III

17. A copper wire of length l and radius r is to be used as fuse. If the fuse wire attains, then the heat lost H per unit surface area per second is :
(a) $H \alpha \frac{a}{r^3}$ (b) $H \alpha r^2$
(c) $H \alpha l$ (d) $H \alpha r^3$

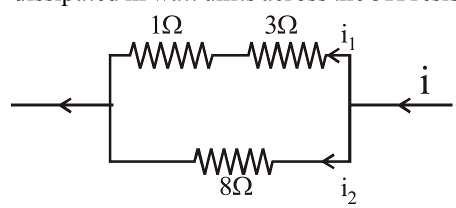
18. Kirchhoff's first and second laws for electrical circuits are consequences of
(a) conservation of electric charge and energy respectively
(b) conservation of electric charge
(c) conservation of energy and electric charge respectively
(d) conservation of energy

19. In which of the following the carriers of electric current are electrons only ?
(a) a super conductor
(b) a voltaic cell
(c) a semiconductor
(d) a hydrogen discharge tube

20. It takes t minutes for a kettle of water to start boiling when placed on an electric heater. If the voltage drops to half its value, the time taken for this water to boil will be:
(a) $\sqrt{2}$ t minutes (b) 2 t minutes
(c) 4 t minutes (d) 8 t minutes

21. Two electric bulbs of the same power, but with different marked voltage are connected in series across a power line. Their brightness will be :
(a) directly proportional to their marked voltages
(b) inversely proportional to their marked voltages
(c) directly proportional to their squares of their marked voltages
(d) Inversely proportional to the square of their marked voltages

22. Power dissipated across the 8Ω resistor in the circuit shown here is 2 watt. The power dissipated in watt units across the 3Ω resistor is

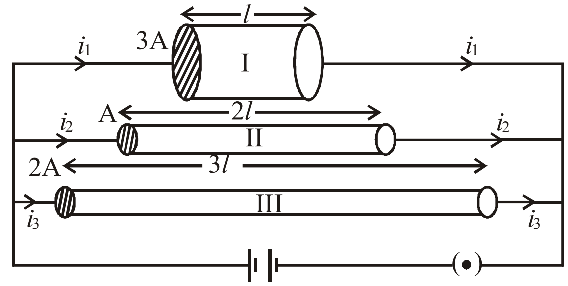


(a) 1.0 (b) 0.5
(c) 3.0 (d) 2.0

23. Two cells of the same emf E have different internal resistances r_1 and r_2. They are connected in series with an external resistance R and the potential difference across the first cell is found to be zero. Therefore, the external resistance R must be
(a) $r_1 - r_2$ (b) $r + r_2$
(c) $2r_1 - r_2$ (d) $r_1 - 2r_2$

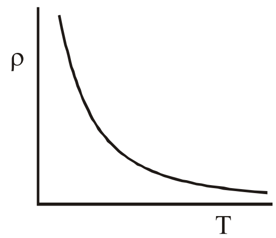
Diagram Based Questions :

1. The figure shows three conductors I, II and III of same material, different lengths l, $2l$ and $3l$ and of different areas of cross-section 3A, A and 2A respectively. Arrange them in the increasing order of current drawn from battery.



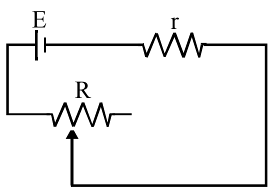
(a) $i_1 < i_2 < i_3$ (b) $i_3 < i_2 < i_1$
(c) $i_2 < i_1 < i_3$ (d) $i_2 < i_3 < i_1$

2. The graph shows the variation of resistivity with temperature T. The graph can be of



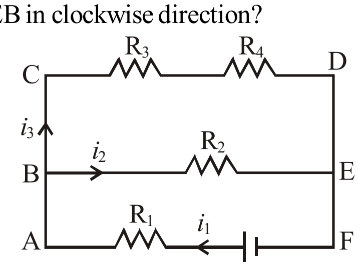
(a) copper (b) nichrome
(c) germanium (d) silver

3. A battery of e.m.f E and internal resistance r is connected to a variable resistor R as shown. Which one of the following is true ?



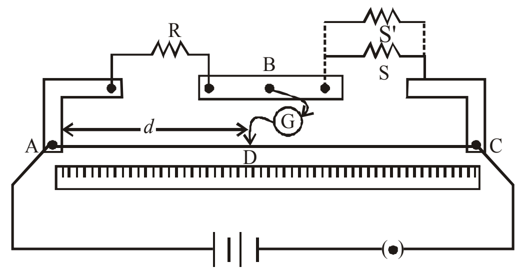
(a) Potential difference across the terminals of the battery is maximum when R = r
(b) Power delivered to resistor is maximum when R = 2r
(c) Current in the circuit is maximum when R = r
(d) Current in the circuit is maximum when R >> r

4. Which of the following is the correct equation when kirchhoff's loop rule is applied to the loop BCDEB in clockwise direction?



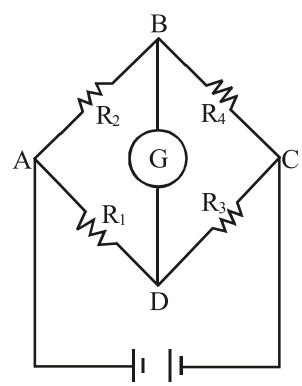
(a) $-i_3 R_3 - i_3 R_4 - i_2 R_2 = 0$
(b) $-i_3 R_3 - i_3 R_4 + i_2 R_2 = 0$
(c) $-i_3 R_3 + i_3 R_4 + i_2 R_2 = 0$
(d) $-i_3 R_3 + i_3 R_4 + i_2 R_2 = 0$

5. The figure shows a meter bridge in which null point is obtained at a length AD = l. When a resistance S' is connected in parallel with resistance S the new position of null point is obtained



(a) to the left of D
(b) to the right of D
(c) at the same point D
(d) to the left of D if S' has lesser value than S and to the right of D if S' has more value than S.

6. In the figure in balanced condition of wheatstone bridge



(a) *B* is at higher potential
(b) *D* is at higher potential
(c) Any of the two *B* or *D* can be at higher potential than other arbitrarily.
(d) *B* and *D* are at same potential.

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion:** Current is a vector quantity.
Reason: Current has magnitude as well as direction.
2. **Assertion:** The statement of Ohm's law is V = IR.
Reason: V = IR is the equation which defines resistance.
3. **Assertion :** A current flows in a conductor only when there is an electric field within the conductor.
Reason : The drift velocity of electron in presence of electric field decreases.
4. **Assertion:** $\vec{E} = \rho \vec{j}$ is the statement of Ohm's law.
Reason: If the resistivity of the conducting material is independent of the direction and magnitude of applied field then the material obeys Ohm's law.
5. **Assertion:** For a conductor resistivity increases with increase in temperature.
Reason: Since $\rho = \frac{m}{ne^2\tau}$, when temperature increases the random motion of free electrons increases and vibration of ions increases which decreases τ.
6. **Assertion :** The drift velocity of electrons in a metallic wire will decrease, if the temperature of the wire is increased.
Reason : On increasing temperature, conductivity of metallic wire decreases.
7. **Assertion :** Bending a wire does not effect electrical resistance.
Reason: Resistance of wire is proportional to resistivity of material.
8. **Assertion :** The e.m.f of the driver cell in the potentiometer experiment should be greater that the e.m.f of the cell to be determined.
Reason : The fall of potential across the potentiometer wire should not be less than the e.m.f of the cell to be determined.
9. **Assertion :** In meter bridge experiment, a high resistance is always connected in series with a galvanometer.
Reason : As resistance increases current more accurately than ammeter.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the Column I and Column II.

Column I	Column II
(A) Ohm's law is applicable to	(1) Metals
(B) Ohm's law is not applicable to	(2) Greater resistivity
(C) Alloys have semiconductors	(3) Diodes, electrolytes
(D) A heat sensitive resistor	(4) Thermistors

(a) (A) $\to$ (2) ; (B) $\to$ (1) ; (C) $\to$ (3) ; (D) $\to$ (4)
(b) (A) $\to$ (1) ; (B) $\to$ (3) ; (C) $\to$ (2) ; (D) $\to$ (4)
(c) (A) $\to$ (4) ; (B) $\to$ (3) ; (C) $\to$ (2) ; (D) $\to$ (1)
(d) (A) $\to$ (2) ; (B) $\to$ (1) ; (C) $\to$ (4) ; (D) $\to$ (3)

2.

Column I	Column II
(A) Silver	(1) Wire bound resistor
(B) Semiconductor	(2) Resistor of higher range
(C) Carbon resistor	(3) Negative temperature coefficient of resistivity
(D) Manganin	(4) Least resistivity

(a) (A) $\to$ (2) ; (B) $\to$ (1) ; (C) $\to$ (3) ; (D) $\to$ (4)
(b) (A) $\to$ (2) ; (B) $\to$ (2) ; (C) $\to$ (4) ; (D) $\to$ (3)
(c) (A) $\to$ (4) ; (B) $\to$ (3) ; (C) $\to$ (2) ; (D) $\to$ (1)
(d) (A) $\to$ (4) ; (B) $\to$ (3) ; (C) $\to$ (2) ; (D) $\to$ (1)

3. Match the physical quantities in Column I and their mathematical expressions in Column II.

Column I	Column II
(A) Current	(1) $\frac{ne^2\tau}{m}$

(B) Conductivity (2) $\frac{1}{p}\left(\frac{dp}{dT}\right)$

(C) Current density (3) $\vec{j}\cdot\overrightarrow{\Delta S}$

(D) Temperature coefficient of resistivity (4) $nq\,\vec{v}_d$

(a) $(A)\to(2)$; $(B)\to(1)$; $(C)\to(3)$; $(D)\to(4)$ (b) $(A)\to(2)$; $(B)\to(2)$; $(C)\to(4)$; $(D)\to(3)$

(c) $(A)\to(3)$; $(B)\to(1)$; $(C)\to(4)$; $(D)\to(2)$ (d) $(A)\to(2)$; $(B)\to(1)$; $(C)\to(4)$; $(D)\to(3)$

4. Match the Column I and Column II.

Column I	**Column II**
(A) Smaller the resistance greater the current applied and resistance are in series	(1) If the same voltager is
(B) Greater or smaller the resistance the current is same	(2) If the same current is passed
(C) Greater the resistance smaller the power	(3) When resistances are connected in series
(D) Greater the resistance greater the power	(4) When resistances are connected in parallel

(a) $(A)\to(3)$; $(B)\to(1)$; $(C)\to(2)$; $(D)\to(4)$ (b) $(A)\to(1)$; $(B)\to(3)$; $(C)\to(2)$; $(D)\to(4)$

(c) $(A)\to(2)$; $(B)\to(1)$; $(C)\to(4)$; $(D)\to(2)$ (d) $(A)\to(4)$; $(B)\to(3)$; $(C)\to(1)$; $(D)\to(2)$

5.

Column I	**Column II**
(A) Junction rule	(1) Another statement of Ohm's law.
(B) Loop rule	(2) Magnitude of drift velocity per unit electric field.
(C) $\vec{j}=\sigma\vec{E}$	(3) Based on law of conservation of charge
(D) Mobility	(4) Based on law of conservation of energy.

(a) $(A)\to(1)$; $(B)\to(2)$; $C\to(3)$; $(D)\to(4)$ (b) $(A)\to(1)$; $(B)\to(3)$; $C\to(2)$; $(D)\to(4)$

(c) $(A)\to(4)$; $(B)\to(2)$; $C\to(1)$; $(D)\to(3)$ (d) $(A)\to(3)$; $(B)\to(4)$; $C\to(1)$; $(D)\to(2)$

6. Column I gives certain situations in which a straight metallic wire of resistance R is used and Column II gives some resulting effects.

Column I	**Column II**
(A) A charged capacitor connected to the is ends of the wire	(1) A constant current flows through the wire
(B) The wire is moved perpendicular to its length with a constant velocity in a uniform magnetic field perpendicular to the plane of motion	(2) Thermal energy is generated in the wire
(C) The wire is placed in a constant electric field that has a direction along the length of the wire	(3) A constant potential difference develops between the ends of the wire
(D) A battery of constant emf is connected to the ends of the wire	(4) charges of constant magnitude appear at ends of the wire.

(a) $(A)\to(2)$; $(B)\to(3)$; $(C)\to(4)$; $(D)\to(1,2,3)$ (b) $(A)\to(1)$; $(B)\to(2,3)$; $(C)\to(4)$; $(D)\to(3)$

(c) $(A)\to(1)$; $(B)\to(2)$; $(C)\to(1,3)$; $(D)\to(4)$ (d) $(A)\to(1)$; $(B)\to(2)$; $(C)\to(3)$; $(D)\to(4)$

7. Match the entries of Column I with their correct mathematical expressions in Column II

Column I	Column II
(A) Balanced condition of wheatstone bridge	(1) $\frac{R_1}{R_2}=\frac{R_3}{R_4}$
(B) Comparison of emf of two cells field.	(2) $\frac{R}{S}=\frac{l_1}{100-l_1}$
(C) Determination of internal resistance of a cell	(3) $\frac{E_1}{E_2}=\frac{l_1}{l_2}$
(D) Determination of unknown resistance by meter bridge	(4) $r=R\left(\frac{l_1}{l_2}-1\right)$

(a) (A) $\rightarrow$ (4); (B) $\rightarrow$ (2); C $\rightarrow$ (3); (D) $\rightarrow$ (1)
(b) (A) $\rightarrow$ (1); (B) $\rightarrow$ (3); C $\rightarrow$ (4); (D) $\rightarrow$ (2)
(c) (A) $\rightarrow$ (3); (B) $\rightarrow$ (4); C $\rightarrow$ (2); (D) $\rightarrow$ (1)
(d) (A) $\rightarrow$ (4); (B) $\rightarrow$ (3); C $\rightarrow$ (2); (D) $\rightarrow$ (1)

Critical Thinking Type Questions :

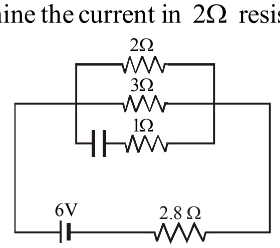
1. Two wires A and B of the same material, having radii in the ratio 1 : 2 and carry currents in the ratio 4 : 1. The ratio of drift speed of electrons in A and B is
(a) 16 : 1 (b) 1 : 16
(c) 1 : 4 (d) 4 : 1

2. The resistance of a wire at room temperature 30°C is found to be 10 Ω. Now to increase the resistance by 10%, the temperature of the wire must be [The temperature coefficient of resistance of the material of the wire is 0.002 per °C]
(a) 36°C (b) 83°C
(c) 63°C (d) 33°C

3. A wire X is half the diameter and half the length of a wire Y of similar material. The ratio of resistance of X to that of Y is
(a) 8 : 1 (b) 4 : 1
(c) 2 : 1 (d) 1 : 1

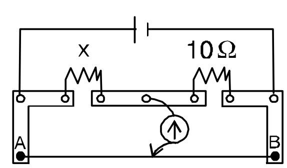
4. Two sources of equal emf are connected to an external resistance R. The internal resistance of the two sources are R_1 and R_2 ($R_2 > R_1$). If the potential difference across the source having internal resistance R_2 is zero, then
(a) $R = R_2 - R_1$
(b) $R = R_2 \times (R_1 + R_2)/(R_2 - R_1)$
(c) $R = R_1R_2/(R_2 - R_1)$
(d) $R = R_1R_2/(R_1 - R_2)$

5. Determine the current in 2Ω resistor.



(a) 1 A (b) 1.5 A
(c) 0.9 A (d) 0.6 A

6. A meter bridge is set up as shown, to determine an unknown resistance 'X' using a standard 10 ohm resistor. The galvanometer shows null point when tapping-key is at 52 cm mark. The end-corrections are 1 cm and 2 cm respectively for the ends A and B. The determined value of 'X' is



(a) 10.2 ohm (b) 10.6 ohm
(c) 10.8 ohm (d) 11.1 ohm

7. If specific resistance of a potentiometer wire is $10^{-7}\Omega$m current flowing through it, is 0.1 amp and cross sectional area of wire is 10^{-6} m^2, then potential gradient will be
(a) 10^{-2} volt/m (b) 10^{-4} volt/m
(c) 10^{-6} volt/m (d) 10^{-8} volt/m

18 MOVING CHARGES AND MAGNETISM

Fill in the Blanks :

1. Ampere's circuital law is equivalent to _______ law.
2. If a current is passed through a spring then the spring will _______ .
3. Energy in a current carrying coil is stored in the form of _______ .
4. In cyclotron the gyro radius is proportional to _______ .
5. A charge q is moving with a velocity v parallel to a magnetic field B. Force on the charge due to magnetic field is _____.
6. In a moving coil galvanometer, the deflection of the coil θ is related to the elecrical current i by the relation _______ .
7. A moving coil galvanometer has N number of turns in a coil of effective area A, carries a current I. The magnetic field B is radial. The torque acting on the coil is ____ .
8. Two parallel circular coils of equal radii having equal number of turns placed coaxially and separated by a distance equal to the radii of the coils carrying equal currents in same direction are known as _______ .
9. If m is magnetic moment and B is the magnetic field, then the torque is given by _______ .

True/ False :

1. Biot-savarts's law is valid for all current distributions.
2. A coil of a metal wire kept stationary in a non–uniform magnetic field has an e.m.f induced in it.
3. Ampere's circuital law is based only on the priciple of magnetism.
4. Lorentz force, in presence of electric field $\vec{E}(r)$ and magnetic field $\vec{B}(r)$ on a moving electric charge is given by $\vec{F} = q[\vec{E}(r) + v \times \vec{B}(r)]$
5. For a static charge the magnetic force is maximum.
6. The magnetic field in the open space exterior to the toroid is constant.
7. Cyclotron cannot accelerates electrons because they have very small mass.

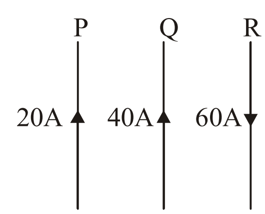
Conceptual MCQs :

1. Two very long, straight, parallel wires carry steady currents I and –I respectively. The distance between the wires is d. At a certain instant of time, at a point charge q is at a point equidistant from the two wires, in the plane of the wires.Its instantaneous velocity v is perpendicular to the plane of wires. The magnitude of the force due to the magnetic field acting on the charge at the instant is

(a) $\frac{\mu_0 Iqv}{2\pi d}$ (b) $\frac{2\mu_0 Iqv}{\pi d}$

(c) $\frac{\mu_0 Iqv}{\pi d}$ (d) zero

2. P, Q and R are long straight wires in air, carrying currents as shown. The force on Q is directed

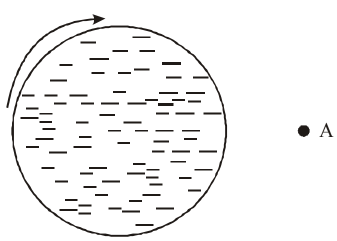


(a) to the left (b) to the right
(c) perpendicular to the plane of the diagram
(d) along the current in Q

3. A particle of charge q and mass m moves in a circular orbit of radius r with angular speed ω. The ratio of the magnitude of its magnetic moment to that of its angular momentum depends on –
(a) ω and q (b) ω, q and m
(c) q and m (d) ω and m

4. Two observers moving with different velocities seen that a point charge produces same magnetic field at the same point A. Their relative velocity must be parallel to $\vec{r}$, where $\vec{r}$ is the position vector of point A with respect to point charge. This statement is –
(a) true
(b) false
(c) nothing can be said
(d) true only if the charge is moving perpendicular to the $\vec{r}$

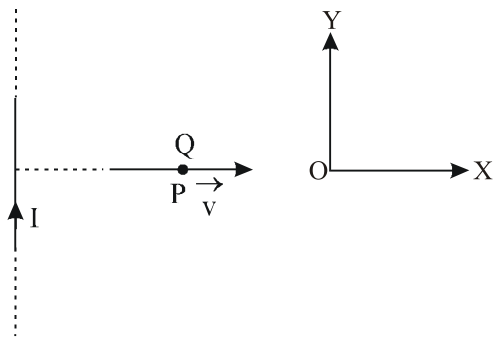
5. The negatively and uniformly charged nonconducting disc as shown is rotated clockwise.



The direction of the magnetic field at point A in the plane of the disc is
(a) into the page (b) out of the page
(c) up the page (d) down the page

6. The magnetic force acting on a charged particle of charge – 2 μC in a magnetic field of 2T acting in y direction, when the particle velocity is $\left(2\hat{i}+3\hat{j}\right)\times10^{6}\,ms^{-1}$, is
(a) 4 N in z direction (b) 8 N in y direction
(c) 8 N in z direction (d) 8 N in – z direction

7. A very long straight wire carries a current I. At the instant when a charge + Q at point P has velocity $\vec{v}$, as shown, the force on the charge is



(a) along OY (b) opposite to OY
(c) along OX (d) opposite to OX

8. A charged paritcle (charge q) is moving in a circle of radius R with uniform speed v. The associated magnetic moment μ is given by
(a) qvR^2 (b) $qvR^2/2$
(c) qvR (d) $qvR/2$

9. A beam of electron passes undeflected through mutually perpendicular electric and magnetic fields. If the electric field is switched off, and the same magnetic field is maintained, the electrons move
(a) in a circular orbit
(b) along a parabolic path
(c) along a straight line
(d) in an elliptical orbit.

10. A galvanometer of 50 ohm resistance has 25 divisions. A current of 4×10^{-4} ampere gives a deflection of one per division. To convert this galvanometer into a voltmeter having a range of 25 volts, it should be connected with a resistance of
(a) 2450 Ω in series (b) 2500 Ω in series.
(c) 245 Ω in series. (d) 2550 Ω in series.

11. A straight wire of diameter 0.5 mm carrying a current of 1 A is replaced by another wire of 1 mm diameter carrying same current. The strength of magnetic field far away is
(a) twice the earlier value
(b) same as the earlier value
(c) one-half of the earlier value
(d) one-quarter of the earlier value

12. When a charged particle moving with velocity $\vec{v}$ is subjected to a magnetic field of induction $\vec{B}$, the force on it is non-zero. This implies that

(a) angle between $\vec{v}$ and $\vec{B}$ can have any value other than 90°

(b) angle between $\vec{v}$ and $\vec{B}$ can have any value other than zero and 180°

(c) angle between $\vec{v}$ and $\vec{B}$ is either zero or 180°

(d) angle between $\vec{v}$ and $\vec{B}$ is necessarily 90°

13. An electron enters a region where magnetic field (B) and electric field (E) are mutually perpendicular, then

(a) it will always move in the direction of B

(b) it will always move in the direction of E

(c) it always possesses circular motion

(d) it can go undeflected also.

14. Current i is flowing in a coil of area A and number of turns N, then magnetic moment of the coil, M is

(a) NiA (b) $\frac{Ni}{A}$

(c) $\frac{Ni}{\sqrt{A}}$ (d) N^2Ai

15. A coil in the shape of an equilateral triangle of side l is suspended between the pole pieces of a permanent magnet such that $\vec{B}$ is in the plane of the coil. If due to a current i in the triangle a torque τ acts on it, the side l of the triangle is

(a) $\frac{2}{\sqrt{3}}\left(\frac{\tau}{B.i}\right)^{\frac{1}{2}}$ (b) $2\left(\frac{\tau}{\sqrt{3}B.i}\right)^{\frac{1}{2}}$

(c) $\frac{2}{\sqrt{3}}\left(\frac{\tau}{B.i}\right)$ (d) $\frac{1}{\sqrt{3}}\frac{\tau}{B.i}$

16. Two flat circular coils have a common center, but their planes are at right angles to each other. The inner coil has 150 turns and radius of π cm. The outer coil has 400 turns and a radius of 2π cm. The magnitude of the resultant magnetic induction at the common centers of the coils when a current of 200 mA is sent through each of them is

(a) 10^{-3} Wb/m^2 (b) 2×10^{-3} Wb/m^2

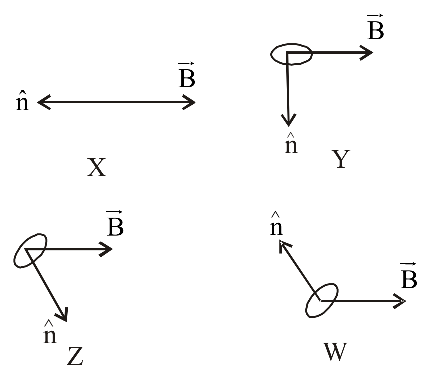
(c) 5×10^{-3} Wb/m^2 (d) 7×10^{-3} Wb/m^2

17. Two long parallel wires carry currents I_1 and I_2 ($I_1 > I_2$). When the currents are in the same direction, the magnetic field at a point midway between the wires is 10 μT. If the direction of I_2 is reversed, the field becomes 40 μT. The ratio I_1/I_2 is

(a) 5/2 (b) 5/3

(c) 4/3 (d) 3/2

18. A current carrying loop is placed in a uniform magnetic field with four different orientations X, Y, Z and W was shown in the figure. The correct decreasing order of potential energy is



(a) X > Y > Z > W (b) Z > W > X > Y

(c) X > W > Y > Z (d) X > Y > W > Z

19. A cylindrical conductor having radius of cross section R carries a steady current I. If the distance from the axis of the conductor is r, then the magnetic field B varies as

(a) 1/r

(b) r for r < R and as 1/r for r $\geq$ R

(c) r

(d) 1/r^2

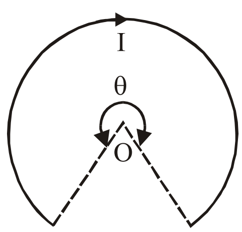
20. A current I flows in the anticlockwise direction through a square loop of side a lying in the xoy plane with its center at the origin. The magnetic induction at the center of the square loop is

(a) $\frac{2\sqrt{2}\mu_0 I}{\pi a}\hat{e}_x$ (b) $\frac{2\sqrt{2}\mu_0 I}{\pi a}\hat{e}_z$

(c) $\frac{2\sqrt{2}\mu_0 I}{\pi a^2}\hat{e}_z$ (d) $\frac{2\sqrt{2}\mu_0 I}{\pi a^2}\hat{e}_x$

Diagram Based Questions :

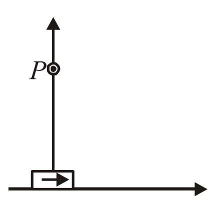
1. A current of I ampere flows in a wire forming a circular arc of radius r metres subtending an angle θ at the centre as shown. The magnetic field at the centre O in tesla is



(a) $\frac{\mu_0 I\theta}{4\pi r}$ (b) $\frac{\mu_0 I\theta}{2\pi r}$

(c) $\frac{\mu_0 I\theta}{2r}$ (d) $\frac{\mu_0 I\theta}{4r}$

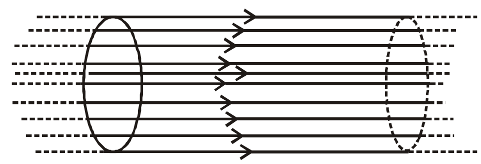
2. An element of $0.05\,\hat{i}$ *m* is placed at the origin as shown in figure which carries a large current of 10 A. distance of 1 m in perpendicular direction. The value of magnetic field is



(a) 4.5×10^{-8} T (b) 5.5×10^{-8} T

(c) 5.0×10^{-8} T (d) 7.5×10^{-8} T

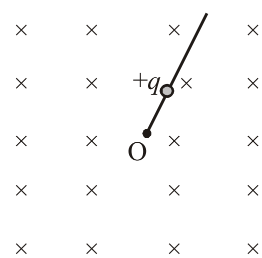
3. The figure shows n (n being an even number) wires placed along the surface of a cylinder of radius r. Each wire carries current i in the same direction. The net magnetic field on the axis of the cylinder is



(a) $\mu_0\, ni$ (b) $\frac{\mu_0 ni}{2\pi r}$

(c) zero (d) $\frac{\mu_0 ni}{4\pi r}$

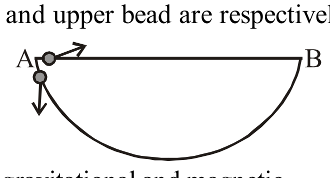
4. The figure shows a thin rod pivoted at point O and rotating clockwise in the plane of paper with constant angular velocity w. A bead having charge $+q$ can slide freely on the rod as the rod rotates.



Which of the following statements is incorrect ?

(a) Magnetic moment of current loop generated by the bead increases.
(b) Angular momentum of the bead increases.
(c) Torque on current loop generated is zero.
(d) Potentential energy of current loop generated decreases.

5. The figure shows a closed loop bent in the form of a semi-circle. One bead having charge $+q$ slides from A to B along the diameter in uniform motion and other bead having the same charge slides along the arc from A to B in uniform circular motion. Both take some time to travel from A to B. When both the beads are at the mid-point of their journey, then the forces exerted by lower bead and upper bead are respectively



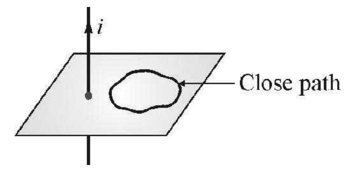
(a) gravitational and magnetic
(b) magnetic and electric
(c) electric and gravitational
(d) gravitational and electric.

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion:** Ampere's circuital law is independent of Biot-Savart's law.
Reason: Ampere's circuital law can be derived from the Biot-savart's law.
2. **Assertion :** The magnetic field due to a very large current carrying loop is zero at its centre.
Reason : Magnetic field at the centre of loop is, $B = \dfrac{\mu_0 i}{2R}$.
3. **Assertion :** If the current in a solenoid is reversed in direction while keeping the same magnitude, the magnetic field energy stored in the solenoid decreases.
Reason : Magnetic field energy density is proportional to square of current.
4. **Assertion :** If a charged particle is released from rest in a region of uniform electric and magnetic fields parallel to each other, it will move in a straight line.
Reason : The electric field exerts no force on the particle but the magnetic field does.
5. **Assertion :** Figure shows a current carrying conductor and a close path. For the close path $\oint \vec{B} \cdot d\vec{\ell} = 0$.



Reason : For the close path, the magnetic field at each point on the path is zero.
6. **Assertion :** The force between two parallel current carrying conductors carrying currents in same direction is attractive because there is no electrical interaction between them.
Reason : The force between two electrons streams moving in the same direction repulsive because there is no magnetic interaction between them.
7. **Assertion :** A current carrying loop placed in a magnetic field must experience a torque.
Reason : Torque on the loop is given by $\tau = MB\sin\theta$.
8. **Assertion:** The frequency of circular motion of a charged particle in cyclotron is independent of the mass of the particle.
Reason: Greater the mass of the particle less will be the frequency of the particle.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match Column I and Column II.

Column I	Column II
(A) Biot-Savart's law	(1) $\oint \vec{B}.\vec{dl} = \mu_0 \Sigma i$
(B) Ampere's circuital law	(2) $q[\vec{E} + (\vec{V} \times \vec{B})]$
(C) Force between two parallel current carrying conductors	(3) $\oint \vec{B}.\vec{dl} = \mu_0 \Sigma i$
(D) Lorentz force	(4) $\vec{B} = \dfrac{\mu_0 i}{4\pi} \int \dfrac{dl \sin\theta}{r^2} \hat{n}$

(a) (A)$\to$(4); (B)$\to$(3); (C)$\to$(1); (D)$\to$(2)
(b) (A)$\to$(2); (B)$\to$(2); (C)$\to$(4); (D)$\to$(3)
(c) (A)$\to$(4); (B)$\to$(3); (C)$\to$(2); (D)$\to$(1)
(d) (A)$\to$(2); (B)$\to$(1); (C)$\to$(4); (D)$\to$(3)

2. Match the entries given in Column I to their analogue entries of electrostatics given in Column II.

	Column I		**Column II**
(A)	Ampere's circuital law	(1)	Electric dipole
(B)	Biot-Savart's law	(2)	Gauss's law in electrostatics
(C)	Planar current loop	(3)	Permitivity of free space
(D)	Permeability of free space	(4)	Coulomb's law

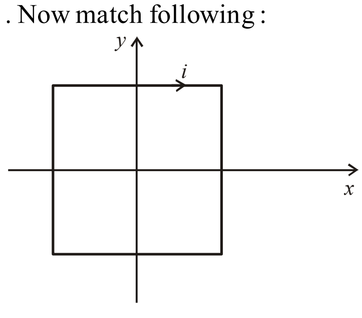
(a) (A) → (2) ; (B) → (4) ; (C) → (1) ; (D) → (3)
(b) (A) → (2) ; (B) → (2) ; (C) → (4) ; (D) → (3)
(c) (A) → (4) ; (B) → (3) ; (C) → (2) ; (D) → (1)
(d) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)

3. A charged particle having charge q and mass m is to be subjected to a combination of constant uniform magnetic field $(\vec{B})$ and a constant uniform gravitational field $(\vec{G})$. Apart from these field forces there exists no other force. Now match the column.

	Column-I		**Column -II**
(A)	The charged particle moves without change in its direction.	(1)	It is possible that both $\vec{B}$ and $\vec{G}$ are zero.
(B)	The charged particle moves without change in its velocity.	(2)	It is possible that both $\vec{B}$ and $\vec{G}$ are non zero.
(C)	The charged particle takes a circular path	(3)	It is possible that $\vec{B}$ is zero and $\vec{G}$ is not zero.
(D)	The charged particle takes a parabolic path	(4)	It is possible that $\vec{B}$ is non zero and $\vec{G}$ is zero.

(a) (A) → (2) ; (B) → (1) ; (C) → (3) ; (D) → (4)
(b) (A) → (2) ; (B) → (2) ; (C) → (4) ; (D) → (3)
(c) (A) → (1,2,3,4) ; (B) → (1,2,4) ; (C) → (4) ; (D) → (3)
(d) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)

4. A square loop of side a and carrying current i as shown in the figure is placed in gravity free space having magnetic field $B = B_0\hat{k}$. Now match following :



	Column-I		**Column -II**
(A)	Torque on loop	(1)	is zero
(B)	Net force on loop	(2)	is in direction $(-\hat{k})$
(C)	Potential energy of magnitudes	(3)	has minimum loop
(D)	Magnetic moment of magnitudes	(4)	has maximum loop

(a) (A) → (2) ; (B) → (1) ; (C) → (3) ; (D) → (4)
(b) (A) → (1,2) ; (B) → (1) ; (C) → (4) ; (D) → (2)
(c) (A) → (4) ; (B) → (3) ; (C) → (2) ; (D) → (1)
(d) (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)

5. Match the physical quantities of Column I with their mathematical expressions in Column II.

Column I	Column II
(A) Torque on a circular current loop placed in uniform magnetic field	(1) $\frac{\mu_0 i}{2R}$
(B) Force per unit length between parallel current carrying wires	(2) $iAB\sin\theta$
(C) Magnetic field at the centre of a circular current carrying loop.	(3) $\frac{mV}{qB}$
(D) Radius of circular path of a charge particle moving in uniform magnetic field.	(4) $\frac{\mu_0 i_1 i_2}{2\pi d}$

(a) $(A)\to(2)$; $(B)\to(1)$; $(C)\to(3)$; $(D)\to(4)$
(b) $(A)\to(2)$; $(B)\to(2)$; $(C)\to(4)$; $(D)\to(3)$
(c) $(A)\to(4)$; $(B)\to(3)$; $(C)\to(2)$; $(D)\to(1)$
(d) $(A)\to(2)$; $(B)\to(4)$; $(C)\to(1)$; $(D)\to(3)$

6. A circular current carrying loop with magnetic moment parallel to the magnetic field is rotated by an angle of 90° slowly about one of its diameter in a uniform magnetic field. Match the quantities of Column I with Column II.

Column I	Column II
(A) Torque on the loop	(1) Decreases from maximum to zero.
(B) Potential energy of the loop	(2) Remains constant
(C) Magnetic moment of the loop	(3) Increases from zero to maximum
(D) Magnetic flux through the loop	(4) Increases from minimum to zero.

(a) $(A)\to(2)$; $(B)\to(1)$; $(C)\to(3)$; $(D)\to(4)$
(b) $(A)\to(3)$; $(B)\to(4)$; $(C)\to(3)$; $(D)\to(1)$
(c) $(A)\to(4)$; $(B)\to(3)$; $(C)\to(2)$; $(D)\to(1)$
(d) $(A)\to(2)$; $(B)\to(1)$; $(C)\to(4)$; $(D)\to(3)$

Critical Thinking Type Questions :

1. A long straight wire in the horizontal plane carries a current of 75 A in north of south direction, magnitude and direction of field B at a point 3 m east of the wire is
(a) 4×10^{-6} T, vertical up
(b) 5×10^{-6} T, vertical down
(c) 5×10^{-6} T, vertical up
(d) 4×10^{-6} T, vertical down

2. A coil of one turn is made of a wire of certain length and then from the same length a coil of two turns is made. If the same current is passed in both the cases, then the ratio of the magnetic inductions at their centres will be
(a) 2 : 1 (b) 1 : 4
(c) 4 : 1 (d) 1 : 2

3. A charged particle with charge q enters a region of constant, uniform and mutually orthogonal fields $\vec{E}$ and $\vec{B}$ with a velocity $\vec{v}$ perpendicular to both $\vec{E}$ and $\vec{B}$, and comes out without any change in magnitude or direction of $\vec{v}$. Then
(a) $\vec{v} = \vec{B}\times\vec{E}/E^2$ (b) $\vec{v} = \vec{E}\times\vec{B}/B^2$
(c) $\vec{v} = \vec{B}\times\vec{E}/B^2$ (d) $\vec{v} = \vec{E}\times\vec{B}/E^2$

4. A cell is connected between two points of a uniformly thick circular conductor and i_1 and i_2 are the currents flowing in two parts of the circular conductor of radius a. The magnetic field at the centre of the loop will be

(a) zero (b) $\frac{\mu_0}{4\pi}(I_1 - I_2)$

(c) $\frac{\mu_0}{2a}(I_1 + I_2)$ (d) $\frac{\mu_0}{a}(I_1 + I_2)$

5. An electron (mass = 9×10^{-31} kg, charge = 1.6×10^{-19} C) moving with a velocity of 10^6 m/s enters a magnetic field. If it describes a circle of radius 0.1m, then strength of magnetic field must be

(a) 4.5×10^{-5} T (b) 1.4×10^{-5} T

(c) 5.5×10^{-5} T (d) 2.6×10^{-5} T

6. A helium nucleus makes a full rotation in a circle of radius 0.8 meter in 2 sec. The value of the magnetic field induction B in tesla at the centre of circle will be

(a) $2 \times 10^{-19} \mu_0$ (b) $10^{-19} / \mu_0$

(c) $10^{-19} \mu_0$ (d) $2 \times 10^{-20} / \mu_0$

7. A galvanometer of resistance 100 Ω gives a full scale deflection for a current of 10^{-5} A. To convert it into a ammeter capable of measuring upto 1 A, we should connect a resistance of

(a) 1 Ω in parallel (b) 10^{-3} Ω in parallel

(c) 10^5 Ω in series (d) 100 Ω in series

8. The orbital speed of electron orbiting around a nucleus in a circular orbit of radius 50 pm is 2.2×10^6 ms^{-1}. Then the magnetic dipole moment of an electron is

(a) 1.6×10^{-19} Am^2 (b) 5.3×10^{-21} Am^2

(c) 8.8×10^{-24} Am^2 (d) 8.8×10^{-26} Am^2

19

MAGNETISM AND MATTER

Fill in the Blanks :

1. The ultimate individual unit of magnetism in any magnet is called _______ .
2. Magnetic dipole moment is a vector quantity directed from _______ pole to _______ pole.
3. At magnetic poles, the angle of dip is _______ .
4. The ratio of intensity of magnetisation and magnetising field is called _______ .
5. Susceptibility is positive and large for a _______ magnetic material.
6. Metals getting magnetised by orientation of atomic magnetic moments in external magnetic field are called _______ .
7. The magnetic susceptibility for diamagnetic materials is _______ .
8. Curie temperature is the temperature above which _____ becomes.
9. The line on the earth's surface Joining the points where the field is horizontal is _______ .

True/ False :

1. The Earth behaves as a magnet with the magnetic field pointing approximately from the geographic South to the North.
2. There is an attractive force between the North–pole of one magnet and the South–pole of other.
3. We can isolate the North or South–pole of a magnet.
4. Paramagnetism is explained by domain theory.
5. A paramagnetic material tends to move from a strong magnetic field to weak magnetic field.
6. The resultant magnetic moment in an atom of a diamagnetic substance is zero.
7. Diamagnetism is explained in terms of electromagnetic induction.
8. Isogonic lines on magnetic map will have zero angle of declination.

Conceptual MCQs :

1. A bar magnet, of magnetic moment $\vec{M}$, is placed in a magnetic field of induction $\vec{B}$. The torque exerted on it is
   (a) $\vec{M} \cdot \vec{B}$ (b) $-\vec{M} \cdot \vec{B}$
   (c) $\vec{M} \times \vec{B}$ (d) $\vec{B} \times \vec{M}$
2. Two magnets of magnetic moments M and 2M are placed in a vibration magnetometer, with the identical poles in the same direction. The time period of vibration is T_1. If the magnets are placed with opposite poles together and vibrate with time period T_2, then
   (a) T_2 is infinite (b) $T_2 = T_1$
   (c) $T_2 > T_1$ (d) $T_2 < T_1$
3. A short bar magnet, placed with its axis at 30° with an external magnetic field of 0.16 T, experiences a torque of magnitude 0.032 J. The magnetic moment of the bar magnet is (in units of J/T)
   (a) 4 (b) 0.2
   (c) 0.5 (d) 0.4
4. Ratio of magnetic intensities for an axial point and a point on board side-on position at equal distance d from the centre of magnet will be or the magnetic field at a distance d from a shot bar magnet in longitudinal and transverse positions are in the ratio of
   (a) 1 : 1 (b) 2 : 3
   (c) 2 : 1 (d) 3 : 2

5. The magnetism of magnet is due to
(a) the spin motion of electron
(b) earth
(c) pressure of big magnet inside the earth
(d) cosmic rays

6. Which of the following is the most suitable material for making permanent magnet ?
(a) Steel (b) Soft iron
(c) Copper (d) Nickel

7. A dip needle lies initially in the magnetic meridian when it shows an angle of dip θ at a place. The dip circle is rotated through an angle x in the horizontal plane and then it shows an angle of dip θ'. Then $\frac{\tan\theta'}{\tan\theta}$ is
(a) $\frac{1}{\cos x}$ (b) $\frac{1}{\sin x}$
(c) $\frac{1}{\tan x}$ (d) $\cos x$

8. The horizontal component of the earth's magnetic field is 3.6×10^{-5} tesla where the dip angle is 60°. The magnitude of the earth's magnetic field is
(a) 2.8×10^{-4} tesla (b) 2.1×10^{-4} tesla
(c) 7.2×10^{-5} tesla (d) 3.6×10^{-5} tesla

9. A torque of 10^{-5} Nm is required to hold a magnet at 90° with the horizontal component H of the earth's magnetic field. The torque to hold it at 30° will be
(a) 5×10^{-6} Nm (b) data is insufficient
(c) $\frac{1}{3}\times10^{-5}$ Nm (d) $5\sqrt{3}\times10^{-6}$ Nm

10. The correct relation is
(a) $B=\frac{B_V}{B_H}$ (b) $B=B_V\times B_H$
(c) $|B|=\sqrt{B_H^2+B_V^2}$ (d) $B=B_H+B_V$

11. Above Curie temperature
(a) a paramagnetic substance becomes diamagnetic
(b) a diamagnetic substance becomes paramagnetic
(c) a paramagnetic substance becomes ferromagnetic
(d) a ferromagnetic substance becomes paramagnetic

12. Which of the following statements is incorrect about hysteresis ?
(a) This effect is common to all ferromagnetic substances
(b) The hysteresis loop area is proportional to the thermal energy developed per unit volume of the material
(c) The hysteresis loop area is independent of the thermal energy developed per unit volume of the material
(d) The shape of the hysteresis loop is characteristic of the material

13. For protecting a sensitive equipment from the external electric arc, it should be
(a) wrapped with insulation around it when a current is passing through it
(b) placed inside an iron can
(c) surrounded with fine copper sheet
(d) placed inside an aluminium can

14. The time period of oscillation of a freely suspended bar magnet with usual notations is given by
(a) $T=2\pi\sqrt{\frac{I}{MB_H}}$ (b) $T=2\pi\sqrt{\frac{MB_H}{I}}$
(c) $T=\sqrt{\frac{I}{MB_H}}$ (d) $T=2\pi\sqrt{\frac{B_H}{MI}}$

15. There are four light–weight–rod samples A,B,C,D separately suspended by threads. A bar magnet is slowly brought near each sample and the following observations are noted
(i) A is feebly repelled
(ii) B is feebly attracted
(iii) C is strongly attracted
(iv) D remains unaffected
Which one of the following is true ?
(a) B is of a paramagnetic material
(b) C is of a diamagnetic material
(c) D is of a ferromagnetic material
(d) A is of a non–magnetic material

16. A coil in the shape of an equilateral triangle of side l is suspended between the pole pieces of a permanent magnet such that $\vec{B}$ is in the plane of the coil. If due to a current i in the triangle a torque τ acts on it, the side l of the triangle is
(a) $\frac{2}{\sqrt{3}}\left(\frac{\tau}{B.i}\right)^{\frac{1}{2}}$ (b) $2\left(\frac{\tau}{\sqrt{3}B.i}\right)^{\frac{1}{2}}$
(c) $\frac{2}{\sqrt{3}}\left(\frac{\tau}{B.i}\right)$ (d) $\frac{1}{\sqrt{3}}\frac{\tau}{B.i}$

17. If the magnetic dipole moment of an atom of diamagnetic material, paramagnetic material and ferromagnetic material are denoted by μ_d, μ_p and μ_f respectively, then

(a) $\mu_d = 0$ and $\mu_p \neq 0$ (b) $\mu_d \neq 0$ and $\mu_p = 0$

(c) $\mu_p = 0$ and $\mu_f \neq 0$ (d) $\mu_d \neq 0$ and $\mu_f \neq 0$

18. A small bar magnet of moment M is placed in a uniform field H. If magnet makes an angle of 30° with field, the torque acting on the magnet is

(a) MH (b) $\frac{MH}{2}$

(c) $\frac{MH}{3}$ (d) $\frac{MH}{4}$

19. The true value of angle of dip at a place is 60°, the apparent dip in a plane inclined at an angle of 30° with magnetic meridian is

(a) $\tan^{-1}\frac{1}{2}$ (b) $\tan^{-1}(2)$

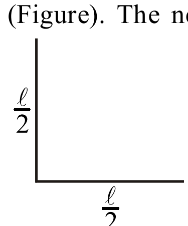
(c) $\tan^{-1}\left(\frac{2}{3}\right)$ (d) None of these

20. The materials suitable for making electromagnets should have

(a) high retentivity and low coercivity
(b) low retentivity and low coercivity
(c) high retentivity and high coercivity
(d) low retentivity and high coercivity

Diagram Based Questions :

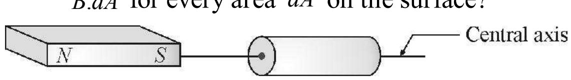
1. A steel wire of length ℓ has a magnetic moment M. It is bent in L-shape (Figure). The new magnetic moment is



(a) M (b) $\frac{M}{\sqrt{2}}$

(c) $\frac{M}{2}$ (d) 2M

2. Imagine rolling a sheet of paper into a cylinder and placing a bar magnet near its end as shown in figure. What can you say about the sign of $\vec{B}.d\vec{A}$ for every area $d\vec{A}$ on the surface?

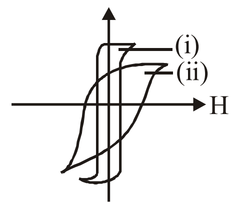


(a) Positive (b) Negative

(c) No sign

(d) Can be positive or negative

3. The B – H curve (i) and (ii) shown in fig associated with



(a) (i) diamagnetic and (ii) paramagnetic substance

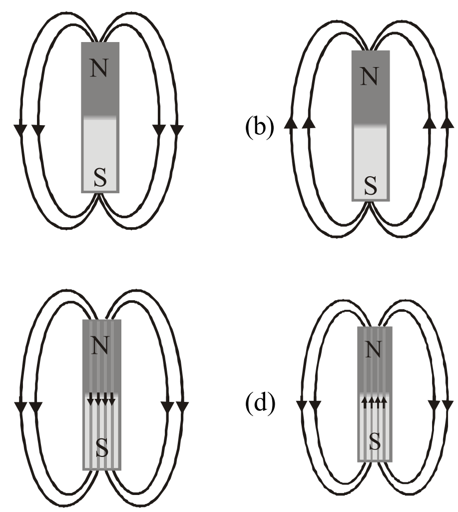
(b) (i) paramagnetic and (ii) ferromagnetic substance

(c) (i) soft iron and (ii) steel

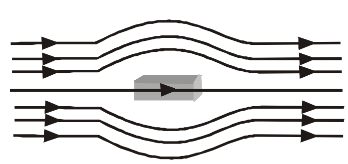
(d) (i) steel and (ii) soft iron

4. The magnetic field lines due to a bar magnet are correctly shown in

(a) (b) (c) (d)



5. The given figure represents a material which is



(a) paramagnetic (b) diamagnetic

(c) ferromagnetic (d) none of these

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The poles of magnet can not be separated by breaking into two pieces.
Reason : The magnetic moment will be reduced to half when a magnet is broken into two equal pieces.

2. **Assertion :** The earth′s magnetic field is due to iron present in its core.
Reason : At a high temperature magnet losses its magnetism.

3. **Assertion :** To protect any instrument from external magnetic field, it is put inside an iron body.
Reason : Iron has high permeability.

4. **Assertion :** The sensitivity of a moving coil galvanometer is increased by placing a suitable magnetic material as a core inside the coil.
Reason : Soft iron has high magnetic permeability and cannot be easily magnetized or demagnetized.

5. **Assertion :** Magnetism is relativistic.
Reason : When we move along with the charge so that there is no motion relative to us, we find no magnetic field associated with the charge.

6. **Assertion :** The ferromagnetic substance do not obey Curie's law.
Reason : At Curie point a ferromagnetic substance start behaving as a paramagnetic substance.

7. **Assertion :** A paramagnetic sample display greater magnetisation (for the same magnetic field) when cooled.
Reason : The magnetisation does not depend on temperature.

8. **Assertion :** Electromagnets are made of soft iron.
Reason : Coercivity of soft iron is small.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column I	Column II
(A) Axial field for a short dipole	(1) $-M.B$
(B) Equatorial field for a short dipole	(2) $M \times B$
(C) External field torque	(3) $\mu_0 2M/4\pi r^3$
(D) External field energy	(4) $-\mu_0 M/4\pi r^3$

(a) $(A)\to(3)$; $(B)\to(4)$; $(C)\to(2)$; $(D)\to(1)$
(b) $(A)\to(3)$; $(B)\to(4)$; $(C)\to(3)$; $(D)\to(1)$
(c) $(A)\to(4)$; $(B)\to(3)$; $(C)\to(2)$; $(D)\to(1)$
(d) $(A)\to(2)$; $(B)\to(1)$; $(C)\to(4)$; $(D)\to(3)$

2.

Column I	Column II
(A) Horizontal component	(1) $B_E \sin\theta$
(B) Vertical component	(2) $\frac{B_V}{B_H}$
(C) $\tan\theta$	(3) $B_E \cos\theta$
(D) Tangent law	(4) $B = B_H \tan\theta$

(a) $A\to(3)$; $B\to(2)$; $C\to(1)$; $D\to(4)$
(b) $A\to(3)$; $B\to(1)$; $C\to(2)$; $D\to(4)$
(c) $A\to(2)$; $B\to(3)$; $C\to(1)$; $D\to(4)$
(d) $A\to(1)$; $B\to(3)$; $C\to(2)$; $D\to(4)$

3.

Column I	Column II
(A) Negative susceptibility	(1) Ferromagnetic
(B) Positive and small	(2) Diamagnetic susceptibility
(C) Positive and large	(3) Paramagnetic susceptibility
(D) Loadstone	(4) Magnetite

(a) $A\to(3)$; $B\to(2)$; $C\to(4)$; $D\to(1)$
(b) $A\to(1)$; $B\to(2)$; $C\to(3)$; $D\to(4)$
(c) $A\to(2)$; $B\to(3)$; $C\to(1)$; $D\to(4)$
(d) $A\to(2)$; $B\to(1)$; $C\to(4)$; $D\to(3)$

Critical Thinking Type Questions :

1. Time periods of vibation of two bar magnets in sum and difference positions are 4 sec and 6 sec respectively. The ratio of their magnetic moments M_1 / M_2 is

(a) 6 : 4 (b) 30 : 16
(c) 2 . 6 : 1 (d) 1 . 5 : 1

2. A bar magnet 8 cms long is placed in the magnetic merdian with the N-pole pointing towards geographical north. Two netural points separated by a distance of 6 cms are obtained on the equatorial axis of the magnet. If horizontal component of earth's field = 3.2×10^{-5} T, then pole strength of magnet is

(a) 5 ab-amp × c (b) 10 ab-amp × cm
(c) 2.5 ab-amp × cm (d) 20 ab-amp × cm

3. Two magnets are held together in a vibration magnetometer and are allowed to oscillate in the earth's magnetic field with like poles together. 12 oscillations per minute are made but for unlike poles together only 4 oscillations per minute are executed. The ratio of their magnetic moments is

(a) 3 : 1 (b) 1 : 3
(c) 3 : 5 (d) 5 : 4

4. A short magnet oscillates in an oscillation magnetometer with a time period of 0.10s where the earth's horizontal magnetic field is 24 μT. A downward current of 18 A is established in a vertical wire placed 20 cm east of the magnet. Find the new time period.

(a) 0.076 s (b) 0.5 s
(c) 0.1 s (d) 0.2 s

5. A magnetising field of 2×10^3 A m^{-1} produces a magnetic flux density of 8π T in an iron rod. The relative permeability of the rod will be

(a) 10^2 (b) 1
(c) 10^4 (d) 10^3

6. At a temperatur of 30°C, the susceptibility of a ferromagnetic material is found to be χ. Its susceptibility at 333°C is

(a) χ (b) 0.5χ
(c) 2χ (d) 11.1χ

7. A bar magnet has coercivity 4×10^3 Am^{-1}. It is desired to demagnetise it by inserting it inside a solenoid 12 cm long and having 60 turns. The current that should be sent through the solenoid is

(a) 2 A (b) 4 A
(c) 6 A (d) 8 A

8. A torque of 10^{-5} Nm is required to hold a magnet at 90° with the horizontal component H of the earth's magnetic field. The torque to hold it at 30° will be

(a) 5×10^{-6} Nm (b) data is insufficient
(c) $\frac{1}{3} \times 10^{-5}$ Nm (d) $5\sqrt{3} \times 10^{-6}$ Nm

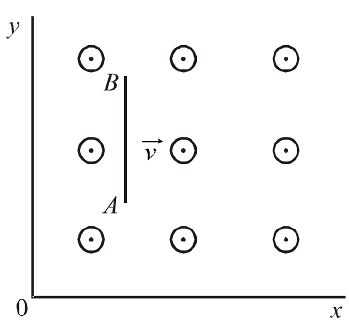
20 Electromagnetic Induction

Fill in the Blanks :

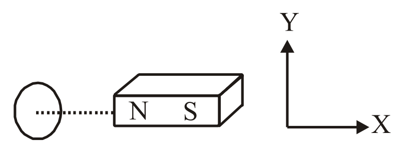
1. Whenever the magnetic flux linked with an electric circuit changes, an emf is induced in the circuit. This is called _______ .
2. A moving conductor coil induces e.m.f. This is in accordance with _______ .
3. Lenz's law is a consequence of the law of conservation of _______ .
4. The average power dissipation in pure inductance is _______ .
5. A conducting wire is dropped along east-west direction then induced current flows from _______ to _______ .
6. A dynamo converts _______ into _______ .
7. Choke coil works on the principle of _______ .
8. Induction furnace make use of _______ current.

True/ False :

1. An e.m.f. can be induced between the two ends of a straight copper wire when it is moved through a uniform magnetic field.
2. A coil of metal wire is kept stationary in a non-uniform magnetic field. An e.m.f. is induced in the coil.
3. A conducting rod *AB* moves parallel to the x-axis (see Fig.) in a uniform magnetic field pointing in the positive z-direction. The end *A* of the rod gets positively charged.



4. A current carrying infinitely long wire is kept along the diameter of a circular wire loop, without touching. The emf induced in the loop is zero if the current decreases at a steady rate.
5. Whenever the magnetic flux linked with a coil changes, an induced e.m.f.is produced in the circuit. The e.m.f. lasts so long as the change in flux takes place
6. Consider coil and magnet



Current is induced in coil when both coil and magnet move along y with same speed.
7. Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon the rates at which currents are changing in the two coils.
8. A coil of self-inductance L is connected in series with a bulb B and an AC source. Brightness of the bulb decreases when an iron rod is inserted in the coil.

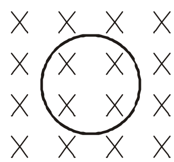
Conceptual MCQs

1. A current of 2.5 A flows through a coil of inductance 5 H. The magnetic flux linked with the coil is
(a) 2 Wb (b) 0.5 Wb
(c) 12.5 Wb (d) Zero
2. A short-circuited coil is placed in a time-varying magnetic field. Electrical power is dissipated due to the current induced in the coil. If the number of turns were to be quadrupled and the wire radius halved, the electrical power dissipated would be –
(a) halved (b) the same
(c) doubled (d) quadrupled

3. If rotational velocity of a dynamo armature is doubled, then induced emf will become

(a) unchanged (b) four times
(c) half (d) two times

4. The coil is in a uniform magnetic field, perpendicular to the plane of the coil, as shown.



Consider now the following :

I. Rotation of the coil about an axis perpendicular to the coil and passing through its centre

II. Displacement of coil at constant speed towards right

III. Rotation of coil about an axis passing through one of its diameters

In which of these an emf will be induced in the coil :

(a) III only (b) I and III
(c) I and II (d) I, II and III

5. Two coils of self inductances 2 mH and 8 mH are placed so close together that the effective flux in one coil is completely linked with the other. The mutual inductance between these coils is

(a) 6mH (b) 4mH
(c) 16mH (d) 10mH

6. In an inductor of self-inductance L = 2 mH, current changes with time according to relation $i = t^2e^{-t}$. At what time emf is zero?

(a) 4s (b) 3s
(c) 2s (d) 1s

7. Two coils have a mutual inductance 0.005 H. The current changes in the first coil according to equation $I=I_0 \sin \omega t$, where $I_0 = 10A$ and $\omega = 100\pi$ radian/sec. The maximum value of e.m.f. in the second coil is

(a) 2π (b) 5π
(c) π (d) 4π

8. A varying current in a coil changes from 10A to zero in 0.5 sec. If the average e.m.f induced in the coil is 220V, the self-inductance of the coil is

(a) 5 H (b) 6 H
(c) 11 H (d) 12 H

9. The total charge induced in a conducting loop when it is moved in a magnetic field depend on

(a) the rate of change of magnetic flux
(b) initial magnetic flux only
(c) the total change in magnetic flux
(d) final magnetic flux only

10. The magnetic flux through a circuit of resistance R changes by an amount $\Delta\phi$ in a time Δt. Then the total quantity of electric charge Q that passes any point in the circuit during the time Δt is represented by

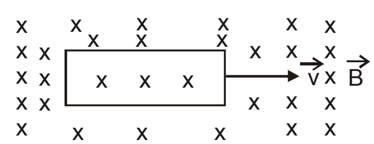
(a) $Q = R.\frac{\Delta\phi}{\Delta t}$ (b) $Q = \frac{1}{R}.\frac{\Delta\phi}{\Delta t}$

(c) $Q = \frac{\Delta\phi}{R}$ (d) $Q = \frac{\Delta\phi}{\Delta t}$

11. A coil having an area A_0 is placed in a magnetic field which changes from B_0 to 4 B_0 in time interval t. The e.m.f. induced in the coil will be

(a) $3A_0 B_0 / t$ (b) $4A_0 B_0 / t$
(c) $3B_0 / A_0 t$ (d) $4A_0 / B_0 t$

12. A conducting square loop of side L and resistance R moves in its plane with a uniform velocity v perpendicular to one of its side. A magnetic induction B constant in



time and space, pointing perpendicular and into the plane of the loop exists everywhere. The current induced in the loop in

(a) $\frac{B\ell v}{R}$ clockwise

(b) $\frac{B\ell v}{R}$ anticlockwise

(c) $\frac{2B\ell v}{R}$ anticlockwise

(d) zero

13. If a current increases from zero to one ampere in 0.1 second in a coil of 5 mH, then the magnitude of the induced e.m.f. will be

(a) 0.005 volt (b) 0.5 volt
(c) 0.05 volt (d) 5 volt

14. A generator has an e.m.f. of 440 Volt and internal resistance of 4000 hm. Its terminals are connected to a load of 4000 ohm. The voltage across the load is

(a) 220 volt (b) 440 volt
(c) 200 volt (d) 400 volt

15. An e.m.f. of 2 volt is produced in a coil when the current changes at a steady rate from 3 to 2 amperes in 1 milli-second. The value of self inductance is

(a) zero (b) 2mH
(b) 2 H (d) 200mH

16. A coil has 200 turns and area of 70 cm^2. The magnetic field perpendicular to the plane of the coil is 0.3 Wb/m^2 and take 0.1 sec to rotate through 180º.The value of the induced e.m.f. will be

(a) 8.4 V (b) 84 V
(c) 42 V (d) 4.2 V

17. A thin circular ring of area A is held perpendicular to a uniform magnetic field of induction B. A small cut is made in the ring and a galvanometer is connected across the ends such that the total resistance of the circuit is R. When the ring is suddenly squeezed to zero area, the charge flowing through the galvanometer is

(a) $\frac{BR}{A}$ (b) $\frac{AB}{R}$
(c) ABR (d) $\frac{B^2A}{R^2}$

18. A 100 millihenry coil carries a current of 1A. Energy stored in its magnetic field is

(a) 0.5 J (b) 1 A
(c) 0.05 J (d) 0.1 J

19. The armature of a dc motor has 20W resistance. It draws a current of 1.5 A when run by a 220 V dc supply. The value of the back emf induced in it is

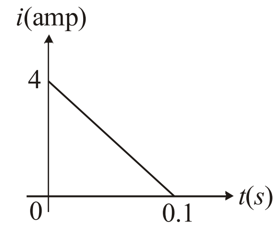
(a) 150 V (b) 170 V
(c) 180 V (d) 190 V

20. An infinitely long cylinder is kept parallel to an uniform magnetic field B directed along positive z axis. The direction of induced current as seen from the z axis will be

(a) zero
(b) anticlockwise of the +ve z axis
(c) clockwise of the +ve z axis
(d) along the magnetic field

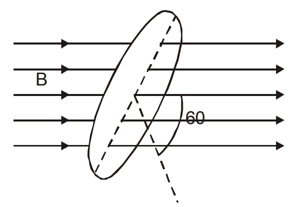
Diagram Based Questions :

1. In a coil of resistance 10 Ω, the induced current developed by changing magnetic flux through it, is shown in figure as a function of time. The magnitude of change in flux through the coil in weber is



(a) 8 (b) 2
(c) 6 (d) 4

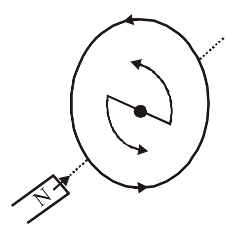
2. Fig shown below represents an area A = 0.5 m^2 situated in a uniform magnetic field B = 2.0 weber/m^2 and making an angle of 60º with respect to magnetic field.



The value of the magnetic flux through the area would be equal to

(a) 2.0 weber (b) $\sqrt{3}$ weber
(c) $\sqrt{3}/2$ weber (d) 0.5 weber

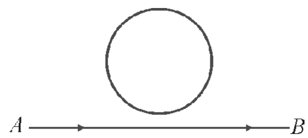
3. In the given situation, the bar magnet experinces a ...A... force due to the ... B ... in coil.



Here, A and B refer to

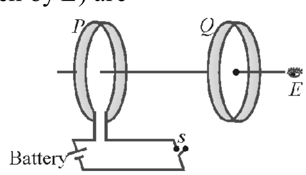
(a) an attractive, air
(b) an attractive, induced current
(c) repulsive, induced current
(d) attractive, vacuum

4. An electron moves along the line AB, which lies in the same plane as a circular loop of conducting wires as shown in the diagram. What will be the direction of current induced if any, in the loop



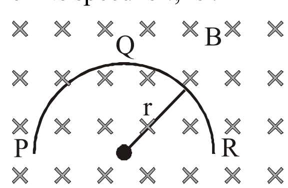
(a) no current will be induced
(b) the current will be clockwise
(c) the current will be anticlockwise
(d) the current will change direction as the electron passes by

5. As shown in the figure, P and Q are two coaxial conducting loops separated by some distance. When the switch S is closed, a clockwise current I_P flows in P (as seen by E) and an induced current I_{Q_1} flows in Q. The switch remains closed for a long time. When S is opened, a current I_{Q_2} flows in Q. Then the directions of I_{Q_1} and I_{Q_2} (as seen by E) are



(a) respectively clockwise and anticlockwise
(b) both clockwise
(c) both anticlockwise
(d) respectively anticlockwise and clockwise

6. A thin semicircular conducting ring (PQR) of radius 'r' is falling with its plane vertical in a horizontal magnetic field B, as shown in figure. The potential difference developed across the ring when its speed is v, is :



(a) Zero
(b) $Bv\pi r^2/2$ and P is at higher potential
(c) πrBv and R is at higher potential
(d) $2rBv$ and R is at higher potential

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

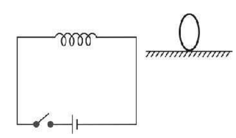
(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Induced emf will always occur whenever there is change in magnetic flux.
Reason : Current always induces whenever there is change in magnetic flux.

2. **Assertion :** Faraday's laws are consequence of conservation of energy.
Reason : In a purely resistive ac circuit, the current legs behind the emf in phase.

3. **Assertion :** Lenz's law violates the principle of conservation of energy.
Reason : Induced emf always opposes the change in magnetic flux responsible for its production.

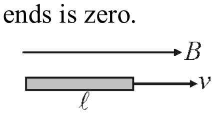
4. **Assertion :** Figure shows a horizontal solenoid connected to a battery and a switch. A copper ring is placed on a smooth surface, the axis of the ring being horizontal. As the switch is closed, the ring will move away from the solenoid.



Reason : Induced emf in the ring, $e = -\dfrac{d\phi}{dt}$.

5. **Assertion :** An emf can be induced by moving a conductor in a magnetic field.
Reason : An emf can be induced by changing the magnetic field.

6. **Assertion :** Figure shows a metallic conductor moving in magnetic field. The induced emf across its ends is zero.



Reason : The induced emf across the ends of a conductor is given by $e = Bv\ell\sin\theta$.

7. **Assertion :** Eddy currents are produced in any metallic conductor when magnetic flux is changed around it.
Reason : Electric potential determines the flow of charge.

8. **Assertion :** When number of turns in a coil is doubled, coefficient of self-inductance of the coil becomes 4 times.
Reason : This is because $L \propto N^2$.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the following column-I and column-II.

	Column I		Column II
(A)	AC generator	(1)	Eddy current
(B)	DC motor	(2)	Slip rings
(C)	Dead beat galvanometer	(3)	Split ring
(D)	Solenoid wound in the form of a cylindrical coil	(4)	Insulated copper wire

(a) (A) → (2); (B) → (3); (C) → (2); (D) → (1)
(b) (A) → (4); (B) → (2); (C) → (1); (D) → (3)
(c) (A) → (2); (B) → (3); (C) → (1); (D) → (4)
(d) (A) → (2); (B) → (1); (C) → (3); (D) → (4)

2.

	Column I		Column II
(A)	Ring uniformly charged	(1)	Constant electrostatic field out of system
(B)	Rotating ring uniformly charged velocity ω	(2)	Magnetic field strength rotating with angular
(C)	Constant current in ring i	(3)	Electric field (induced)
(D)	$i = i_0 \cos\omega t$	(4)	Magnetic dipole moment

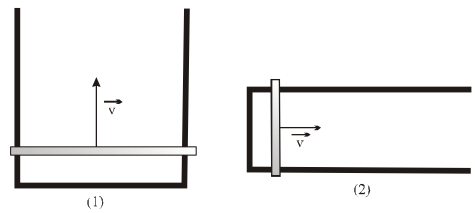
(a) (A) → (2); (B) → (2, 3); (C) → (1, 4, 3); (D) → (3)
(b) (A) → (3, 4); (B) → (1); (C) → (2,3); (D) → (2)
(c) (A) → (1); (B) → (1, 2, 4); (C) → (2, 4); (D) → (3)
(d) (A) → (2); (B) → (4, 2, 1); (C) → (2, 1); (D) → (4, 2)

3. Time varying magnetic field is present in a circular region of radius R. Then

	Column-I		Column-II
(A)	If a rod is placed along the diameter of the length of the rod.	(1)	Electric field is perpendicular to the magnetic field
(B)	Induced electric field at a point within magnetic field (r < R)	(2)	Constant along the length of conductor.
(C)	Induced electric field at a point out side the magnetic field (r > R)	(3)	$-\dfrac{r}{2}\dfrac{dB}{dt}$
(D)	Induced electric field in a conductor has a component parallel to length of conductor	(4)	$-\dfrac{R^2}{2r}\dfrac{dB}{dt}$

(a) (A) $\rightarrow$ (1); (B) $\rightarrow$ (3); (C) $\rightarrow$ (4); (D) $\rightarrow$ (2)
(b) (A) $\rightarrow$ (4); (B) $\rightarrow$ (2); (C) $\rightarrow$ (1); (D) $\rightarrow$ (3)
(c) (A) $\rightarrow$ (2); (B) $\rightarrow$ (3); (C) $\rightarrow$ (1); (D) $\rightarrow$ (4)
(d) (A) $\rightarrow$ (2); (B) $\rightarrow$ (1); (C) $\rightarrow$ (3); (D) $\rightarrow$ (4)

4. Figure shows two circuits in which a conducting bar is sliding at the same speed v through the same uniform magnetic field and along a U-shaped wire. The parallel lengths of the wire are separated by 2L in circuit 1 and by L in circuit 2. The current induced a circuit 1 is counterclockwise.



Column-I	Column-II
(A) Direction of current in circuit 1	(1) clockwise
(B) Direction of current in circuit 2	(2) anti-clockwise
(C) Large induce emf circuit	(3) 1
(D) Smaller induce emf circuit	(4) 2

(a) (A) $\rightarrow$ (2); (B) $\rightarrow$ (3); (C) $\rightarrow$ (2); (D) $\rightarrow$ (1)
(b) (A) $\rightarrow$ (4); (B) $\rightarrow$ (2); (C) $\rightarrow$ (1); (D) $\rightarrow$ (3)
(c) (A) $\rightarrow$ (2); (B) $\rightarrow$ (2); (C) $\rightarrow$ (3); (D) $\rightarrow$ (4)
(d) (A) $\rightarrow$ (2); (B) $\rightarrow$ (1); (C) $\rightarrow$ (3); (D) $\rightarrow$ (4)

Critical Thinking Type Questions :

1. The flux linked with a coil at any instant 't' is given by
$\phi = 10t^2 - 50t + 250$. The induced emf at t = 3s is
(a) –190 V (b) –10 V
(c) 10 V (d) 190 V

2. In a uniform magnetic field of induction B, a wire in the form of a semicircle of radius r rotates about the diameter of the circle with an angular frequency ω. The axis of rotation is perpendicular to the field. If the total resistance of the circuit is R, the mean power generated per period of rotation is

(a) $\frac{(B\pi r\omega)^2}{2R}$ (b) $\frac{(B\pi r^2\omega)^2}{2R}$

(c) $\frac{B\pi r^2\omega}{2R}$ (d) $\frac{(B\pi r\omega^2)^2}{8R}$

3. A circular coil of radius 6 cm and 20 turns rotates about its vertical diameter with an angular speed of 40 rad s^{-1} in a uniform horizontal magnetic field of magnitude 2×10^{-2} T. If the coil form a closed loop of resistance 8Ω, then the average power loss due to joule heating is
(a) 2.07×10^{-3} W (b) 1.23×10^{-3} W
(c) 3.14×10^{-3} W (d) 1.80×10^{-3} W

4. A long solenoid having 200 turns per cm carries a current of 1.5 amp. At the centre of it is placed a coil of 100 turns of cross-sectional area 3.14×10^{-4} m^2 having its axis parallel to the field produced by the solenoid. When the direction of current in the solenoid is reversed within 0.05 sec, the induced e.m.f. in the coil is
(a) 0.48 V (b) 0.048 V
(c) 0.0048 V (d) 48 V

5. In an AC generator, a coil with N turns, all of the same area A and total resistance R, rotates with frequency ω in a magnetic field B. The maximum value of emf generated in the coil is
(a) N.A.B.R.ω (b) N.A.B.
(c) N.A.B.R. (d) N.A.B.ω

6. The inductance of a closed-packed coil of 400 turns is 8 mH. A current of 5 mA is passed through it. The magnetic flux through each turn of the coil is

(a) $\frac{1}{4\pi}\mu_0$ Wb (b) $\frac{1}{2\pi}\mu_0$ Wb

(c) $\frac{1}{3\pi}\mu_0$ Wb (d) $0.4\,\mu_0$ Wb

21 Alternating Current

Fill in the Blanks :

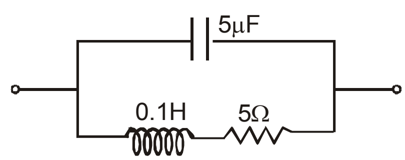
1. The maximum value of a.c. voltage in a circuit is 707 V. Its r.m.s. value is _______ .
2. All a.c. meters are based on _______ effect of current.
3. The alternating current of equivalent value of $\frac{I_0}{\sqrt{2}}$ is _______ current.
4. In LCR circuit if resistance increases, quality factor ____ .
5. The core of transformer is laminated to reduce ______ .
6. A transformer is based on the principle of _______ .
7. The parallel combination of inductor and capacitor is called as _______ circuit.
8. Transformers are used in _______ circuits only.

True/ False :

1. The frequency of a.c. mains in India is 60 Hz.
2. Most of the electrical energy sold by power companies is transmitted and distributed as alternating current.
3. The natural frequency of a L.C. circuit is equal to $\frac{1}{2\pi}\sqrt{\frac{L}{C}}$
4. In LCR series ac circuit, as the frequency of the source increases, the impedence of the circuit first decreases and then increases.
5. Below resonance, voltage leads the current while above it, current leads the voltage.
6. An alternating voltage of frequency ω is induced in electric circuit consisting of an inductance L and capacitance C, connected in parallel. Then across the inductance coil the current is minimum when $\omega^2 = 1/(LC)$.
7. If quality factor is large, i.e., R is low or L is large, the circuit is more selective.

Conceptual MCQs

1. In an A.C. circuit, the current flowing in inductance is $I = 5\sin(100t - \pi/2)$ amperes and the potential difference is $V = 200\sin(100t)$ volts. The power consumption is equal to
   (a) 1000 watts (b) 40 watts
   (c) 20 watts (d) 0 watt
2. A step down transformer is connected to 2400 volts line and 80 amperes of current is found to flow in output load. The ratio of the turns in primary and secondary coil is 20 : 1. If transformer efficiency is 100%, then the current flowing in the primary coil will be
   (a) 1600 A (b) 20 A
   (c) 4 A (d) 1.5 A
3. In the circuit shown in fig, the resonant frequency is



   (a) 75 kc/s (b) 750 kc/s
   (c) 7.5 kc/s (d) 75 mc/s
4. The power factor of an AC circuit having resistance (R) and inductance (L) connected in series and an angular velocity ω is
   (a) $R/\omega L$ (b) $R/(R^2\omega^2L^2)$
   (c) $\omega L/R$ (d) $R/(R^2\omega^2L^2)^{1/2}$
5. In an experiment, 200V A.C is applied at the ends of an LCR circuit. The circuit consists of an inductive reactance $(X_L) = 50\Omega$, capacitive reactance $(X_C) = 50\Omega$ and ohmic resistance (R) $= 10\Omega$. The impedance of the circuit is
   (a) 10Ω (b) 20Ω (c) 30Ω (d) 40Ω
6. In an A.C. circuit with phase voltage V and current I, the power dissipated is
   (a) VI (b) V^2I (c) VI^2 (d) V^2I^2

7. In a transformers, number of turns in primary coil are 140 and that in secondary coil are 280. If current in primary coil is 4A, then that in secondary coil is
(a) 4 A (b) 2 A (c) 6 A (d) 10 A

8. The core of any transformer is laminated so as to
(a) reduce the energy loss due to eddy currents
(b) make it light weight
(c) make it robust and sturdy
(d) increase secondary voltage

9. In an oscillating LC circuit the max. charge on the capacitor is Q. The charge on capacitor when the energy is stored equally between electric and magnetic field is
(a) Q/2 (b) $Q/\sqrt{3}$
(c) $Q/\sqrt{2}$ (d) Q

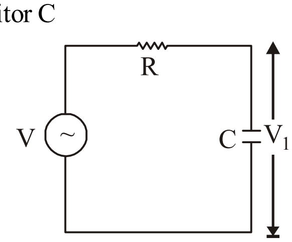
10. In an ac circuit an alternating voltage e = 200 $\sqrt{2}$ sin 100 t volts is connected to a capacitor of capacity 1 μF. The r.m.s. value of the current in the circuit is
(a) 10 mA (b) 100 mA
(c) 200 mA (d) 20 mA

11. An inductance L having a resistance R is connected to an alternating source of angular frequency ω. The Quality factor Q of inductance is
(a) $R/\omega L$ (b) $(\omega L/R)^2$
(c) $(R/\omega L)^{1/2}$ (d) $\omega L/R$

12. A capacitor has capacitance C and reactance X, if capacitance and frequency become double, then reactance will be
(a) 4X (b) X/2
(c) X/4 (d) 2X

13. Which of the following will have the dimensions of time
(a) LC (b) R/L
(c) L/R (d) C/L

14. In the circuit shown, the voltage V_1 across capacitor C



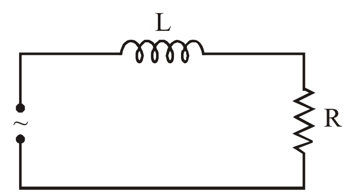
(a) is in phase with the source voltage V
(b) leads the source voltage V by 90°
(c) leads the source voltage V by an angle between 0° and 90°
(d) lags behind the source voltage V by an angle between 0° and 90°.

15. A coil of 40 henry inductance is connected in series with a resistance of 8 ohm and the combination is joined to the terminals of a 2 volt battery. The time constant of the circuit is
(a) 20 seconds (b) 5 seconds
(c) 1/5 seconds (d) 40 seconds

16. Resonance frequency of a circuit is f. If the capacitance is made 4 times the initial value, then the resonance frequency will become :
(a) f/2 (b) 2f (c) f (d) f/4

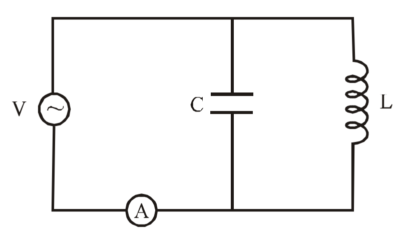
17. The average power delivered to an AC circuit by the source of emf is maximum when the circuit is
(a) consisting LCR away from resonance
(b) purely capacitive
(c) purely inductive
(d) purely resistive

18. An inductor and a resistor in series are connected to an A.C. supply of variable frequency. As the frequency of the source is increased, the phase angle between current and the potential difference across L will:



(a) first increase and then decrease
(b) first decrease and then increase
(c) go on decreasing
(d) go on increasing

19. An AC source of variable frequency is connected to a capacitor C and an inductor L as shown. A is an ammeter



As the frequency is steadily increased the current in A will :
(a) go on decreasing gradually
(b) go on increasing gradually
(c) first increase and then decrease
(d) first decrease and then increase

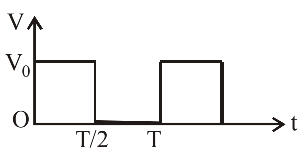
20. In a series LCR circuit, if the applied voltage V and the current in the circuit I at any instant t are given as :
$V = V_0 \sin \omega t$ and $I = I_0 \sin (\omega t - \phi)$
then which of the following holds good :

(a) $\omega L = \frac{1}{\omega C}$ (b) $\omega L > \frac{1}{\omega C}$

(c) $\omega L < \frac{1}{\omega C}$ (d) none of these

Diagram Based Questions :

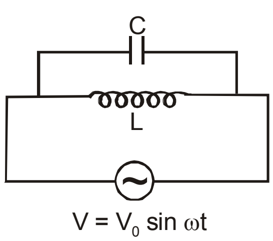
1. The r.m.s. value of potential difference V shown in the figure is



(a) V_0 (b) $V_0/\sqrt{2}$

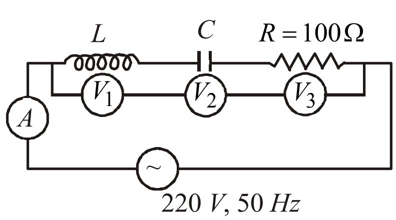
(c) $V_0/2$ (d) $V_0/\sqrt{3}$

2. For the circuit shown in the fig., the current through the inductor is 0.9 A while the current through the condenser is 0.4 A. Then



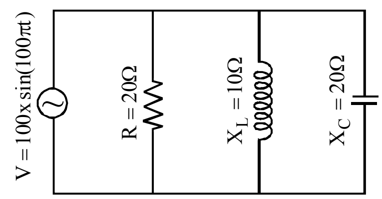
(a) current drawn from source I = 1.13 A
(b) $\omega = 1/(1.5\,LC)$
(c) I = 0.5 A
(d) I = 0.6 A

3. In the given circuit the reading of voltmeter V_1 and V_2 are 300 volt each. The reading of the voltmeter V_3 and ammeter A are respectively



(a) 150 V and 2.2 A (b) 220 V and 2.0 A
(c) 220 V and 2.0 A (d) 100 V and 2.0 A

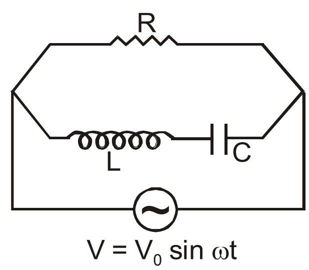
4. In the given circuit, the current drawn from the source is



(a) 20 A (b) 10 A

(c) 5 A (d) $5\sqrt{2}$ A

5. The current in resistance R at resonance is



(a) zero
(b) minimum but finite
(c) maximum but finite
(d) infinite

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Average value of ac over a complete cycle is always zero.
Reason: Average value of ac is always defined over half cycle.

2. **Assertion :** The inductive reactance limits amplitude of the current in a purely inductive circuit.

Reason: The inductive reactance is independent of the frequency of the current.

3. **Assertion :** A capacitor is connected to a direct current source. Its reactance is infinite.
Reason : Reactance of a capacitor is given by $X_c = \dfrac{1}{\omega C}$.

4. **Assertion :** In a purely inductive or capacitive circuit, the current is referred to as wattless current.
Reason: No power is dissipated in a purely inductive or capacitive circuit even though a current is flowing in the circuit.

5. **Assertion :** The power in an ac circuit is minimum if the circuit has only a resistor.
Reason: Power of a circuit is independent of the phase angle.

6. **Assertion :** When the frequency of the AC source in an LCR circuit equals the resonant frequency, the reactance of the circuit is zero, and so there is no current through the inductor or the capacitor.
Reason : The net current in the inductor and capacitor is zero.

7. **Assertion :** In series LCR resonance circuit, the impedance is equal to the ohmic resistance.
Reason: At resonance, the inductive reactance exceeds the capacitive reactance.

8. **Assertion :** The power is produced when a transformer steps up the voltage.
Reason : In an ideal transformer VI = constant.

9. **Assertion :** A laminated core is used in transformers to increase eddy currents.
Reason: The efficiency of a transformer increases with increase in eddy currents.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

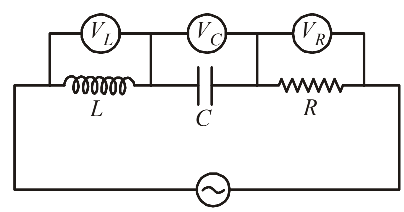
1. Match Columns I and II.

Column I	Column II
(A) RL circuit	(1) Leading quantity - current
(B) RC circuit	(2) Leading quantity - voltage
(C) Inductive circuit	(3) Phase difference between voltage and current 0°
(D) Resistive circuit	(4) Phase difference between voltage and current 90°

(a) (A) $\to$ (2) ; (B) $\to$ (1) ; (C) $\to$ (3) ; (D) $\to$ (4)
(b) (A) $\to$ (2) ; (B) $\to$ (2) ; (C) $\to$ (4) ; (D) $\to$ (3)
(c) (A) $\to$ (4) ; (B) $\to$ (3) ; (C) $\to$ (2) ; (D) $\to$ (1)
(d) (A) $\to$ (2) ; (B) $\to$ (1) ; (C) $\to$ (4) ; (D) $\to$ (3)

2. In an LCR series circuit connected to an ac source, the supply voltage is $V = V_0 \sin\left(100\pi t + \dfrac{\pi}{6}\right)$. $V_L = 40$ V, $V_R = 40 V$, $Z = 5\Omega$ and $R = 4\Omega$. Then match the column I and II.

Column I	Column II
(A) Peak current (in A)	(1) $10\sqrt{2}$
(B) V_0 (in volts)	(2) $50\sqrt{2}$
(C) Effective value of applied voltage (in volts)	(3) 50
(D) X_C (in Ω)	(4) 1



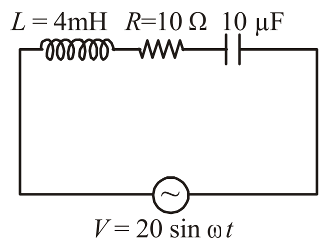
(a) (A) $\to$ (1); (B) $\to$ (2); (C) $\to$ (1); (D) $\to$ (4)
(b) (A) $\to$ (2); (B) $\to$ (3); (C) $\to$ (1); (D) $\to$ (4)
(c) (A) $\to$ (4); (B) $\to$ (3); (C) $\to$ (2); (D) $\to$ (1)
(d) (A) $\to$ (4); (B) $\to$ (1); (C) $\to$ (3); (D) $\to$ (2)

3. In a series LCR circuit, the e.m.f. leads current. Now the driving frequency is decreased slightly. Match columns I and II.

	Column I		**Column II**
(A)	Current amplitude	(1)	Increases
(B)	Phase constant	(2)	Decreases
(C)	Power developed in resistor	(3)	Remains same
(D)	Impedance decrease	(4)	May increase or

(a) (A) $\rightarrow$ (1, 2); (B) $\rightarrow$ (2); (C) $\rightarrow$ (3, 4); (D) $\rightarrow$ (1)
(b) (A) $\rightarrow$ (1); (B) $\rightarrow$ (2); (C) $\rightarrow$ (1); (D) $\rightarrow$ (2)
(c) (A) $\rightarrow$ (1); (B) $\rightarrow$ (3); (C) $\rightarrow$ (1); (D) $\rightarrow$ (1, 2)
(d) (A) $\rightarrow$ (2); (B) $\rightarrow$ (3); (C) $\rightarrow$ (4); (D) $\rightarrow$ (1)

4. Consider the circuit shown in figure given below and match the columns.



	Column-I		**Column-II**
(A)	For $\omega = 5{,}000$ rad/sec	(1)	The current in circuit leads the voltage
(B)	For $\omega = 2{,}500$ rad/sec	(2)	The current and voltage in circuit are in same phase
(C)	For $\omega = 75{,}00$ rad/sec	(3)	The peak current in circuit is less than $2A$
(D)	For $\omega = 5{,}000$ rad/sec and $R = 20\Omega$ in place of 10Ω	(4)	Voltage in circuit leads the current.

(a) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (1) ; (C) $\rightarrow$ (3) ; (D) $\rightarrow$ (4)
(b) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (2) ; (C) $\rightarrow$ (4) ; (D) $\rightarrow$ (3)
(c) (A) $\rightarrow$ (4) ; (B) $\rightarrow$ (3) ; (C) $\rightarrow$ (2) ; (D) $\rightarrow$ (1)
(d) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (1) ; (C) $\rightarrow$ (4) ; (D) $\rightarrow$ (3)

5.

	Column-I		**Column-II**
(A)	An L-C-R series circuit with 100 Ω resistance is connected to an A.C source of 200V and angular frequency 300 rad/sec. When only the capacitance is removed, the current lags behind the voltage by 60° When only the inductance is removed, the current lead by the voltage 60°. Impedance of circuit will be	(1)	(5/3) Ω
(B)	A 50 W, 100 V lamp is to be connected to an ac mains of 200V, 50 Hz. A capacitor of capacitance C is essential to be put in series with lamp. What is the capacitance reactance	(2)	$\sqrt{12} \times 10^2\ \Omega$
(C)	A choke coil is needed to operate an arc lamp at 160V and 50 Hz. The arc lamp has an effective resistance of 5Ω when running at 10A. If the same arc lamp is to be operated on 160V (dc), what addition resistance is required.	(3)	11 Ω

(D) An a.c. source of angular frequency ω is fed across a resistance R and capacitor of capacitance C in series. The current registered is ℓ If now the frequency of the source is changed to $\omega/3$ (keeping voltage same) the current is found to the halved, the initial reactance is initial resistance will be (4) $100\,\Omega$

(a) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (1) ; (C) $\rightarrow$ (3) ; (D) $\rightarrow$ (4)
(b) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (2) ; (C) $\rightarrow$ (4) ; (D) $\rightarrow$ (3)
(c) (A) $\rightarrow$ (4) ; (B) $\rightarrow$ (3) ; (C) $\rightarrow$ (2) ; (D) $\rightarrow$ (1)
(d) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (1) ; (C) $\rightarrow$ (4) ; (D) $\rightarrow$ (3)

Critical Thinking Type Questions :

1. A coil of inductance 300 mH and resistance 2Ω is connected to a source of voltage 2 V. The current reaches half of its steady state value in
(a) 0.1 s (b) 0.05 s
(c) 0.3 s (d) 0.15 s

2. In an LCR series resonant circuit, the capacitance is changed from C to 4C. For the same resonant frequency, the inductance should be changed from L to
(a) 2L (b) $\frac{L}{2}$
(c) 4L (d) $\frac{L}{4}$

3. The instantaneous values of alternating current and voltages in a circuit are given as

$$i = \frac{1}{\sqrt{2}}\sin(100\pi t)\ A$$

$$e = \frac{1}{\sqrt{2}}\sin(100\pi t + \pi/3)\ \text{Volt}$$

The average power in Watt consumed in the circuit is
(a) $\frac{1}{4}$ (b) $\frac{\sqrt{3}}{4}$
(c) $\frac{1}{2}$ (d) $\frac{1}{8}$

4. A step up transformer operates on a 230 V line and supplies a current of 2 ampere. The ratio of primary and secondary winding is 1:25 . The current in primary is
(a) 25 A (b) 50 A
(c) 15 A (d) 12.5 A

5. The primary winding of a transformer has 100 turns and its secondary winding has 200 turns. The primary is connected to an A.C. supply of 120 V and the current flowing in it is 10 A. The voltage and the current in the secondary are
(a) 240 V, 5 A (b) 240 V, 10 A
(c) 60 V, 20 A (d) 120 V, 20 A

6. A fully charged capacitor C with initial charge Q_0 is connected to a coil of self inductance L at $t = 0$. The time at which the energy is stored equally between the electric and the magnetic field is
(a) $\frac{\pi}{4}\sqrt{LC}$ (b) $2\pi\sqrt{LC}$
(c) $\sqrt{LC}$ (d) $\pi\sqrt{LC}$

7. The primary of a transformer has 400 turns while the secondary has 2000 turns. If the power output from the secondary at 1000 V is 12 kW, what is the primary voltage?
(a) 200 V (b) 300 V
(c) 400 V (d) 500 V

8. A transformer connected to 220 V mains is used to light a lamp of rating 100 W and 110 V. If the primary current is 0.5 A, the efficiency of the transformer is (approximately)
(a) 60% (b) 35%
(c) 50% (d) 90%

9. A transformer having efficiency of 90% is working on 200V and 3kW power supply. If the current in the secondary coil is 6A, the voltage across the secondary coil and the current in the primary coil respectively are :
(a) 300 V, 15A (b) 450 V, 15A
(c) 450V, 13.5A (d) 600V, 15A

22 Electromagnetic Waves

Fill in the Blanks :

1. Electromagnetic waves are transverse in nature is evident by _______ .
2. If a variable frequency ac source connected to a capacitor then with decrease in frequency, the displacement current will _______ .
3. The displacement current was first postulated by ______ .
4. According to Maxwell's equation the velocity of light in any medium is expressed as c = _______ .
5. The electromagnetic radiation used in food processing sterilizing agent is _______ .
6. _______ are the cause of "Green house effect"
7. It is possible to take pictures of those objects which are not fully visible to the eye using camera films sensitive to _______ rays.

True/ False :

1. Displacement current comes into play in a region where electric field is changing with time.
2. β-rays are electromagnetic waves.
3. An electromagnetic wave of intensity *I* falls on a surface kept in vacuum and exerts radiation pressure *P* on it. Radiation pressure is *I*/*c* if the wave is totally absorbed.
4. Energy stored in electromagnetic oscillations is in the form of electric energy only.
5. The amplitude of an electromagnetic wave in vacuum is doubled with no other changes made to the wave. As a result of this doubling of the amplitude, the speed of wave propagation changes.
6. Frequency of microwaves is greater than that of ultraviolet rays.
7. Gamma ray has shortest wavelength in the electromagnetic spectrum.

Conceptual MCQs :

1. The electromagnetic radiation used in food processing sterilizing agent is:
   (a) microwaves (b) UV rays
   (c) gamma rays (d) radio waves
2. The electric field associated with an e.m. wave in vacuum is given by $\vec{E} = \hat{i}\ 40 \cos (kz - 6 \times 10^8 t)$, where *E*, *z* and *t* are in volt/m, meter and seconds respectively. The value of wave vector *k* is :
   (a) $2\ m^{-1}$ (b) $0.5\ m^{-1}$
   (c) $6\ m^{-1}$ (d) $3\ m^{-1}$
3. Electromagnetic radiation will be emitted in the case of a
   (a) neutron moving in a straight line with a constant speed
   (b) proton moving in a straight line with a constant speed
   (c) is constant inside and decays as I r outside the solenoid
   (d) is constant inside and decays as exp $\left(-\frac{1}{r}\right)$ outside
4. Intensity of electromagnetic wave will be :
   (a) $I = c\mu_0 B_0^2 / 2$ (b) $I = c\varepsilon_0 B_0^2 / 2$
   (c) $I = B_0^2 / c\mu_0$ (d) $I = E_0^2 / 2c\varepsilon_0$
5. The electric (E) and magnetic (B) field amplitudes associated with an electromagnetic radiation from a point source behave at a distance r from the source as
   (a) E = constant, B = constant
   (b) $E \propto \frac{1}{r}, B \propto \frac{1}{r}$ (c) $E \propto \frac{1}{r^2}, B \propto \frac{1}{r^2}$
   (d) $E \propto \frac{1}{r^3}, B \propto \frac{1}{r^3}$

6. In 1825, the existence of electromagnetic waves was predicted by
   (a) Maxwell (b) Hertz
   (c) Bose (d) Marconi
7. The electric field of a plane electromagnetic wave in free space travelling along x-direction is given by : $E_z = 60 \sin(kx + \omega t)$ V/m.
   The magnetic field component will be given as :
   (a) $B_z = \frac{60}{c}\sin(kz + \omega t)T$
   (b) $B_z = \frac{60}{c}\sin(kx + \omega t)T$
   (c) $B_y = \frac{60}{c}\sin(ky + \omega t)T$
   (d) $B_y = \frac{60}{c}\sin(kx + \omega t)T$
   Here c represents the speed of light in free space
8. If a source is transmitting electromagnetic wave of frequency 8.2×10^6 Hz, then wavelength of the electromagnetic waves transmitted from the source will be
   (a) 36.6 m (b) 40.5 m
   (c) 42.3 m (d) 50.9 m
9. We consider the radiation emitted by the human body. Which of the following statements is true?
   (a) The radiation emitted lies in the ultraviolet region and hence is not visible.
   (b) The radiation emitted is in the infra-red region.
   (c) The radiation is emitted only during the day.
   (d) The radiation is emitted during the summers and absorbed during the winters.
10. The frequency of electromagnetic wave, which best suited to observe a particle of radii 3×10^{-4} cm is of the order of
   (a) 10^{15} (b) 10^{14}
   (c) 10^{13} (d) 10^{12}
11. The ratio of amplitude of magnetic field to the amplitude of electric field for an electromagnetic wave propagating in vacuum is equal to :
   (a) the speed of light in vacuum
   (b) reciprocal of speed of light in vacuum
   (c) the ratio of magnetic permeability to the electric susceptibility of vacuum
   (d) unity
12. In a plane electromagnetic wave propagating in space has an electric field of amplitude 9×10^3 V/m, then the amplitude of the magnetic field is
   (a) 2.7×10^{12} T (b) 9.0×10^{-3} T
   (c) 3.0×10^{-4} T (d) 3.0×10^{-5} T
13. Electromagnetic waves are transverse in nature is evident by
   (a) polarization (b) interference
   (c) reflection (d) diffraction
14. Which of the following are not electromagnetic waves?
   (a) cosmic rays (b) gamma rays
   (c) β-rays (d) X-rays.
15. Which of the following radiations has the least wavelength ?
   (a) γ-rays (b) β-rays
   (c) α-rays (d) X-rays
16. The electric field part of an electromagnetic wave in a medium is represented by $E_x=0$;
   $$E_y = 2.5\frac{N}{C}\cos\left[\left(2\pi\times10^6\ \frac{rad}{m}\right)t - \left(\pi\times10^{-2}\ \frac{rad}{s}\right)x\right];$$
   $E_z = 0$. The wave is :
   (a) moving along x direction with frequency 10^6 Hz and wavelength 100 m.
   (b) moving along x direction with frequency 10^6 Hz and wavelength 200 m.
   (c) moving along – x direction with frequency 10^6 and wavelength 200 m.
   (d) moving along y direction with frequency $2\pi \times 10^6$ Hz and wavelength 200 m.
17. If $\lambda = 10\,Å$ then it corresponds to
   (a) infrared (b) microwaves
   (c) ultraviolet (d) X-rays
18. 10 cm is a wavelength corresponding to the spectrum of
   (a) infrared rays (b) ultra-violet rays
   (c) microwaves (d) γ-rays

19. In an electromagnetic wave, the amplitudes of magnetic field H_o and electric field E_o in free space are related as :

(a) $H_o = E_o$ (b) $H = \frac{E_o}{c}$

(c) $H_o = E_o\sqrt{\mu_o \varepsilon_o}$ (d) $H_o = E_o\sqrt{\frac{\varepsilon_o}{\mu_o}}$

20. In an electromagnetic wave
(a) power is transmitted along the magnetic field
(b) power is transmitted along the electric field
(c) power is equally transferred along the electric and magnetic fields
(d) power is transmitted in a direction perpendicular to both the fields

21. The frequency modulated waves are
(a) reflected by atmosphere
(b) absorbed by atmosphere
(c) bend by atmosphere
(d) radio waves

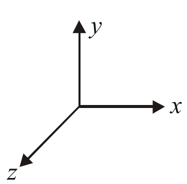
22. The energy of electromagnetic wave in vacuum is given by the relation

(a) $\frac{E^2}{2\varepsilon_0} + \frac{B^2}{2\mu_0}$ (b) $\frac{1}{2}\varepsilon_0 E^2 + \frac{1}{2}\mu_0 B^2$

(c) $\frac{E^2 + B^2}{c}$ (d) $\frac{1}{2}\varepsilon_0 E^2 + \frac{B^2}{2\mu_0}$

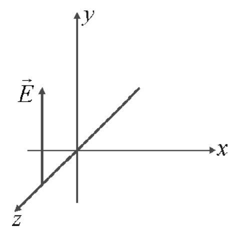
Diagram Based Questions :

1. Light wave is travelling along y-direction. If the corresponding $\vec{E}$ vector at any time is along the x-axis, the direction of $\vec{B}$ vector at that time is along :



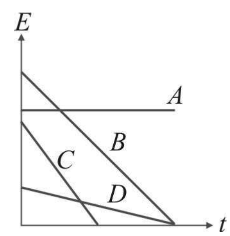
(a) y-axis (b) x-axis
(c) $+z$-axis (d) $-z$-axis

2. The figure here gives the electric field of an electromagnetic wave at a certain point and a certain instant. The wave is transporting energy in the negative z-direction. The direction of the magnetic field of the wave at that point and instant is



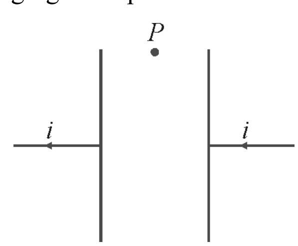
(a) + ve x-direction
(b) –ve x-direction
(c) +ve z-direction
(d) –ve y-direction

3. The figure shows graphs of the electric field magnitude E versus time t for four uniform electric fields, all contained within identical circular regions. Which of them is according to the magnitudes of the magnetic field?



(a) A (b) B
(c) C (d) D

4. Figure shows a parallel plate capacitor and the current in the connecting wires that is discharging the capacitor.



(a) The displacement current is leftward.
(b) The displacement current is rightward
(c) The electric field $\vec{E}$ is rightward
(d) The magnetic field at point P is out the page.

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Displacement current goes through the gap between the plates of a capacitor when the charge of the capacitor does not change.
   Reason : The displacement current arises in the region in which the electric field is constant with time.
2. **Assertion :** Electromagnetic wave are transverse in nature.
   Reason : The electric and magnetic fields in electromagnetic waves are perpendicular to each other and the direction of propagation.
3. **Assertion :** Electromagnetic waves interact with matter and set up oscillations.
   Reason : Interaction is independent of the wavelength of the electromagnetic wave.
4. **Assertion :** Electromagnetic waves carry energy and momentum.
   Reason : Electromagnetic waves can be polarised.
5. **Assertion :** Electromagnetic waves exert radiation pressure.
   Reason : Electromagnetic waves carry energy.
6. **Assertion :** The velocity of electromagnetic waves depends on electric and magnetic properties of the medium.
   Reason : Velocity of electromagnetic waves in free space is constant.
7. **Assertion :** The basic difference between various types of electromagnetic waves lies in their wavelength or frequencies.
   Reason : Electromagnetic waves travel through vacuum with the same speed.
8. **Assertion :** Microwaves are better carrier of signals than optical waves.
   Reason : Microwaves move faster than optical waves.
9. **Assertion :** Infrared radiation plays an important role in maintaining the average temperature of earth.
   Reason : Infrared radiations are sometimes referred to as heat waves.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns I and II.

Column I	Column II
(A) Energy associated with an electromagnetic wave	(1) $\frac{1}{\sqrt{\mu\varepsilon}}$
(B) Radiation pressure	(2) $\frac{u}{c}$
(C) Speed of EM wave in a medium	(3) $\frac{1}{2}\varepsilon_0 E^2 + \frac{1}{2}\frac{B^2}{\mu_0}$
(D) Displacement current	(4) $I_D = \varepsilon_0 \frac{d\phi E}{dt}$

(a) (A)$\to$(3); (B)$\to$(2); (C)$\to$(1); (D)$\to$(4)
(b) (A)$\to$(2); (B)$\to$(2); (C)$\to$(4); (D)$\to$(3)
(c) (A)$\to$(4); (B)$\to$(3); (C)$\to$(2); (D)$\to$(1)
(d) (A)$\to$(2); (B)$\to$(1); (C)$\to$(4); (D)$\to$(3)

2. Various electromagnetic waves are given in column I and various frequency ranges in column II. Match the two columns.

Column I	**Column II**
(A) Radio waves	(1) 1×10^{16} to 3×10^{21} Hz
(B) γ–rays	(2) 1×10^{9} to 3×10^{11} HZ
(C) Microwaves	(3) 3×10^{18} to 5×10^{22} Hz
(D) X-rays	(4) 5×10^{5} to 10^{9} Hz.

(a) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (5) ; (C) $\rightarrow$ (3) ; (D) $\rightarrow$ (4)
(b) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (2) ; (C) $\rightarrow$ (4) ; (D) $\rightarrow$ (3)
(c) (A) $\rightarrow$ (4) ; (B) $\rightarrow$ (3) ; (C) $\rightarrow$ (2) ; (D) $\rightarrow$ (1)
(d) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (1) ; (C) $\rightarrow$ (4) ; (D) $\rightarrow$ (3)

3. Match the Column I and Column II.

Column I **Electromagnetic wave**	**Column II** **Use**
(A) ultraviolet rays	(1) In satellite for army purpose
(B) Infrared rays	(2) Aircraft navigation in RADAR
(C) Microwave	(3) Television and cellular phones
(D) Radio wave	(4) Checking mineral sample

(a) (A) $\rightarrow$ (4) ; (B) $\rightarrow$ (1) ; (C) $\rightarrow$ (2) ; (D) $\rightarrow$ (3)
(b) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (2) ; (C) $\rightarrow$ (4) ; (D) $\rightarrow$ (3)
(c) (A) $\rightarrow$ (4) ; (B) $\rightarrow$ (3) ; (C) $\rightarrow$ (2) ; (D) $\rightarrow$ (1)
(d) (A) $\rightarrow$ (2) ; (B) $\rightarrow$ (1) ; (C) $\rightarrow$ (4) ; (D) $\rightarrow$ (3)

4. Match Column-I (Wavelength range of electromagnetic spectrum) with Column-II (Method of production of these waves) and select the correct option from the options given below the lists.

Column I	**Column II**
(A) 700 nm to 1 mm	(1) Vibration of atoms and molecules.
(B) 1 nm to 400 nm	(2) Inner shell electrons in atoms moving from one energy level to a lower level.
(C) $< 10^{-3}$ nm	(3) Radioactive decay of the nucleus.
(D) 1 mm to 0.1 m	(4) Magnetron valve.

(a) (A) $\rightarrow$ (4), (B) $\rightarrow$ (3), (C) $\rightarrow$ (2), (D) $\rightarrow$ (1)
(b) (A) $\rightarrow$ (3), (B) $\rightarrow$ (4), (C) $\rightarrow$ (1), (D) $\rightarrow$ (2)
(c) (A) $\rightarrow$ (2), (B) $\rightarrow$ (3), (C) $\rightarrow$ (4), (D) $\rightarrow$ (1)
(d) (A) $\rightarrow$ (1), (B) $\rightarrow$ (2), (C) $\rightarrow$ (3), (D) $\rightarrow$ (4)

5. Match the Column-I (Phenomenon associated with electromagnetic radiation) with Column-II (Part of electromagnetic spectrum) and select the correct code from the choices given below the lists:

Column I	**Column II**
(A) Doublet of sodium	(1) Visible radiation
(B) Wavelength corresponding to temperature associated with the isotropic radiation filling all space	(2) Microwave
(C) Wavelength emitted by atomic hydrogen in interstellar space	(3) Short radio wave
(D) Wavelength of radiation arising from two close energy levels in hydrogen	(4) X-rays

(a) (A) $\rightarrow$ (1), (B) $\rightarrow$ (2), (C) $\rightarrow$ (2), (D) $\rightarrow$ (3)
(b) (A) $\rightarrow$ (1), (B) $\rightarrow$ (2), (C) $\rightarrow$ (3), (D) $\rightarrow$ (4)
(c) (A) $\rightarrow$ (4), (B) $\rightarrow$ (3), (C) $\rightarrow$ (1), (D) $\rightarrow$ (2)
(d) (A) $\rightarrow$ (2), (B) $\rightarrow$ (1), (C) $\rightarrow$ (4), (D) $\rightarrow$ (3)

Critical Thinking Type Questions :

1. In order to establish an instantaneous displacemet current of 1 mA in the space between the plates of 2μF parallel plate capacitor, the potential difference need to apply is
   (a) 100 Vs^{-1} (b) 200 Vs^{-1}
   (c) 300 Vs^{-1} (d) 500 Vs^{-1}
2. An electromagnetic wave of frequency $\upsilon = 3$ MHz passes from vacuum into a dielectric medium with permittivity
   $\varepsilon = 4$. Then
   (a) wavelength and frequency both become half.
   (b) wavelength is doubled and frequency remains unchanged.
   (c) wavelength and frequncy both remain unchanged.
   (d) wavelength is halved and frequency remains unchanged.
3. The electric field associated with an e.m. wave in vacuum is given by $\vec{E} = \hat{i}\ 40 \cos (kz - 6 \times 10^8 t)$, where E, z and t are in volt/m, meter and seconds respectively. The value of wave vector k is
   (a) 2 m^{-1} (b) 0.5 m^{-1}
   (c) 6 m^{-1} (d) 3 m^{-1}
4. The magnetic field in a travelling electromagnetic wave has a peak value of 20 nT. The peak value of electric field strength is
   (a) 3 V/m (b) 6 V/m
   (c) 9 V/m (d) 12 V/m
5. In an electromagnetic wave, the electric and magnetic fields are 100 V m^{-1} and 0.265 A m^{-1}. The maximum energy flow is
   (a) 26.5 W/m^2 (b) 36.5 W/m^2
   (c) 46.7 W/m^2 (d) 765 W/m^2
6. The transmitting antenna of a radiostation is mounted vertically. At a point 10 km due north of the transmitter the peak electric field is 10^{-3} Vm^{-1}. The magnitude of the radiated magnetic field is
   (a) 3.33×10^{-10} T (b) 3.33×10^{-12} T
   (c) 10^{-3} T (d) 3×10^5 T
7. A plane electromagnetic wave travels in free space along x-axis. At a particular point in space, the electric field along y-axis is 9.3V m^{-1}. The magnetic induction (B) along z-axis is
   (a) 3.1×10^{-8} T (b) 3×10^{-5} T
   (c) 3×10^{-6} T (d) 9.3×10^{-6} T
8. The rms value of the electric field of the light coming from the Sun is 720 N/C. The average total energy density of the electromagnetic wave is
   (a) 4.58×10^{-6} J/m^3 (b) 6.37×10^{-9} J/m^3
   (c) 81.35×10^{-12} J/m^3 (d) 3.3×10^{-3} J/m^3
9. The electric field of an electromagnetic wave travelling through vaccum is given by the equation $E = E_0 \sin (kx - \omega t)$. The quantity that is independent of wavelength is
   (a) $k\omega$ (b) $\frac{k}{\omega}$
   (c) $k^2\omega$ (d) ω

23

RAY OPTICS AND OPTICAL INSTRUMENTS

Fill in the Blanks :

1. The minimum distance between an object and its real image formed by a convex lens is _______.
2. Intensity of light after reflection _______ .
3. The equation $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ holds true for any _______ .
4. When the angle of incidence of a light ray is greater than the critical angle it gets _______ .
5. Critical angle of light passing from glass to water is minimum for _______ colour of light.
6. A ray of light is refracted through a prism producing minimum deviation. If *i* and *e* denote the angle of incidence and emergence for this prism, then *i* and *e* related as _______ .
7. The focal length of a normal eye-lens is about ______ .
8. To increase the angular magnification of a simple microscope, one should increase _____ of lens.

True/ False :

1. The incident ray, the reflected ray and the normal all lie in the same plane.
2. After reflection, velocity, wavelength and frequency of light remains same.
3. A convex mirror is used to form the real image of an object.
4. In case of reflection over spherical surface, normal is taken as perpendicular of tangent at point of incidence.
5. Sunlight reaches to us in composite form and not in its constituent colours because vacuum is non–dispersive and speed of all colours is same in vacuum.
6. At sunset or sunrise, the sun's rays have to pass through a larger distance in the atmosphere.
7. According to Rayleigh, scattering is proportional to $(1/\lambda)^2$.

Conceptual MCQs

1. A convex mirror of focal length f produces an image $1/n^{th}$ of the size of the object. The distance of the object from the mirror is
   (a) $\frac{f}{n-1}$ (b) $(n-1)f$
   (c) $nf - 1$ (d) $\left(\frac{n-1}{n}\right)f$
2. Time taken by sunlight to pass through a window of thickness 4 mm whose refractive index is $\frac{3}{2}$ is
   (a) 2×10^{-4} sec (b) 2×10^{8} sec
   (c) 2×10^{-11} sec (d) 2×10^{11} sec
3. The hypermetropia is a
   (a) short-sight defect
   (b) long-sight defect
   (c) bad vision due to old age
   (d) none of these
4. A thin prism P_1 with angle 4° made of glass of refractive index 1.54 is combined with another thin prism P_2 made of glass of refractive index 1.72 to produce no deviation. The angle of prism P_2 is
   (a) 3° (b) 2.6°
   (c) 4° (d) 5.33°
5. Green light of wavelength 5460 Å is incident on an air-glass interface. If the refractive index of glass is 1.5, the wavelength of light in glass would be ($c = 3 \times 10^8$ ms^{-1})
   (a) 3640 Å (b) 5460 Å
   (c) 4861 Å (d) none of the above

6. A rectangular block of glass is placed on a printed page lying on a horizontal surface. The minimum value of the refractive index of glass for which the letters on the page are not visible from any of the vertical faces of block is –

(a) $\geq \sqrt{3}$ (b) ≥ 1.55
(c) $\geq \sqrt{2}$ (d) ≥ 1.38

7. For the normal setting of telescope
(a) neither the object nor the final image has to be at infinity.
(b) both object and the final image is at infinity
(c) only object is at the infinity
(d) only the final image is at infinity

8. A point object is moving on the principal axis of a concave mirror of focal length 24 cm towards the mirror. When it is at a distance of 60 cm from the mirror its velocity is 9 cm/sec. What is the velocity of the image at that instant ?
(a) 9 cm/sec away from the mirror
(b) 9 cm/sec away from the mirror
(c) 4 cm/sec towards the mirror
(d) 4 cm/sec away from the mirror

9. A planoconvex lens of focal length 6.0 cm is constructed from a material of refractive index $\mu = 1.5$with respect to air. The radius of curvature of the curved surface is :
(a) 6.0 cm (b) 3.0 cm
(c) 9.0 cm (d) 4.5 cm

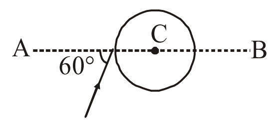
10. A convex lens of focal length 80 cm and a concave lens of focal length 50 cm are combined together. What will be their resulting power?
(a) $+6.5$ D (b) -6.5 D
(c) $+7.5$ D (d) -0.75 D

11. The diameter of the moon is 3.5×10^3 km and its distance from the earth is 3.8×10^5 km. The angular diameter of the moon formed by a telescope, if the focal length of the objective is 4m and that of the eyepiece is 10 cm, will be near to :
(a) 0.37° (b) 11°
(c) 21° (d) 57°

12. A plano-convex lens has curved surface having radius of curvature 60 cm and it is made of material of refractive index 1.5. When the convex surface is silvered, the system will work as a concave mirror of focal length
(a) 20 cm (b) 24 cm
(c) 30 cm (d) 15 cm

13. For glass prism $(\mu = \sqrt{3})$, the angle of minimum deviation is equal to the angle of prism. The angle of prism is
(a) 30° (b) 45°
(c) 60° (d) 90°

14. A ray of light falls on transparent sphere with centre at C as shown in the figure. The ray emerges from the sphere parallel to the line AB. The refractive index of the sphere is



(a) $\sqrt{2}$ (b) $\sqrt{3}$
(c) 3/2 (d) 1/2

15. A normal eye is not able to see objects closer than 25 cm because
(a) the focal length of the eye is 25 cm
(b) the distance of the retina from the eye-lens is 25 cm
(c) the eye is not able to decrease the distance between the eye-lens and the retina beyond a limit
(d) the eye is not able to decrease the focal length beyond a limit

16. A man's near point is 0.5 m and far point is 3 m. Power of spectacle lenses required for (i) reading purposes, (ii) seeing distant objects, respectively, are
(a) –2 D and + 3 D (b) +2 D and –3 D
(c) +2 D and –0.33 D (d) –2 D and + 0.33 D

17. If two mirrors are kept at 60º to each other, then the number of images formed by them is
(a) 5 (b) 6
(c) 7 (d) 8

18. Light travels through a glass plate of thickness t and having refractive index μ. If c be the velocity of light in vacuum, the time taken by the light to travel this thickness of glass is
(a) $\frac{t}{\mu c}$ (b) $t\mu c$
(c) $\frac{\mu t}{c}$ (d) $\frac{tc}{\mu}$

19. The refractive index of water is 1.33. What will be speed of light in water ?
(a) 3×10^8 m/s (b) 2.25×10^8 m/s
(c) 4×10^8 m/s (d) 1.33×10^8 m/s

20. A vessel is half filled with a liquid of refractive index μ. The other half of the vessel is filled with an immiscible liquid of refrative index $1.5\ \mu$. The apparent depth of the vessel is 50% of the actual depth. Then μ is
(a) 1.4 (b) 1.5
(c) 1.6 (d) 1.67

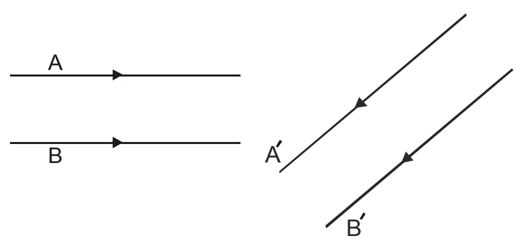
21. Two thin lenses of focal lengths f_1 and f_2 are in contact and coaxial. Its power is same as power of a single lens given by

(a) $\dfrac{f_1 + f_2}{f_1 f_2}$ (b) $\sqrt{\left(\dfrac{f_1}{f_2}\right)}$

(c) $\sqrt{\left(\dfrac{f_2}{f_1}\right)}$ (d) $\dfrac{f_1 + f_2}{2}$

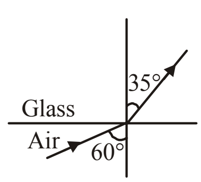
Diagram Based Questions :

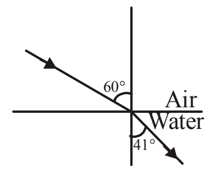
1. Figure shows two rays A and B being reflected by a mirror and going as A' and B'. The mirror

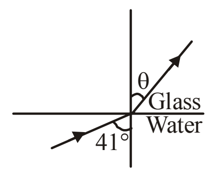


(a) is plane
(b) is convex
(c) is concave
(d) may be any spherical mirror

2. Refraction of light from air to glass and from air to water are shown in figure (i) and figure (ii) below. The value of the angle θ in the case of refraction as shown in figure (iii) will be

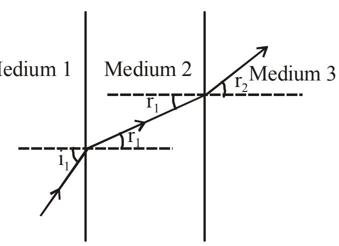
(i) 

(ii) 

(iii) 

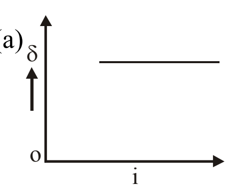
(a) 30° (b) 35°
(c) 60° (d) 41°

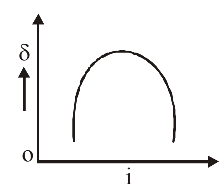
3. The following figure shows refraction of light at the interface of three media.

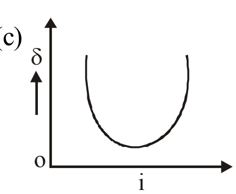


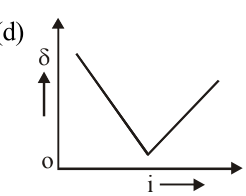
Correct the order of optical density of the three media is
(a) $d_1 > d_2 > d_3$ (b) $d_2 > d_1 > d_3$
(c) $d_3 > d_1 > d_2$ (d) $d_2 > d_3 > d_1$

4. The graph between angle of deviation (δ) and angle of incidence (i) for a triangular prism is represented by

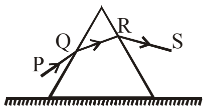
(a) 

(b) 

(c) 

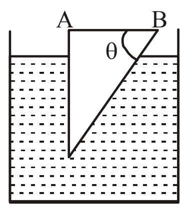
(d) 

5. An equilateral prism is placed on a horizontal surface. A ray PQ is incident onto it. For minimum deviation



(a) PQ is horizontal
(b) QR is horizontal
(c) RS is horizontal
(d) Any one will be horizontal

6. A glass prism of refractive index 1.5 is immersed in water (refractive index 4/3). A light beam incident normally on the face AB is totally reflected to reach on the face BC if



(a) $\sin\theta \geq \frac{8}{9}$ (b) $\frac{2}{3} < \sin\theta < \frac{8}{9}$

(c) $\sin\theta \leq \frac{2}{3}$ (d) None of these

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Plane mirror may form real image.
Reason : Plane mirror forms virtual image, if object is real.

2. **Assertion :** The focal length of the convex mirror will increase, if the mirror is placed in water.
Reason : The focal length of a convex mirror of radius R is equal to , $f = R/2$.

3. **Assertion :** The image formed by a concave mirror is certainly real if the object is virtual.
Reason : The image formed by a concave mirror is certainly virtual if the object is real.

4. **Assertion :** An object is placed at a distance of f from a convex mirror of focal length f its image will form at infinity.
Reason : The distance of image in convex mirror can never be infinity.

5. **Assertion :** The image of a point object situated at the centre of hemispherical lens is also at the centre.

6. **Assertion :** When a convex lens ($\mu_g = 3/2$) of focal length f is dipped in water, its focal length becomes $\frac{4}{3}f$.
Reason : The focal length of convex lens in water becomes $4f$.

7. **Assertion:** The focal length of an equiconvex lens of radius of curvature R made of material of refractive index $\mu = 1.5$, is R.
Reason : The focal length of the lens will be R/2.

8. **Assertion :** If the rays are diverging after emerging from a lens; the lens must be concave.
Reason : The convex lens can give diverging rays.

9. **Assertion :** The resolving power of a telescope is more if the diameter of the objective lens is more.
Reason : Objective lens of large diameter collects more light.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the Column-I and Column-II

Column – I	**Column – II**
(A) An object is placed at focus before aconvex mirror	(1) Magnification is $-\infty$
(B) An object is placed at centre of curvature before a concave mirror	(2) Magnification is 0.5

(C) An object is placed at focus before a concave mirror — (3) Magnification is +1

(D) An object is placed at centre of curvature before a convex mirror — (4) Magnification is –1

(5) Magnification is 0.33

(a) (A) → (2); (B) → (3); (C) → (4); (D) → (5)
(b) (A) → (5); (B) → (4); (C) → (3); (D) → (1)
(c) (A) → (2); (B) → (4); (C) → (1); (D) → (5)
(d) (A) → (3); (B) → (5); (C) → (2); (D) → (4)

2.

Column I	**Column II**
(A) Mirage	(1) Refraction of light by
(B) Apparent depth of object is lesser than the actual depth in water	(2) Scattering of sunlight
(C) Blue colour of sky	(3) Total internal reflection
(D) The formation of rainbow	(4) Dispersion of sunlight

(a) (A) → (2); (B) → (3); (C) → (4); (D) → (1)
(b) (A) → (3); (B) → (4); (C) → (1); (D) → (2)
(c) (A) → (4); (B) → (1); (C) → (2); (D) → (3)
(d) (A) → (3); (B) → (1); (C) → (2); (D) → (4)

3.

Column I	**Column II**
(A) Lens of power + 2.0 D	(1) Convex lens of focal length 200 cm.
(B) Lenses of combination of power +0.25 D and +0.25 D	(2) Concave lens of focal length 40 cm
(C) Lens of power –2.0 D	(3) Convex lens of focal length 50 cm
(D) Lenses combination of power –60 D and +3.5 D	(4) Concave lens of focal length 50 cm

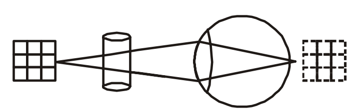
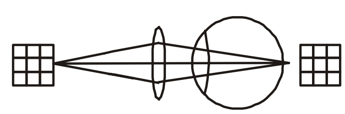
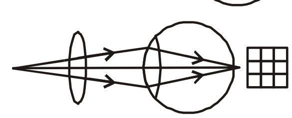
(a) (A) → (1); (B) → (2); (C) → (3); (D) → (4)
(b) (A) → (3); (B) → (1); (C) → (4); (D) → (2)
(c) (A) → (4); (B) → (3); (C) → (1); (D) → (2)
(d) (A) → (3); (B) → (4); (C) → (2); (D) → (1)

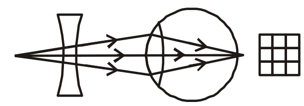
4. For an object placed in front of a mirror, magnification (m) is given in Column I, Column II gives the possible nature of the mirror or that of image. Match appropriately.

Column – I	**Column – II**
(A) $m = \frac{1}{4}$	(1) Concave mirror
(B) $m = –1$	(2) Convex mirror
(C) $m = 2$	(3) Plane mirror
(D) $m = 1$	(4) Real

(a) (A) → (2); (B) → (1); (C) → (1); (D) → (3)
(b) (A) → (1); (B) → (2); (C) → (4); (D) → (2)
(c) (A) → (2); (B) → (4); (C) → (1); (D) → (3)
(d) (A) → (1); (B) → (4); (C) → (3); (D) → (2)

5.

Column I	**Column II**
(A) Hypermetropia	(1) 
(B) Myopia	(2) 
(C) Astigmatism	(3) 

(D) Presbyopia (4) 

(a) (A) → (3); (B) → (1); (C) → (2); (D) → (4)
(b) (A) → (4); (B) → (3); (C) → (2); (D) → (1)
(c) (A) → (1); (B) → (2); (C) → (3); (D) → (4)
(d) (A) → (3); (B) → (4); (C) → (1); (D) → (2)

6. Match the columns I and II

Column I	**Column II**
(A) Terrestrial telescope	(1) Final image is inverted w.r.t. the object.
(B) Galileo's telescope	(2) No chromatic aberration
(C) Reflecting telescope	(3) Final image is erected.
(D) Astronomical telescope	(4) Uses concave lens for the eyepiece to obtain an erected image.

(a) (A) → (3); (B) → (2); (C) → (4); (D) → (1)
(b) (A) → (1); (B) → (4); (C) → (3); (D) → (2)
(c) (A) → (3); (B) → (4); (C) → (2); (D) → (1)
(d) (A) → (2); (B) → (1); (C) → (2); (D) → (3)

Critical Thinking Type Questions :

1. A vessel of depth x is half filled with oil of refractive index μ_1 and the other half is filled with water of refractive index μ_2. The apparent depth of the vessel when viewed from above is

(a) $\dfrac{x(\mu_1+\mu_2)}{2\mu_1\mu_2}$ (b) $\dfrac{x\mu_1\mu_2}{2(\mu_1+\mu_2)}$

(c) $\dfrac{x\mu_1\mu_2}{(\mu_1+\mu_2)}$ (d) $\dfrac{2x(\mu_1+\mu_2)}{\mu_1\mu_2}$

2. Light travels in two media A and B with speeds 1.8×10^8 m s^{-1} and 2.4×10^8 m s^{-1} respectively. Then the critical angle between them is

(a) $\sin^{-1}\left(\dfrac{2}{3}\right)$ (b) $\tan^{-1}\left(\dfrac{3}{4}\right)$

(c) $\tan^{-1}\left(\dfrac{2}{3}\right)$ (d) $\sin^{-1}\left(\dfrac{3}{4}\right)$

3. A thin glass (refractive index 1.5) lens has optical power of – 5 D in air. Its optical power in a liquid medium with refractive index 1.6 will be

(a) – 1D (b) 1 D
(c) – 25 D (d) 25 D

4. Two identical thin plano-convex glass lenses (refractive index 1.5) each having radius of curvature of 20 cm are placed with their convex surfaces in contact at the centre. The intervening space is filled with oil of refractive index 1.7. The focal length of the combination is

(a) –25 cm (b) –50 cm
(c) 50 cm (d) –20 cm

5. The refracting angle of a prism is 'A', and refractive index of the material of the prism is cot(A/2). The angle of minimum deviation is :

(a) $180° - 2A$ (b) $90° - A$
(c) $180° + 2A$ (d) $180° - 3A$

6. The focal lengths of objective and eye lens of an astronomical telelscope are respectively 2 meter and 5 cm. Final image is formed at (i) least distance of distinct vision (ii) infinity Magnifying power in two cases will be

(a) – 48, – 40 (b) – 40, – 48
(c) – 40, + 48 (d) – 48, + 40

7. A light ray falls on a rectangular glass slab as shown. The index of refraction of the glass, if total internal reflection is to occur at the vertical face, is

(a) $\sqrt{3/2}$ (b) $\dfrac{(\sqrt{3}+1)}{2}$

(c) $\dfrac{(\sqrt{2}+1)}{2}$ (d) $\sqrt{5}/2$

24

WAVE OPTICS

Fill in the Blanks :

1. The locus of all particles in a medium, vibrating in the same phase is called _______ .

2. A plane wave passes through a convex lens. The geometrical shape of the wavefront that emerges is _______ .

3. If two coherent sources are vibrating in phase then we have _______ interference at any point whenever the path difference is $n\lambda$.

4. In young's double slit experiment, the central point on the screen is _______ .

5. If Young's double slit experiment is performed in water keeping the rest of the set-up same, the fringe width will _____.

6. When ordinary light is made incident on a quarter wave plate, the emergent light is _______ polarised.

7. In a diffraction pattern by a wise, on increasing diameter of wire, fringe width _____.

8. Polaroid glass is used in sun glasses because it ______ intensity of sunlight.

9. According to Brewster's law of polarisation, μ = _______ .

True/ False :

1. Shape of wavefront in case of light emerging out of a convex lens when a point source is placed at its focus is plane.

2. A point source emitting waves uniformly in all directions.

3. At a small distance from the source, a small portion of sphere can be considered as plane wave.

4. In order to observe good interference and diffraction pattern, the distance between the slits should be very small (~ mm).

5. The resolving power of a telescope is limited by the diameter of objective lens.

6. The magnification by objective lens of a microscope does not depend upon the angle subtended by the diameter of the objective lens at the focus of the microscope.

7. Fringes with blue light are thicker than those for red light.

Conceptual MCQs

1. In a diffraction pattern due to a single slit of width 'a', the first minimum is observed at an angle 30° when light of wavelength 5000 Å is incident on the slit. The first secondary maximum is observed at an angle of :

(a) $\sin^{-1}\left(\frac{1}{4}\right)$ (b) $\sin^{-1}\left(\frac{2}{3}\right)$

(c) $\sin^{-1}\left(\frac{1}{2}\right)$ (d) $\sin^{-1}\left(\frac{3}{4}\right)$

2. A parallel beam of light pass through a screen S_1 containing a slit and then produces a diffraction pattern on a screen S_2 placed behind it. The width of the central maximum observed on the scren S_2 can be increased by

(a) decreasing the distance between the screens S_1 and S_2

(b) increasing the width of the slit in screen S_1

(c) decreasng the momentum of the electrons

(d) increasing the momentum of the electron

3. In Young's double slit experiment 10th order maximum is obtained at the point of observation in the interference pattern for $\lambda = 7000$ Å. If the source is replaced by another one of wavelength 5000 Å then the order of maximum at the same point will be –

(a) 12 th (b) 14 th
(c) 16 th (d) 18 th

4. A double slit is illuminated by two wavelength 450 nm and 600 nm. What is the lowest order at which the maxima of one wavelength coincides with the minima of the other wavelength –
(a) 1 (b) 2
(c) 3 (d) 4

5. In the far field diffraction pattern of a single slit under polychromatic illumination, the first minimum with the wavelength λ_1 is found to be coincident with the third maximum at λ_2. So –
(a) $3\lambda_1 = 0.3\lambda_2$ (b) $3\lambda_1 = \lambda_2$
(c) $\lambda_1 = 3.5\,\lambda_2$ (d) $0.3\lambda_1 = 3\lambda_2$

6. Which of the following cannot exhibit diffraction phenomenon ?
(a) photons (b) electrons
(c) neutrons (d) none of the above

7. An unpolarised beam of light is incident on a plane surface separating air and glass at an angle equal to the Brewster angle. Then :
(a) the reflected light has electric component only perpendicular to the incident plane.
(b) the reflected light has electric component only in the plane of incidence.
(c) the electric component parallel to the plane of incidence in refracted ray completely disappear.
(d) the magnetic component of the refracted light completely disappear.

8. In Young's double slit experiment, the intensity of light at a point on the screen where the path difference is λ is K units. What is the intensity of light at a point where the path difference is $\lambda/3$; λ being the wavelength of light used?
(a) K/4 (b) K/3
(c) K/2 (d) K

9. A single slit is illuminated by light whose wavelengths are λ_a and λ_b, so chosen that the first diffraction minimum of λ_a coincides with the second minimum of λ_b. The two wavelengths are related as :
(a) $\lambda_a = \lambda_b$ (b) $2\lambda_a = \lambda_b$
(c) $\lambda_a = 2\lambda_b$ (d) $2\lambda_a = 3\lambda_b$

10. If the source of light used in a Young's double slit experiment is changed from red to violet:
(a) the fringes will become brighter
(b) consecutive fringes will comes closer
(c) the intensity of minima will increase
(d) the central fringe- will became a dark fringe

11. A parallel beam of fast moving electrons is incident normally on a narrow slit. A fluorescent screen is placed at a large distance from the slit. If the speed of the electrons is increased, which of the following statements is correct ?
(a) The angular width of the central maximum of the diffraction pattern will increase.
(b) The angular width of the central maximum will decrease.
(c) The angular width of the central maximum will be unaffected.
(d) Diffraction pattern is not observed on the screen in case of electrons.

12. In the Young's double slit experiment the separation between the slits is halved and the distance between slits and the screen is doubled the fringe width is
(a) quadrupled (b) doubled
(c) unchanged (d) halved

13. The Young's double slit experiment is performed with blue and with green light of wavelengths 4360Å and 5460Å respectively. If x is the distance of 4th maxima from the central one, then
(a) x (blue) = x (green)
(b) x (blue) > x (green)
(c) x (blue) < x (green)
(d) $\dfrac{x(\text{blue})}{x(\text{green})} = \dfrac{5460}{4360}$

14. In Young's double slit experiment, the fringe width is found to be 0.4 mm. If the whole apparatus is immersed in water of refrative index $\dfrac{4}{3}$, without disturbing the geometrical arrangement, the new fringe width will be
(a) 0.30 mm (b) 0.40 mm
(c) 0.53 mm (d) 450 microns

15. In Young's experiment, two coherent sources are placed 0.90 mm apart and fringe are observed one metre away. If it produces second dark fringe at a distance of 1 mm from central fringe, the wavelength of monochromatic light used would be
(a) 60×10^{-4} cm (b) 10×10^{-4} cm
(c) 10×10^{-5} cm (d) 6×10^{-5} cm

16. In Young's double slit experiment carried out with light of wavelength (λ) = 5000Å, the distance between the slits is 0.2 mm and the screen is at 200 cm from the slits. The central maximum is at x = 0. The third maximum (taking the central maximum as zeroth maximum) will be at x equal to
(a) 1.67 cm (b) 1.5 cm
(c) 0.5 cm (d) 5.0 cm

17. If yellow light emitted by sodium lamp in Young's double slit experiment is replaced by a monochromatic blue light of the same intensity
(a) fringe width will decrease
(b) finge width will increase
(c) fringe width will remain unchanged
(d) fringes will become less intense

18. Interference was observed in interference chamber where air was present, now the chamber is evacuated, and if the same light is used, a careful observer will see
(a) No interference
(b) Interference with brighter bands
(c) Interference with dark bands
(d) Interference fringe with larger width

19. Two linear polarizers are crossed at an angle of 60°. The fraction of intensity of light transmitted by the pair is
(a) 1/4 (b) 1/8 (c) 3/8 (d) 1/2

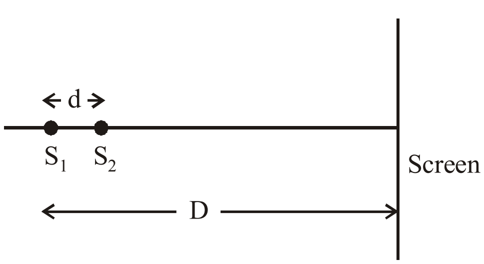
20. When wave of wavelength 0.2 cm is made incident normally on a slit of width 0.004m, then the semi-angular width of central maximum of diffraction pattern will be-
(a) 60° (b) 30° (c) 90° (d) 0°

21. In Young's experiment the wavelength of red light is 7.5×10^{-5} cm. and that of blue light 5.0×10^{-5} cm. The value of n for which $(n+1)^{th}$ the blue bright band coincides with n^{th} red band is -
(a) 8 (b) 4 (c) 2 (d) 1

22. The equation of two light waves are
$y_1 = 6 \cos\omega t$ and $y_2 = 8 \cos(\omega t + \phi)$.
The ratio of maximum to minimum intensities produced by the superposition of these waves will be
(a) 49 : 1 (b) 1 : 49 (c) 1 : 7 (d) 7 : 1

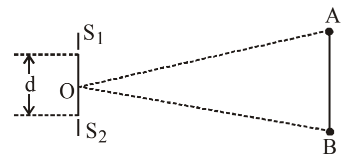
Diagram Based Questions :

1. Two coherent point sources S_1 and S_2 are separated by a small distance 'd' as shown in figure. The fringes obtained on the screen will be



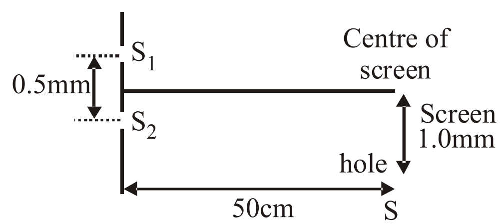
(a) points (b) straight lines
(c) semi-circles (d) concentric circles

2. Figure shows two coherent sources S_1 and S_2 vibrating in same phase. AB is an irregular wire lying at a far distance from the sources S_1 and S_2. Let $\frac{\lambda}{d} = 10^{-3}$ and $\angle BOA = 0.12°$. How many bright spots will be seen on the wire, including points A and B?



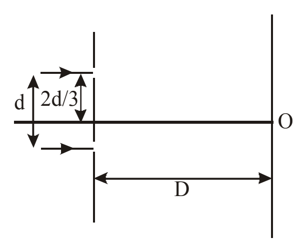
(a) 5 (b) 4
(c) 3 (d) 7

3. In Young's double slit experiment shown in figure S_1 and S_2 are coherent sources and S is the screen having a hole at a point 1.0mm away from the central line. White light (400 to 700nm) is sent through the slits. Which wavelength passing through the hole has strong intensity?



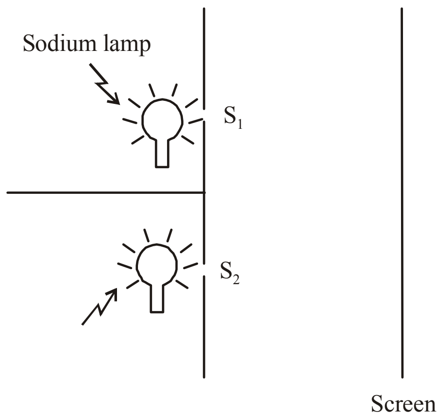
(a) 400 nm (b) 700 nm
(c) 500 nm (d) 667 nm

4. In the figure shown if a parallel beam of white light is incident on the plane of the slits then the distance of the
nearest white spot on the screen from O is d/A. Find the value of A. (assume $d << D$, $\lambda << d$]



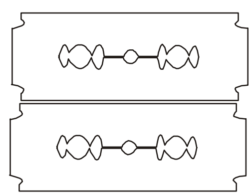
(a) 3 (b) 5
(c) 6 (d) 4

5. For the given arrangement, the screen will have



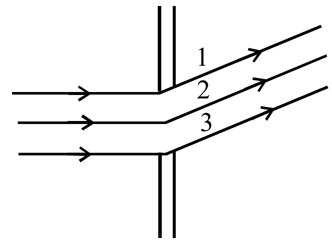
(a) interference pattern with central maxima
(b) interference pattern with central minima
(c) two separate interference patterns with central maxima
(d) doubly illuminated screen with no interference pattern at all

6. A single-slit-diffraction pattern, through following arrangement using an electric bulb as the source of light only will be



(a) central dark fringe followed by bright fringe of red colour
(b) central bright fringe followed by dark fringe than bands of varying intensity
(c) central bright fringe followed by dark fringe then wider red fringes and narrower blue fringes.
(d) central bright fringe followed by dark fringe then wider blue fringes followed by narrower red fringes.

7. The figure shows Fraunhoffer's diffraction due to a single slit. If first minimum is obtained in the direction shown, then the path difference between rays 1 and 3 is



(a) 0 (b) $\lambda / 4$
(c) $\lambda / 2$ (d) λ

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** No interference pattern is detected when two coherent sources are infinitely close to each other.
Reason : The fringe width is inversely proportional to the distance between the two sources.

2. **Assertion :** It is necessary to have two waves of equal intensity to study interference pattern.
Reason : There will be an effect on clarity if the waves are of unequal intensity.

3. **Assertion :** White light falls on a double slit with one slit is covered by a green filter. The bright fringes observed are of green colour.
Reason : The fringes observed are coloured.

4. **Assertion :** In YDSE, if a thin film is introduced in front of the upper slit, then the fringe pattern shifts in the downward direction.
Reason : In YDSE if the slit widths are unequal, the minima will be completely dark.

5. **Assertion :** In YDSE, if $I_1 = 9I_0$ and $I_2 = 4I_0$ then $\frac{I_{max}}{I_{min}} = 25.$
Reason : In YDSE $I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2$ and $I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2$.

6. **Assertion :** In YDSE number of bright fringe or dark fringe can not be unlimited
Reason : In YDSE path difference between the superposing waves can not be more than the distance between the slits.

7. **Assertion :** Interference pattern is made by using yellow light instead of red light, the fringes becomes narrower.
Reason : In YDSE, fringe width is given by $\beta = \dfrac{D\lambda}{d}$.

8. **Assertion :** Coloured spectrum is seen when we look through a muslin cloth.
Reason : It is due the diffraction of white light on passing through fine slits.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column I	Column II.
(A) Interference of light	(1) $I = I_0 \cos^2 \theta$
(B) Brewster's Law	(2) Obstacle/aperture of size = l
(C) Diffraction of light	(3) $\mu = \tan i_p$
(D) Law of Malus	(4) Coherent sources

(a) (A) → (3); (B) → (4); (C) → (2); (D) → (1)
(b) (A) → (1); (B) → (2); (C) → (3); (D) → (4)
(c) (A) → (4); (B) → (3); (C) → (2); (D) → (1)
(d) (A) → (4); (B) → (3); (C) → (2); (D) → (1)

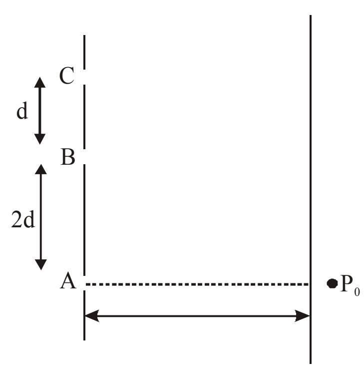
2.

Column I	Column II.
(A) Reflection	(1) Used for reducing glare
(B) Refraction	(2) Change in path of light without change in medium
(C) Interference	(3) $\mu = \sin i/\sin r$
(D) Polarization	(4) Light added to light produces darkness

(a) (A) → (2); (B) → (3); (C) → (4); (D) → (1)
(b) (A) → (1); (B) → (2); (C) → (3); (D) → (4)
(c) (A) → (4); (B) → (3); (C) → (2); (D) → (1)
(d) (A) → (1); (B) → (3); (C) → (2); (D) → (1)

3. In the figure shown A, B and C are the three slits each of which individually produces the same intensity ℓ_0, at point P_0 when they are illuminated by parallel beam of light of wavelength λ.
(Given: $BP_0 - AP_0 = \dfrac{\lambda}{2}$, $d << D$, $\ell_0 = 4\ W/m^2$, Amplitude of each wave = 2 units, λ = 6000Å)

Column-I	Column-II
(A) Resultant intensity at P_0 in (W/m²)	(1) 4
(B) Resultant amplitude at P_0 (in unit)	(2) zero
(C) If slit C is closed then resultant intensity at P_0	(3) 2
(D) If slit B is closed resulting amplitude at P_0 (in SI unit)	(4) $2\sqrt{2}$



(a) (A) $\rightarrow$ (3); (B) $\rightarrow$ (3); (C) $\rightarrow$ (2); (D) $\rightarrow$ (2)
(b) (A) $\rightarrow$ (1); (B) $\rightarrow$ (2); (C) $\rightarrow$ (3); (D) $\rightarrow$ (4)
(c) (A) $\rightarrow$ (4); (B) $\rightarrow$ (3); (C) $\rightarrow$ (2); (D) $\rightarrow$ (1)
(d) (A) $\rightarrow$ (1); (B) $\rightarrow$ (3); (C) $\rightarrow$ (2); (D) $\rightarrow$ (1)

4.

Column-I	**Column-II**
(A) Central fringes is bright and all fringes are equally spaced	(1) Interference in wedge-shaped thin film
(B) Central fringes is dark and all fringes are equally spaced	(2) Young's double slit experiment
(C) Central fringes is bright and fringes are not equally spaced	(3) Fraunhofer single slit diffraction experiment
(D) All fringes are equally spaced	(4) Lloyd's mirror experiment

(a) (A) $\rightarrow$ (2); (B) $\rightarrow$ (3); (C) $\rightarrow$ (4); (D) $\rightarrow$ (1)
(b) (A) $\rightarrow$ (2); (B) $\rightarrow$ (4); (C) $\rightarrow$ (3); (D) $\rightarrow$ (1)
(c) (A) $\rightarrow$ (4); (B) $\rightarrow$ (3); (C) $\rightarrow$ (2); (D) $\rightarrow$ (1)
(d) (A) $\rightarrow$ (1); (B) $\rightarrow$ (3); (C) $\rightarrow$ (2); (D) $\rightarrow$ (1)

Critical Thinking Type Questions :

1. Two light waves superimposing at the mid-point of the screen are coming from coherent sources of light with phase difference 3π rad. Their amplitudes are 1 cm each. The resultant amplitude at the given point will be.

(a) 5 cm (b) 3 cm
(c) 2 cm (d) zero

2. In a Young's double-slit experiment, let β be the fringe width, and let I_0 be the intensity at the central bright fringe. At a distance x from the central bright fringe, the intensity will be

(a) $I_0 \cos\left(\frac{x}{\beta}\right)$ (b) $I_0 \cos^2\left(\frac{x}{\beta}\right)$

(c) $I_0 \cos^2\left(\frac{\pi x}{\beta}\right)$ (d) $\left(\frac{I_0}{4}\right)\cos^2\left(\frac{\pi x}{\beta}\right)$

3. In the Young's double-slit experiment, the intensity of light at a point on the screen where the path difference is λ is K, (λ being the wavelength of light used). The intensity at a point where the path difference is $\lambda/4$, will be

(a) K (b) K/4
(c) K/2 (d) Zero

4. Two nicols are oriented with their principal planes making an angle of 60º. Then the percentage of incident unpolarised light which passes through the system is

(a) 100 (b) 50
(c) 12.5 (d) 37.5

5. If the polarizing angle of a piece of glass for green light is 54.74°, then the angle of minimum deviation for an equilateral prism made of same glass is
[Given, tan 54.74° = 1.414]

(a) 45° (b) 54.74°
(c) 60° (d) 30°

6. Two beams, A and B, of plane polarized light with mutually perpendicular planes of polarization are seen through a polaroid. From the position when the beam A has maximum intensity (and beam B has zero intensity), a rotation of polaroid through $30°$ makes the two beams appear equally bright. If the initial intensities of the two beams are I_A and I_B respectively, then $\frac{I_A}{I_B}$ equals:

(a) 3 (b) $\frac{3}{2}$

(c) 1 (d) $\frac{1}{3}$

25 Dual Nature of Radiation and Matter

Fill in the Blanks :

1. When the speed of electrons increase, then the value of its specific charge _______ .
2. Photoelectric emmision occurs only when the incident light has _______ than a certain minimum frequency.
3. A photosensitive substance emits _____ when illuminated by light.
4. In a photon-particle collision, _______ does not remain conserved.
5. The maximum energy of electrons released in a photocell is independent of _______ of incident light.
6. Positive rays are very identical to _______ rays.
7. One electron volt (ev) = _______ joule.
8. In Heinrich Hertz's experiment on the production of electromagnetic waves by means of spark discharge, high voltage sparks across the detector loop were enhanced when the emitter plate was illuminated by _____ light.

True/ False :

1. Dual nature of radiation is shown by photoelectric effect and diffraction.
2. Cathode rays do not deflect in electric field.
3. Electromagnetic radiations with high intensity have high frequency.
4. The stopping potential depends on the intensity of incident radiation.
5. In the interaction with matter, radiation behaves as if it is made up of photons.
6. Davisson and Germer experiment proved wave nature of light.

Conceptual MCQs

1. The phenomenon which can be explained only by quantum nature of light is
   (a) photoelectric effect (b) reflection
   (c) interference (d) polarization
2. No photoelectrons are emitted from a metal if the wavelength of the light exceeds 600 nm. The work function of the metal is approximately equal to
   (a) 3×10^{-16} J (b) 3×10^{-19} J
   (c) 3×10^{-20} J (d) 3×10^{-22} J
3. Which metal will be suitable for a photoelectric cell using light of wavelength 4000Å. The work functions of sodium and copper are respectively 2.0 eV and 4.0 eV.
   (a) Sodium (b) Copper
   (c) Both (d) None of these
4. The potential difference that must be applied to stop the fastest photoelectrons emitted by a nickel surface, having work function 5.01 eV, when ultraviolet light of 200 nm falls on it, must be
   (a) 2.4 V (b) – 1.2 V
   (c) –2.4 V (d) 1.2 V
5. In the Davisson and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by
   (a) increasing the potential difference between the anode and filament
   (b) increasing the filament current
   (c) decreasing the filament current
   (d) decreasing the potential difference between the anode and filament

6. A 200 W sodium street lamp emits yellow light of wavelength 0.6 μm. Assuming it to be 25% efficient in converting electrical energy to light, the number of photons of yellow light it emits per second is

(a) 1.5×10^{20} (b) 6×10^{18}
(c) 62×10^{20} (d) 3×10^{19}

7. According to Einstein's photoelectric equation, the plot of the kinetic energy of the emitted photoelectrons from a metal versus the frequency of the incident radiation gives a straight line whose slope

(a) depends both on the intensity of the radiation and the metal used
(b) depends on the intensity of the radiation
(c) depends on the nature of the metal used
(d) is the same for all metals and independent of the intensity of the radiation

8. Two identical photocathodes receive light of frequencies f_1 and f_2. If the velocites of the photoelectrons (of mass m) coming out are with velocity v_1 and v_2 respectively, then

(a) $v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$
(b) $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{1/2}$
(c) $v_1^2 + v_2^2 = \frac{2h}{m}(f_1 + f_2)$
(d) $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{1/2}$

9. A proton accelerated through a potential difference of 100V, has de-Broglie wavelength λ_0. The de-Broglie wavelength of an α-particle, accelerated through 800V is

(a) $\frac{\lambda_0}{\sqrt{2}}$ (b) $\frac{\lambda_0}{2}$
(c) $\frac{\lambda_0}{4}$ (d) $\frac{\lambda_0}{8}$

10. For same energy, find the ratio of λ_{photon} and $\lambda_{electron}$. (m is mass of electron)

(a) $c\sqrt{\frac{2m}{E}}$ (b) $\frac{1}{c}\sqrt{\frac{2m}{E}}$
(c) $\frac{1}{c^2}\sqrt{\frac{2m}{E}}$ (d) $\frac{1}{c}\sqrt{\frac{2m}{E^2}}$

11. A photon of 1.7×10^{-13} joule is absorbed by a material under special circumstances. The correct statement is

(a) Electrons of the atom of absorbed material will go the higher energy states
(b) Electron and positron pair will be created
(c) Only positron will be produced
(d) Photoelectric effect will occur and electron will be produced

12. Photoelectric emission is observed from a metallic surface for frequencies v_1 and v_2 of the incident light rays ($v_1 > v_2$). If the maximum values of kinetic energy of the photoelectrons emitted in the two cases are in the ratio of 1 : k, then the threshold frequency of the metallic surface is

(a) $\frac{v_1 - v_2}{k-1}$ (b) $\frac{kv_1 - v_2}{k-1}$
(c) $\frac{kv_2 - v_1}{k-1}$ (d) $\frac{v_2 - v_1}{k}$

13. The surface of a metal is illuminted with the light of 400 nm. The kinetic energy of the ejected photoelectrons was found to be 1.68 eV. The work function of the metal is
(hc = 1240 eV.nm)

(a) 1.41 eV (b) 1.51 eV
(c) 1.68 eV (d) 3.09 eV

14. If in a photoelectric cell, the wavelength of incident light is changed from 4000Å to 3000 Å then change in stopping potential will be

(a) 0.66 V (b) 1.03 V
(c) 0.33 V (d) 0.49 V

15. Light from a hydrogen discharge tube is incident on the cathode of a photoelectric cell, the work function of the cathode surface is 4.2 eV. In order to reduce the photocurrent to zero the voltage of the anode relative to the cathode must be made

(a) –4.2 V (b) –9.4 V
(c) – 17.8 V (d) +9.4 V

16. The frequency and work function of an incident photon are v and ϕ_0. If v_0 is the threshold frequency then necessary condition for the emission of photoelectron is

(a) $v < v_0$ (b) $v = \frac{v_0}{2}$
(c) $v \geq v_0$ (d) None of these

17. The work function of aluminium is 4.2 eV. If two photons, each of energy 3.5 eV strike an electron of aluminium, then emission of electrons
(a) will be possible
(b) will not be possible
(c) Data is incomplete
(d) Depends upon the density of the surface

18. The potential energy of a particle of mass m is given by

$$U(x) = \begin{cases} E_0; & 0 \le x \le 1 \\ 0; & x > 1 \end{cases}$$

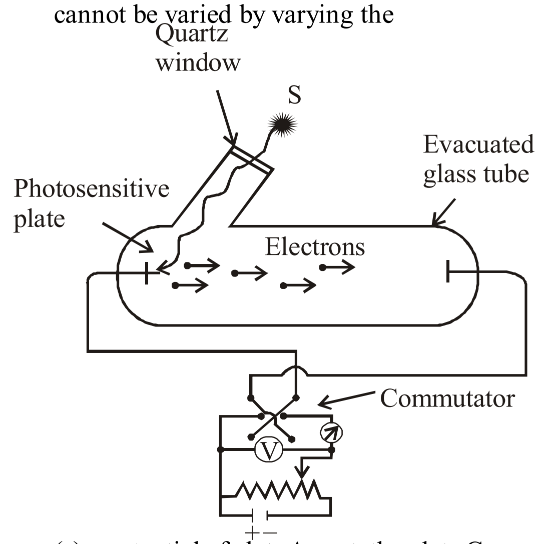
λ_1 and λ_2 are the de-Broglie wavelengths of the particle, when $0 \le x \le 1$ and $x > 1$ respectively. If the total energy of particle is $2E_0$, then ratio $\frac{\lambda_1}{\lambda_2}$ will be
(a) 2 (b) 1
(c) $\sqrt{2}$ (d) $\frac{1}{\sqrt{2}}$

19. A silver sphere of radius 1 cm and work function 4.7 eV is suspended from an insulating thread in freespace. It is under continuous illumination of 200 nm wavelength light. As photoelectrons are emitted, the sphere gets charged and acquires a potential. The maximum number of photoelectrons emitted from the sphere is $A \times 10^z$ (where $1 < A < 10$). The value of 'z' is
(a) 8 (b) 7
(c) 6 (d) 4

20. When a metal surface is illuminated by light of wavelengths 400 nm and 250 nm, the maximum velocities of the photoelectrons ejected are υ and 2υ respectively. The work function of the metal is (h = Planck's constant, c = velocity of light in air)
(a) $2\,hc \times 10^6$ J (b) $1.5\,hc \times 10^6$ J
(c) $hc \times 10^6$ J (d) $0.5\,hc \times 10^6$ J

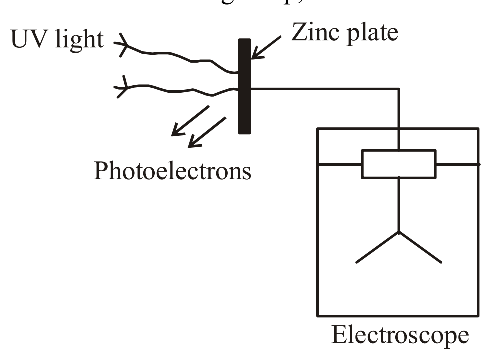
Diagram Based Questions :

1. In the given set-up, the photoelectric current cannot be varied by varying the



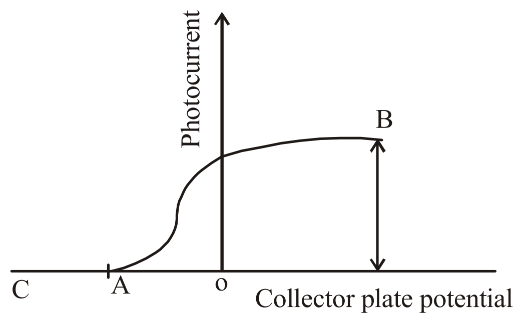
(a) potential of plate A w.r.t. the plate C
(b) intensity of incident light
(c) material of plate A
(d) material of plate C

2. In Hallwach's experiment on photoelectric emission with following setup, it was observed that



The zinc plate became _____ if initially negatively charged.
(a) positively charged
(b) negatively charged
(c) uncharged
(d) more positively charged

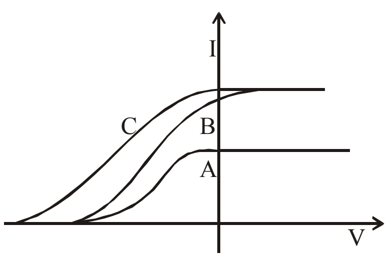
3. In the given graph of photoelectric current versus collector plate potential the quantities (A), (B), and (C) represent



(i) A (1) Retarding potential
(ii) B (2) Stopping potential
(iii) C (3) Saturation current

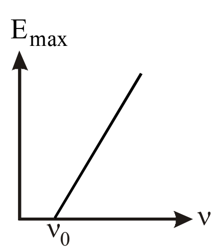
(a) (i) – 2; (ii) – 1; (iii) – 3
(b) (i) – 2; (ii) – 3; (iii) – 1
(c) (i) – 3; (ii) – 2; (iii) – 1
(d) (i) – 1; (ii) – 2; (iii) – 3

4. In a photoelectric experiment, anode potential (v) is plotted against plate current (I)



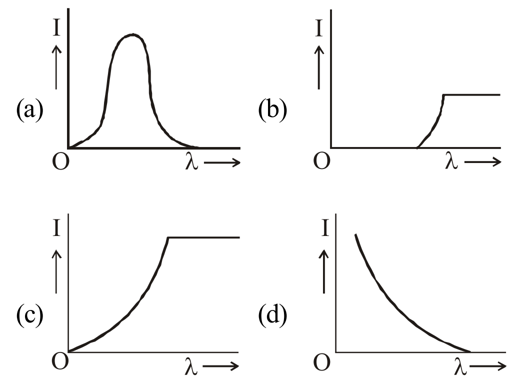
(a) A and B will have different intensities while B and C will have different frequencies
(b) B and C will have different intensities while A and C will have different frequencies
(c) A and B will have different intensities while A and C will have equal frequencies
(d) A and B will have equal intensities while B and C will have different frequencies

5. The maximum kinetic energy (E_{max}) of photoelectrons emitted in a photoelectric cell varies with frequency (ν) as shown in the graph. The slope of the graph is equal to



(a) charge of the electron
(b) $\frac{e}{m}$ of the electron
(c) work function of the emitter
(d) Plank's constant

6. The anode voltage of a photocell is kept fixed. The wavelength λ of the light falling on the cathode is gradually changed. The plate current I of the photocell varies as follows



Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. Assertion : In process of photoelectric emission, all emitted electrons do not have same kinetic energy.
Reason : If radiation falling on photosensitive surface of a metal consists of different wavelength then energy acquired by electrons absorbing photons of different wavelengths shall be different.

2. Assertion : Though light of a single frequency (monochromatic) is incident on a metal, the energies of emitted photoelectrons are different.
Reason : The energy of electrons emitted from

inside the metal surface, is lost in collision with the other atoms in the metal.

3. **Assertion :** The phtoelectrons produced by a monochromatic light beam incident on a metal surface have a spread in their kinetic energies.
Reason : The work function of the metal is its characteristics property.

4. **Assertion :** Photoelectric saturation current increases with the increase in frequency of incident light.
Reason : Energy of incident photons increases with increase in frequency and as a result photoelectric current increases.

5. **Assertion :** Photosensitivity of a metal is high if its work function is small.
Reason : Work function = hf_0 where f_0 is the threshold frequency.

6. **Assertion :** Two sources of equal intensity always emit equal number of photons in any time interval.
Reason : Two sources of equal intensity may emit equal number of photons in any time interval.

7. **Assertion :** Two photons of equal wavelength must have equal linear momentum.
Reason : Two photons of equal linear momentum will have equal wavelength.

8. **Assertion :** The kinetic energy of photoelectrons emitted from metal surface does not depend on the intensity of incident photon.
Reason : The ejection of electrons from metallic surface is not possible with frequency of incident photons below the threshold frequency.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. | Column I | Column II |
|---|---|
| (A) Field emission | (1) Heat is supplied to the metal surface |
| (B) Photoelectric | (2) Electric field is applied to the metal surface |
| (C) Thermionic emission | (3) Light of suitable frequency illuminates the metal surface |
| (D) Secondary emission | (4) Striking fast moving electrons on the metal surface. |

(a) (A) $\to$ (2); (B) $\to$ (3); C $\to$ (1); (D) $\to$ (4)
(b) (A) $\to$ (1); (B) $\to$ (3); C $\to$ (2); (D) $\to$ (4)
(c) (A) $\to$ (4); (B) $\to$ (1); C $\to$ (3); (D) $\to$ (2)
(d) (A) $\to$ (4); (B) $\to$ (3); C $\to$ (2); (D) $\to$ (1)

2. | Column I | Column II |
|---|---|
| (A) Electromagnetism | (1) Hertz |
| (B) Detection of electromagnetic waves | (2) Roentgen |
| (C) X-rays | (3) J.J. Thomson |
| (D) Electron | (4) Maxwell |

(a) (A) $\to$ 1; (B) $\to$ 4; (C) $\to$ 3; (D) $\to$ 2
(b) (A) $\to$ 2; (B) $\to$ 3; (C) $\to$ 1; (D) $\to$ 4
(c) (A) $\to$ 3; (B) $\to$ 2; (C) $\to$ 4; (D) $\to$ 1
(d) (A) $\to$ 4; (B) $\to$ 1; (C) $\to$ 2; (D) $\to$ 3

3. | Column I | Column II |
|---|---|
| (A) Einstein Photoelectric equation | (1) $\lambda = \frac{h}{p}$ |
| (B) de-Broglie relation | (2) $K_{max} = h\nu - \phi_0$ |
| (C) Threshold frequency | (3) $\Delta x \Delta p \simeq h$ |
| (D) Heisenberg's uncertainty principle | (4) $\nu = \frac{\phi_0}{h}$ |

(a) (A)$\rightarrow$(2); (B)$\rightarrow$(3); (C)$\rightarrow$(1); (D)$\rightarrow$(4)
(b) (A)$\rightarrow$(1); (B)$\rightarrow$(3); (C)$\rightarrow$(2); (D)$\rightarrow$(4)
(c) (A)$\rightarrow$(4); (B)$\rightarrow$(1); (C)$\rightarrow$(3); (D)$\rightarrow$(2)
(d) (A)$\rightarrow$(4); (B)$\rightarrow$(3); (C)$\rightarrow$(2); (D)$\rightarrow$(1)

4.

Column I	Column II
(A) Photocurrent	(1) The minimum energy required by electron to escape from the metal surface
(B) Saturation current	(2) The minimum retarding potential
(C) Stopping potential	(3) The number of photoelectric emitted per second
(D) Work function	(4) The maximum number of photoelectrons emitted per second

(a) (A)$\rightarrow$(1); (B)$\rightarrow$(2); (C)$\rightarrow$(3); (D)$\rightarrow$(4)
(b) (A)$\rightarrow$(3); (B)$\rightarrow$(4); (C)$\rightarrow$(2); (D)$\rightarrow$(1)
(c) (A)$\rightarrow$(2); (B)$\rightarrow$(1); (C)$\rightarrow$(4); (D)$\rightarrow$(1)
(d) (A)$\rightarrow$(4); (B)$\rightarrow$(3); (C)$\rightarrow$(1); (D)$\rightarrow$(2)

Critical Thinking Type Questions :

1. 4eV is the energy of incident photon and the work function is 2eV. The stopping potential will be
(a) 2V (b) 4V
(c) 6V (d) $2\sqrt{2}$V

2. The photoelectric work function for a metal surface is 4.125 eV. The cut-off wavelength for this surface is
(a) 4125 Å (b) 3000 Å
(c) 6000 Å (d) 2062 Å

3. The threshold frequency for a photosensitive metal is 3.3×10^{14} Hz. If light of frequency 8.2×10^{14} Hz is incident on this metal, the cut-off voltage for the photoelectric emission is nearly
(a) 2V (b) 3V
(c) 5V (d) 1V

4. For photoelectric emission from certain metal the cut-off frequency is ν. If radiation of frequency 2ν impinges on the metal plate, the maximum possible velocity of the emitted electron will be (m is the electron mass)
(a) $\sqrt{h\nu/m}$ (b) $\sqrt{2h\nu/m}$
(c) $2\sqrt{h\nu/m}$ (d) $\sqrt{h\nu/(2m)}$

5. The photoelectric threshold of Tungsten is 2300Å. The energy of the electrons ejected from the surface by ultraviolet light of wavelength 1800Å is
(a) 0.15 eV (b) 1.5 eV
(c) 15 eV (d) 150 eV

6. If the momentum of electron is changed by P, then the de Broglie wavelength associated with it changes by 0.5%. The initial momentum of electron will be
(a) $200\,P$ (b) $400\,P$
(c) $\frac{P}{200}$ (d) $100\,P$

7. The wavelength λ_e of an electron and λ_p of a photon are of same energy E are related by
(a) $\lambda_p \propto \lambda_e$ (b) $\lambda_p \propto \sqrt{\lambda_e}$
(c) $\lambda_p \propto \frac{1}{\sqrt{\lambda_e}}$ (d) $\lambda_p \propto \lambda_e^2$

8. A material particle with a rest mass m_0 is moving with speed of light c. The de-Broglie wavelength associated is given by
(a) $\frac{h}{m_0 c}$ (b) $\frac{m_0 c}{h}$
(c) zero (d) ∞

9. A proton has kinetic energy E = 100 keV which is equal to that of a photon. The wavelength of photon is λ_2 and that of proton is λ_1. The ratio of λ_2/λ_1 is proportional to
(a) E^2 (b) $E^{1/2}$
(c) E^{-1} (d) $E^{-1/2}$

26

ATOMS

Fill in the Blanks :

1. Electrons in the atom are held to the nucleus by _______ forces.
2. Equivalent energy of mass equal to 1 a.m.u. is _______ .
3. The empirical atom model was given by _______ .
4. According to the Rutherford's atomic model, nucleus is _______ charged.
5. The angular momentum of the electron in hydrogen atom in the ground state is given by _______ .
6. The first spectral series was disscovered by _______ .
7. Balmer series in the spectrum of hydrogen atom lies in the _______ region of the electromagnetic spectrum.
8. The radius of nth Bohr's orbit of Hydrogen atom is given by _______ .

True/ False :

1. The ratio of the kinetic energy to the total energy of an electron in a Bohr orbit is 1 : 2.
2. Rutherford's nuclear model could not explain, how could an atom as simple as hydrogen consisting of a single electron and a single proton, emit a complex spectrum of specific wavelengths.
3. Rutherford's α-particle scattering experiment concludes that there is a heavy mass at centre.
4. The observations of Geiger-Marsden experiment are many of α particles pass straight through the gold foil and only about 0.14% of α-particles scatter by more than 1°.
5. According to Bohr's model of hydrogen atom, orbiting speed of electron decreases as it shifts to discrete orbits away from the nucleus.
6. Radii of allowed orbits of electron are proportional to the principal quantum number.
7. Frequency with which electrons orbit around the nucleus in discrete orbits is inversely proportional to the cube of principal quantum number.
8. Binding force with which the electron is bound to the nucleus increases as it shifts to outer orbits.

Conceptual MCQs :

1. The following statements are all true. Which one did Rutherford consider to be supported by the results of experiments in which α-particles were scattered by gold foil?
   (a) The nucleus of an atom is held together by forces which are much stronger than electrical or gravitational forces.
   (b) The force of repulsion between an atomic nucleus and an α-particle varies with distance according to inverse square law.
   (c) α-particles are nuclei of Helium atoms.
   (d) Atoms can exist with a series of discrete energy levels.
2. The proof of quantization of energy states in an atom is obtained by the experiment performed by:
   (a) Thomson (b) Millikan
   (c) Rutherford (d) Franck & Hertz
3. Which of the following types of radiation is not emitted by the electronic structure of atoms:
   (a) Ultraviolet light (b) X-rays
   (c) Visible light (d) γ-rays
4. The angular speed of the electron in the n^{th} orbit of Bohr hydrogen atom is:
   (a) directly proportional to n
   (b) inversely proportional to $\sqrt{n}$
   (c) inversely proportional to n^2
   (d) inversely proportional to n^3

5. The ionization energy of hydrogen atom is 13.6 eV. Following Bohr's theory, the energy corresponding to a transition between 3rd and 4th orbit is
(a) 3.40 eV (b) 1.51 eV
(c) 0.85 eV (d) 0.66 eV

6. Lines of Blamer series are emitted by the hydrogen atom when the electron jumps:
(a) from higher orbits to first orbit.
(b) from higher orbit to second orbit.
(c) from second orbit to any other orbit.
(d) from third orbit to higher orbits.

7. According to Bohr's model of hydrogen atom:
(a) the linear velocity of the electron is quantised.
(b) the angular velocity of the electron is quantised.
(c) the linear momentum of the electron is quantised.
(d) the angular momentum of the electron is quantised.

8. Consider the spectral line resulting from the transition $n = 2 \rightarrow n = 1$, in the atoms and ions given below, the shortest wavelength is produced by:
(a) hydrogen atom (b) deuterium atom
(c) singly ionised helium
(d) doubly ionised lithium

9. Of the various series of the hydrogen spectrum, the one which lies wholly in the ultraviolet region is:
(a) Lyman series (b) Balmer series
(c) Paschen series (d) Bracket series

10. As the quantum number increases, the difference of energy between consecutive energy levels:
(a) remain the same (b) increases
(c) decreases
(d) sometimes increases and sometimes decreases.

11. Of the following transitions in hydrogen atom, the one which gives an absorption line of highest frequency is:
(a) n = 1 to n = 2 (b) n = 3 to n = 8
(c) n = 2 to n = 1 (d) n = 8 to n = 3

12. If the radius of the first orbit of hydrogen atom is 5.29×10^{-11} meter, the radius of the second orbit will be:
(a) 21.16×10^{-11} metre
(b) 15.87×10^{-11} metre
(c) 10.58×10^{-11} metre
(d) 2.64×10^{-11} metre

13. The minimum energy required to excite a hydrogen atom from its ground state is:
(a) 3.4 eV (b) 13.6 eV
(c) –13.6 eV (d) 10.2 eV

14. Line spectrum is obtained whenever the incandescent vapours at low pressure of the excited substance are in their
(a) atomic state (b) molecular state
(c) nuclear state (d) none of these

15. The total energy of electron in the ground state of hydrogen atom is – 13.6 eV. The kinetic energy of an electron in the first excited state is
(a) 6.8 eV (b) 13.6 eV
(c) 1.7 eV (d) 3.4 eV.

16. According to Bohr's theory of hydrogen atom, the angular momentum of an electron in any orbit of hydrogen atom is:
(a) directly proportional to the radius of the orbit
(b) inversely proportional to the radius of the orbit
(c) directly proportional to the square of the radius of the orbit
(d) directly proportional to the square root of the radius of the orbit.

17. According to Bohr's model of the hydrogen atom, the radius of a stationary orbit characterised by the principal quantum numbern is proportional to:
(a) n^{-1} (b) n
(c) n^{-2} (d) n^2

18. The ionization energy of the electron in the hydrogen atom in its ground state is 13.6 eV. The atoms are excited to higher energy levels to emit radiations of 6 wavelengths. Maximum wavelength of emitted radiation corresponds to the transition between
(a) n = 3 to n = 1 state
(b) n = 2 to n = 1 state
(c) n = 4 to n = 3 state
(d) n = 3 to n = 2 state

19. Fraunhofer lines are observed in the spectrum of:
(a) a hydrogen discharge tube
(b) a carbon arc
(c) the sun
(d) sodium vapour lamp.

20. In which region of electromagnetic spectrum does the Lyman series of hydrogen atom lie:
(a) ultraviolet (b) infrared
(c) visible (d) X-ray

21. According to the Bohr theory of H-atom, the speed of the electron, its energy and the radius of its orbit varies with the principal quantum number n, respectively, as :
(a) $\frac{1}{n}, n^2, \frac{1}{n^2}$ (b) $n, \frac{1}{n^2}, n^2$
(c) $n, \frac{1}{n^2}, \frac{1}{n^2}$ (d) $\frac{1}{n}, \frac{1}{n^2}, n^2$

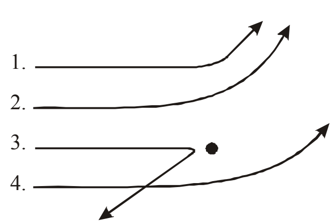
22. What is the wavelength of the most energetic photon emitted in the Balmer series of the Hydrogen atom ?
(a) 654 nm (b) 580 nm
(c) 435 nm (d) 365 nm

23. In a hydrogen atom following the Bohr's postulates the product of linear momentum and angular momentum is proportional to $(n)^x$ where 'n' is the orbit number. Then 'x' is-
(a) 0 (b) 2
(c) –2 (d) 1

24. One of the lines in the emission spectrum of Li^{2+} has the same wavelength as that of the 2nd line of Balmer series in hydrogen spectrum. The electronic transition corresponding to this line is –
(a) $n = 4 \rightarrow n = 2$ (b) $n = 8 \rightarrow n = 2$
(c) $n = 8 \rightarrow n = 4$ (d) $n = 12 \rightarrow n = 6$

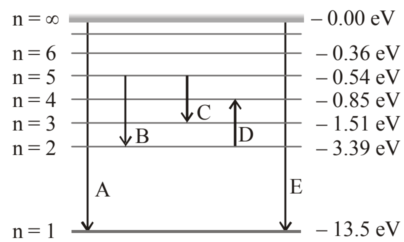
Diagram Based Questions :

1. The diagram shows the path of four α-particles of the same energy being scattered by the nucleus of an atom simulateneously which of those is not physically possible?



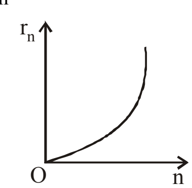
(a) 3 and 4 (b) 2 and 3
(c) 1 and 4 (d) 4 only

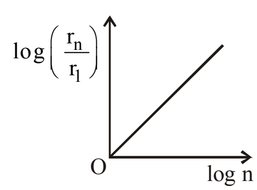
2. The energy levels of the hydrogen spectrum is shown in figure. There are some transitions A, B, C, D and E. Transition A, B and C respectively represent

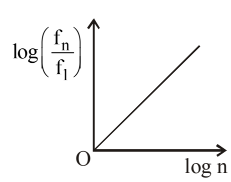


(a) first member of Lyman series, third spectral line of Balmer series and the second spectral line of Paschen series
(b) ionization potential of hydrogen, second spectral line of Balmer series, third spectral line of Paschen series
(c) series limit of Lyman series, third spectral line of Balmer series and second spectral line of Paschen series
(d) series limit of Lyman series, second spectral line of Balmer series and third spectral line of Paschen series

3. If in hydrogen atom, radius of n^{th} Bohr orbit is r_n, frequency of revolution of electron in n^{th} orbit is f_n, choose the correct option.

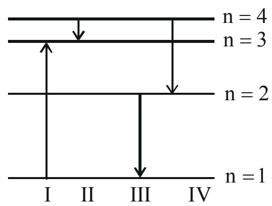
(a)


(b)


(c)


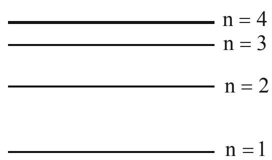
(d) Both (a) and (b)

4. The diagram shows the energy levels for an electron in a certain atom. Which transition shown represents the emission of a photon with the most energy?



(a) 4 (b) 3
(c) 2 (d) 1

5. Four lowest energy levels of H-atom are shown in the figure. The number of possible emission lines would be



(a) 3 (b) 4
(c) 5 (d) 6

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The force of repulsion between atomic nucleus and α-particle varies with distance according to inverse square law.
Reason : Rutherford did α-particle scattering experiment.

2. **Assertion :** According to classical theory the proposed path of an electron in Rutherford atom model will be parabolic.
Reason : According to electromagnetic theory an accelerated particle continuously emits radiation.

3. **Assertion :** Bohr had to postulate that the electrons in stationary orbits around the nucleus do not radiate.
Reason: According to classical physics all moving electrons radiate.

4. **Assertion :** Electrons in the atom are held due to coulomb forces.
Reason : The atom is stable only because the centripetal force due to Coulomb's law is balanced by the centrifugal force.

5. **Assertion :** Hydrogen atom consists of only one electron but its emission spectrum has many lines.
Reason : Only Lyman series is found in the absorption sepectrum of hydrogen atom whereas in the emission spectrum, all the series are found.

6. **Assertion :** Balmer series lies in the visible region of electromagnetic spectrum.
Reason : $\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{n^2}\right]$ where $n = 3, 4, 5.$

7. **Assertion :** Between any two given energy levels, the number of absorption transitions is always less than the number of emission transitions.
Reason : Absorption transitions start from the lowest energy level only and may end at any higher energy level. But emission transitions may start from any higher energy level and end at any energy level below it.

8. **Assertion :** In Lyman series, the ratio of minimum and maximum wavelength is $\frac{3}{4}$.
Reason : Lyman series constitute spectral lines corresponding to transition from higher energy to ground state of hydrogen atom.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the Column-I and Column-II.

Column – I	Column – II
(A) J.J. Thomson	(1) Nuclear model of the atom
(B) E. Rutherford	(2) Plum pudding model of the atom
(C) Franck-Hertz	(3) Explanation of the hydrogen spectrom
(D) Nills Bohr	(4) Existence of discrete energy levels in an atom

(a) (A) → (4); (B) → (1); (C) → (3); (D) → (2)
(b) (A) → (4); (B) → (1); (C) → (2); (D) → (3)
(c) (A) → (2); (B) → (1); (C) → (4); (D) → (3)
(d) (A) → (3); (B) → (2); (C) → (4); (D) → (3)

2. Consider Bohr's model to be valid for a hydrogen like atom with atomic number Z. Match quantities given in Column -I to those given in Column II.

Column – I	Column – II
(A) $\frac{Z^3}{n^5}$	(1) Angular speed
(B) $\frac{Z^2}{n^2}$	(2) Magnetic field at the centre due to revolution of electron
(C) $\frac{Z^2}{n^3}$	(3) Potential energy of an electron in n^{th} orbit
(D) $\frac{Z}{n}$	(4) Frequency of revolution of electron

(a) (A) → (1); (B) → (3); (C) → (2); (D) → (4)
(b) (A) → (4); (B) → (2); (C) → (1); (D) → (3)
(c) (A) → (3,4); (B) → (2,3); (C) → (1,2); (D) → (1)
(d) (A) → (1); (B) → (2); (C) → (3); (D) → (4)

3. Match the following Column II gives nature of image formed in various cases given in column I

Column – I	Column – II
(A) $n = 5$ to $n = 2$	(1) Lyman series
(B) $n = 8$ to $n = 4$	(2) Brackett series
(C) $n = 3$ to $n = 1$	(3) Paschen
(D) $n = 4$ to $n = 3$	(4) Balmer

(a) (A) → (2); (B) → (3); (C) → (1); (D) → (4)
(b) (A) → (4); (B) → (2); (C) → (1); (D) → (3)
(c) (A) → (3); (B) → (2); (C) → (4); (D) → (1,4)
(d) (A) → (1,3); (B) → (4); (C) → (3); (D) → (1)

4. Match the Column-I and Column-II.

Column – I	Column – II
(A) Radius of n^{th} orbit	(1) $\frac{2\pi kze^2}{nh}$
(B) Velocity of electron in n^{th} orbit	(2) $\frac{-kze^2}{rh}$

(C) Potential energy in n^{th} orbit | (3) $\frac{kze^2}{2rh}$

(D) Kinetic energy in n^{th} orbit | (4) $\frac{n^2h^2}{4\pi kze^2 m}$

(a) (A)→(4); (B)→(1); (C)→(2); (D)→(3)
(b) (A)→(4); (B)→(3); (C)→(1); (D)→(2)
(c) (A)→(2); (B)→(1); (C)→(4); (D)→(3)
(d) (A)→(4); (B)→(2); (C)→(1); (D)→(3)

Critical Thinking Type Questions :

1. Electron in hydrogen atom first jumps from third excited state to second excited state and then from second excited to the first excited state. The ratio of the wavelength $\lambda_1 : \lambda_2$ emitted in the two cases is
(a) 7/5
(b) 27/20
(c) 27/5
(d) 20/7

2. If the k_α radiation of Mo (Z = 42) has a wavelength of 0.71Å. Calculate the wavelength of the corresponding radiation of Cu (Z = 29).
(a) 1.52Å
(b) 2.52Å
(c) 0.52Å
(d) 4.52Å

3. If the atom $_{100}Fm^{257}$ follows the Bohr model and the radius of $_{100}Fm^{257}$ is *n* times the Bohr radius, then find *n*.
(a) 100
(b) 200
(c) 4
(d) 1/4

4. The ratio of longest wavelengths corresponding to Lyman and Blamer series in hydrogen spectrum is
(a) $\frac{3}{23}$
(b) $\frac{7}{29}$
(c) $\frac{9}{31}$
(d) $\frac{5}{27}$

5. If υ_1 is the frequency of the series limit of Lyman series, υ_2 is the frequency of the first line of Lyman series and υ_3 is the frequency of the series limit of the Balmer series then
(a) $\upsilon_1 - \upsilon_2 = \upsilon_3$
(b) $\upsilon_1 = \upsilon_2 - \upsilon_3$
(c) $\frac{1}{\upsilon_2} = \frac{1}{\upsilon_1} + \frac{1}{\upsilon_3}$
(d) $\frac{1}{\upsilon_1} = \frac{1}{\upsilon_2} + \frac{1}{\upsilon_3}$

6. The radiation corresponding to $3 \to 2$ transition of hydrogen atom falls on a metal surface to produce photoelectrons. These electrons are made to enter a magnetic field of 3×10^{-4} T. If the radius of the largest circular path followed by these electrons is 10.0 mm, the work function of the metal is close to:
(a) 1.8 eV
(b) 1.1 eV
(c) 0.8 eV
(d) 1.6 eV

7. What is the ratio of the shortest wavelength of the Balmer series to the shortest wavelength to the Lyman series ?
(a) 4 : 1
(b) 4 : 3
(c) 4 : 9
(d) 5 : 9

8. The wavelength of the first line of Lyman series for hydrogen atom is equal to that of the second line of Balmer series for a hydrogen like ion. The atomic number Z of hydrogen like ion is
(a) 3
(b) 4
(c) 1
(d) 2

27

Nuclei

Fill in the Blanks :

1. Positron has the mass closest in value to that of the _______ .
2. Chadwick was awarded the 1935 nobel prize in physics for his discovery of the _______ .
3. A nuclei having same number of neutron but different number of protons / atomic number are called _______ .
4. The mass of an atomic nucleus is _______ than the sum of the masses of its constituents.
5. Artificial radioactivity was discovered by _______ .
6. Fusion reaction occurs at temperatures of the order of _______ .
7. Control rods used in nuclear reactors are made of ______ .
8. According to radioactive decay law, the rate of disintegration, at a given instant, is ______ to the number of atoms present at that instant.

True/ False :

1. A reaction between a proton and $_8O^{18}$ that produces $_9F^{18}$ must also liberate 0^{e1}.
2. Atomic species of the same element differing in mass but same in atomic number are called isotopes.
3. For binding energy per nucleon *versus* mass number curve. Binding energy per nucleon E_{bn} is independent of mass number range 30 < A < 170.
4. In one half-life time duration, activity of a sample reduced to half of its initial value.
5. At a specific instant, emission of radioactive element is deflected in a magnetic field. The compound can emit electrons, protons, He^{2+}, and neutrons.
6. Nuclear density is very large compared to ordinary matter.
7. Mass of ordinary matter is mainly due to nucleus.
8. The phenomenon in which proton flips is called nuclear fusion.

Conceptual MCQs :

1. An element A decays into an element C by a two step process

   $A \rightarrow B + 2He^4$ and $B \rightarrow C + 2e^-$. Then,
   (a) A and C are isotopes
   (b) A and C are isobars
   (c) B and C are isotopes
   (d) A and B are isobars
2. Heavy water is used as a moderator in a nuclear reactor. The function of the moderator is
   (a) to control energy released in the reactor
   (b) to absorb neutrons and stop chain reaction
   (c) to cool the reactor
   (d) to slow down the neutrons to thermal energies.
3. Nuclear forces are
   (a) spin dependent and have no non-central part
   (b) spin dependent and have a non-central part
   (c) spin independent and have no non-central part
   (d) spin independent and have a non-central part
4. Which one of the following nuclear reactions is possible?
   (a) ${}^{14}_{7}N \longrightarrow {}^{13}_{6}C + \beta^+ + \nu_c$
   (b) ${}^{13}_{7}N \longrightarrow {}^{13}_{6}C + \beta^+ + \nu_c$

(c) $^{13}_{7}N \longrightarrow ^{13}_{6}C + \beta^{+}$

(d) $^{13}_{7}N \longrightarrow ^{13}_{7} + \beta^{+} + \nu_c$

5. The ratio of the radius of the nucleus of mass number 216 to the radius of the nucleus of mass number 64 is approximately :
(a) 1.0 (b) 1.2
(c) 1.5 (d) 1.8

6. At what rate must the ^{235}U nuclei undergo fission reaction to generate energy at the rate of 3.0 W. Assume the Q-value of fission to be 200 MeV:
(a) 10^{23} (b) 10^{19}
(c) 10^{11} (d) 10^{6}

7. What is the energy released in the β-decay of

$$^{32}P \longrightarrow ^{32}S$$

(Given : Atomic masses : 31.97391 u for ^{32}P and 31.97207 u for ^{32}S)
(a) – 1.2 MeV (b) + 1.7 MeV
(c) + 2.1 MeV (d) – 0.9 MeV

8. In a nuclear reaction between a deuteron and $_6C^{12}$, $_7N^{13}$ is produced. The other liberated particle is a/an :
(a) proton (b) electron
(c) neutron (d) positron

9. How many alpha α – and β– decays does U^{238} experiences before turning finally into stable Pb^{206} isotope ?
(a) 12, 6 (b) 10, 4
(c) 8, 6 (d) 8, 8

10. The activity of a certain radioactive sample is 128 mCi. If the decay constant of the material be 6.93 per hour then its activity after 30 minutes will reduced.
(a) 4mCi (b) 12.8 mCi
(c) 16 mCi (d) 32 mCi

11. Actinium $^{231}AC_{89}$, emit in succession two β particles, four alphas, one β and one alpha plus several γ rays. What is the resultant isotope:
(a) $^{221}Au_{79}$ (b) $^{211}Au_{79}$
(c) $^{221}Pb_{82}$ (d) $^{211}Pb_{82}$

12. The energy equivalent of one atomic mass unit is
(a) 1.6×10^{-19} J (b) 6.02×10^{23} J
(c) 931 MeV (d) 9.31 MeV

13. In which sequence the radioactive radiation are emitted in the following nuclear reaction

$$_ZX^A \longrightarrow _{Z+1}Y^A \longrightarrow$$

$$_{Z-1}K^{A-4} \longrightarrow _{Z-1}K^{A-4}$$

(a) γ, α, β (b) α, β, γ
(c) β, γ, α (d) β, α, γ

14. The radioactive decay of uranium into thorium is expressed by the equation

$$_{92}U^{238} \longrightarrow Th + X, \text{ what X is?}$$

(a) A deuteron (b) An alpha particle
(c) A proton (d) An electron

15. The activity of a radioactive substance is R_1 at time t_1 and R_2 at a later time instant t_2. Its decay constant is λ. Then,
(a) $R_1t_1 = R_2t_2$
(b) $R_2 \exp(\lambda t_2) = R_1 \exp(\lambda t_1)$
(c) $R_2 = R_1 \exp[\lambda(t_2 - t_1)]$
(d) $R_1 - R_2 = \text{a constant } (t_2 - t_1)$

16. An element X decays, first by positron emission and then two α-particles are emitted in successive radioactive decay. If the product nuclei has a mass number 229 and atomic number 89, the mass number and atomic number of element X are –
(a) 237, 93 (b) 237, 94
(c) 221, 84 (d) 237, 92

17. A heavy nucleus having mass number 200 gets disintegrated into two small fragments of mass number 80 and 120. If binding energy per nucleon for parent atom is 6.5 MeV and for daughter nuclei is 7 MeV and 8 MeV respectively, then the energy released in the decay will be –
(a) 200 MeV (b) –220 MeV
(c) 220 MeV (d) 180 MeV

18. A U^{235} atom undergoes fission by thermal neutrons according to the following reaction :

$$U^{235} + n = ^{140}_{54}Xe + ^{94}_{38}Sr + 2n$$

Then Xenon undergoes four and Strontium undergoes two consecutive β decays and six electrons are detected. What is the atomic number of the two final decay products of Xenon and Strontium ?
(a) 50, 36 (b) 58, 40
(c) 56, 42 (d) 57, 41

19. At an instant, the ratio of the amounts of radioactive substances is 2 : 1. If their half lives be respectively 12 and 16 hours, then after 2 days, the ratio of amounts of substances left over will be

(a) 1 : 1 (b) 2 : 1
(c) 1 : 2 (d) 1 : 4

20. Determine the energy released in the process

$$_1H^2 + {}_1H^2 \longrightarrow {}_2He^4 + Q$$

Given $M(_1H^2) = 2.01471$ amu $M(_2He^4) = 4.00388$ amu

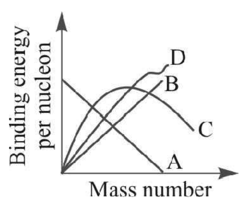
(a) 3.79 MeV (b) 13.79 MeV
(c) 0.79 MeV (d) 23.79 MeV

21. The half life of a radioactive substance is 34.65 minute. If 10^{22} atoms are active at any time then find the activity of substance?

(a) 3.34×10^{18} disintegration /sec
(b) 0.34×10^{18} disintegration /sec
(c) 1.34×10^{18} disintegration /sec
(d) 3.4×10^{18} disintegration /sec

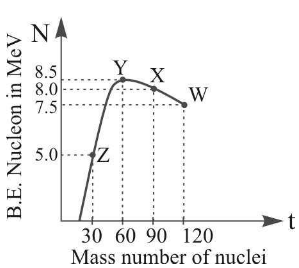
Diagram Based Questions :

1. Binding energy per nucleon plot against the mass number for stable nuclei is shown in the figure. Which curve is correct?



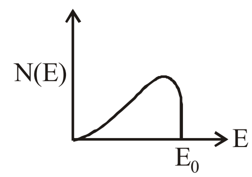
(a) A (b) B
(c) C (d) D

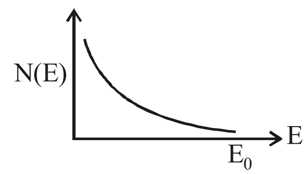
2. Binding energy per nucleon versus mass number curve for nuclei is shown in the figure. W, X, Y and Z are four nuclei indicated on the curve. The process that would release energy is

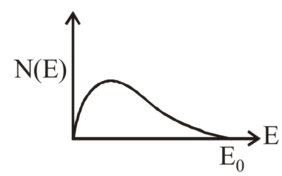


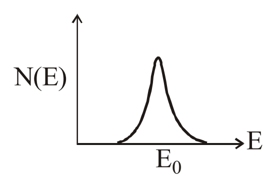
(a) $Y \rightarrow 2Z$ (b) $W \rightarrow X + Z$
(c) $W \rightarrow 2Y$ (d) $X \rightarrow Y + Z$

3. The energy spectrum of β-particles [number N(E) as a function of β-energy E] emitted from a radioactive source is

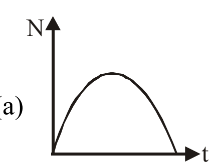
(a) 

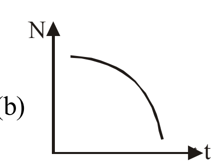
(b) 

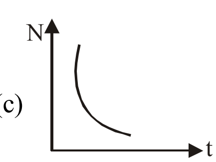
(c) 

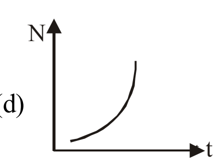
(d) 

4. Radioactive element decays to form a stable nuclide, then the rate of decay of reactant is

(a) 

(b) 

(c) 

(d) 

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Density of all the nuclei is same.
Reason : Radius of nucleus is directly proportional to the cube root of mass number.
2. **Assertion :** Neutrons penetrate matter more readily as compared to protons.
Reason : Neutrons are slightly more massive than protons.
3. **Assertion :** The mass number of a nucleus is always less than its atomic number.
Reason : Mass number of a nucleus may be equal to its atomic number.
4. **Assertion :** The binding energy per nucleon, for nuclei with atomic mass number A > 100, decrease with A.
Reason : The forces are weak for heavier nuclei.
5. **Assertion :** Radioactivity of 10^8 undecayed radioactive nuclei of half life of 50 days is equal to that of 1.2×10^8 number of undecayed nuclei of some other material with half life of 60 days.
Reason : Radioactivity is proportional to half-life.
6. **Assertion :** The ionising power of β-particle is less compared to α-particles but their penetrating power is more.
Reason : The mass of β-particle is less than the mass of α-particle.
7. **Assertion :** Radioactive nuclei emit β^{-1} particles.
Reason : Electrons exist inside the nucleus.
8. **Assertion :** Cobalt-60 is useful in cancer therapy.
Reason : Cobalt -60 is source of γ- radiations capable of killing cancerous cells.
9. **Assertion :** It is not possible to use ^{35}Cl as the fuel for fusion energy.
Reason : The binding energy of ^{35}Cl is to small.
10. **Assertion :** Energy is released when heavy nuclei undergo fission or light nuclei undergo fusion and
Reason : For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei it decreases with increasing Z.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the Column I and Column II.

	Column – I		Column – II
(A)	Isotopes	(1)	Mass number same but different atomic number
(B)	Isobars	(2)	Atomic number same but different mass number.
(C)	Isotones	(3)	Number of nentrons plus number of protons
(D)	Nucleons	(4)	Number of nentrons same but different atomic number

(a) (A) → (3); (B) → (1); (C) → (2); (D) → (4)
(b) (A) → (2); (B) → (1); (C) → (4); (D) → (3)
(c) (A) → (1); (B) → (2); (C) → (3); (D) → (4)
(d) (A) → (1); (B) → (3); (C) → (2); (D) → (4)

2. Match Column I of the nuclear processes with Column II containing parent nucleus and one of the end products of each process.

	Column I		Column II
(A)	Alpha decay	(1)	${}^{15}_{8}O \rightarrow {}^{15}_{7}N + ...$
(B)	β^+ decay	(2)	${}^{238}_{92}U \rightarrow {}^{234}_{90}Th + ...$

(C) Fission
(3) $^{185}_{83}Bi \rightarrow ^{184}_{82}Pb + ...$

(D) Proton emission
(4) $^{239}_{94}Pu \rightarrow ^{140}_{57}La + ...$

(a) (A)→(1); (B)→(3); (C)→(2); (D)→(4)
(b) (A)→(4); (B)→(3); (C)→(2); (D)→(1)
(c) (A)→(2); (B)→(1); (C)→(4); (D)→(3)
(d) (A)→(3); (B)→(1); (C)→(2); (D)→(4)

3.

Column – I	**Column – II**
(A) Nuclear fusion	(1) $E = mc^2$
(B) Nuclear fission	(2) Generally possible for nuclei with low atomic number
(C) β-decay	(3) Generally possible for nuclei with higher atomic number
(D) Mass-energy equivalence	(4) Essentially proceeds by weak reaction nuclear forces

(a) (A)→(2); (B)→(3); (C)→(4); (D)→(1)
(b) (A)→(4); (B)→(1); (C)→(2); (D)→(4)
(c) (A)→(1); (B)→(3); (C)→(2); (D)→(4)
(d) (A)→(3); (B)→(4); (C)→(2); (D)→(1)

4.

Column – I	**Column – II**
(A) Hydrogen bomb	(1) Fission
(B) Atom bomb	(2) Fusion
(C) Binding energy	(3) Critical mass
(D) Nuclear reactor	(4) Mass defect

(a) (A)→(3); (B)→(2); (C)→(1); (D)→(4)
(b) (A)→(2); (B)→(1); (C)→(4); (D)→(3)
(c) (A)→(3); (B)→(1); (C)→(2); (D)→(4)
(d) (A)→(4); (B)→(2); (C)→(3); (D)→(1)

Critical Thinking Type Questions :

1. In the options given below, let E denote the rest mass energy of a nucleus and *n* neutron. Then the correct option is

(a) $E\left(^{236}_{92}U\right) > E\left(^{137}_{53}I\right) + E\left(^{97}_{39}Y\right) + 2E(n)$

(b) $E\left(^{236}_{92}U\right) < E\left(^{137}_{53}I\right) + E\left(^{97}_{39}Y\right) + 2E(n)$

(c) $E\left(^{236}_{92}U\right) < E\left(^{140}_{56}Ba\right) + E\left(^{94}_{36}Kr\right) + 2E(n)$

(d) $E\left(^{236}_{92}U\right) = E\left(^{140}_{56}Ba\right) + E\left(^{94}_{36}Kr\right) + 2E(n)$

2. If the total binding energies of $^{2}_{1}H$, $^{4}_{2}He$, $^{56}_{26}Fe$ & $^{235}_{92}U$ nuclei are 2.22, 28.3, 492 and 1786 MeV respectively, identify the most stable nucleus of the following.

(a) $^{56}_{26}Fe$
(b) $^{2}_{1}H$
(c) $^{235}_{92}U$
(d) $^{4}_{2}He$

3. The binding energies per nucleon for a deuteron and an α-particle are x_1 and x_2 respectively. What will be the energy Q released in the reaction $_1H^2 + {}_1H^2 \rightarrow {}_2He^4 + Q$

(a) $4(x_1 + x_2)$
(b) $4(x_2 - x_1)$
(c) $2(x_1 + x_2)$
(d) $2(x_2 - x_1)$

4. Two radioactive nuclei P and Q, in a given sample decay into a stable nucleus R. At time t = 0, number of P species are 4 N_0 and that of Q are N_0. Half-life of P (for conversion to R) is 1 minute where as that of Q is 2 minutes. Initially there are no nuclei of R present in the sample. When number of nuclei of P and Q are equal, the number of nuclei of R present in the sample would be

(a) $3N_0$ (b) $\frac{9N_0}{2}$

(c) $\frac{5N_0}{2}$ (d) $2N_0$

5. The half life of a radioactive nucleus is 50 days. The time interval $(t_2 - t_1)$ between the time t_2 when $\frac{2}{3}$ of it has decayed and the time t_1 when $\frac{1}{3}$ of it had decayed is

(a) 30 days (b) 50 days

(c) 60 days (d) 15 days

6. A mixture consists of two radioactive materials A_1 and A_2 with half lives of 20 s and 10 s respectively. Initially the mixture has 40 g of A_1 and 160 g of A_2. The amount of the two in the mixture will become equal after

(a) 60 s (b) 80 s

(c) 20 s (d) 40 s

7. The half-life period of a radio-active element X is same as the mean life time of another radio-active element Y. Initially they have the same number of atoms. Then

(a) X and Y decay at same rate always

(b) X will decay faster than Y

(c) Y will decay faster than X

(d) X and Y have same decay rate initially

8. Assume that a neutron breaks into a proton and an electron. The energy released during this process is : (mass of neutron = 1.6725×10^{-27} kg, mass of proton = 1.6725×10^{-27} kg, mass of electron = 9×10^{-31} kg).

(a) 0.511 MeV (b) 7.10 MeV

(c) 6.30 MeV (d) 5.4 MeV

28 Semiconductor Electronics : Materials, Devices and Simple Circuits

Fill in the Blanks :

1. The majority charge carriers in P-type semiconductor are ______ .
2. In P-N junction, avlanche current flows in circuit when biasing is _______ .
3. In a semiconductor, the forbidden energy gap between the valence band and the conduction band is of the order of _______ .
4. Zener diode is used for _______ .
5. The part of a transistor which is most heavily doped to produce large number of majority carriers is _______ .
6. To use a transistor as an amplifier, emitter-base junction is _______ biased and base-collector junction is _____ biased.
7. An oscillator is nothing but an amplifier with _______ .
8. NAND and NOR gates are called _______ gates.

True/ False :

1. The depletion layer in the P-N junction region is caused by migration of impurity ions.
2. Function of rectifier is to convert d.c. into a.c.
3. Substances with energy gap of the order of 10 eV are insulators.
4. The resistivity of a semiconductor increases with increase in temperature.
5. In forward biasing electrons from n-sdie crosses junction and reach p-side.
6. Due to diffusion of electrons from n to p-side an ionised acceptor is left in the p-region.
7. For transistor action Base, emitter and collector region have similar size and doping concentrations.

Conceptual MCQs :

1. In a full wave rectifier circuit operating from 50 Hz mains frequency, the fundamental frequency in the ripple would be
   (a) 25 Hz (b) 50 Hz
   (c) 70.7 Hz (d) 100 Hz
2. If the forward voltage in a semiconductor diode is changed from 0.5V to 0.7 V, then the forward current changes by 1.0 mA. The forward resistance of diode junction will be
   (a) 100 Ω (b) 120 Ω
   (c) 200 Ω (d) 240 Ω
3. Current gain of a transistor in common base mode is 0.95. Its value in common emitter mode is
   (a) 0.95 (b) 1.5
   (c) 19 (d) $(19)^{-1}$
4. A transistor has a base current of 1 mA and emitter current 90 mA. The collector current will be
   (a) 90 mA (b) 1 mA
   (c) 89 mA (d) 91 mA
5. For a common base amplifier, the values of resistance gain and voltage gain are 3000 and 2800 respectively. The current gain will be
   (a) 1.1 (b) 0.98
   (c) 0.93 (d) 0.83
6. The current gain for a transistor working as common-base amplifier is 0.96. If the emitter current is 7.2 mA, then the base current is
   (a) 0.29 mA (b) 0.35 mA
   (c) 0.39 mA (d) 0.43 mA
7. A half-wave rectifier is being used to rectify an alternating voltage of frequency 50 Hz. The number of pulses of rectified current obtained in one second is

(a) 50 (b) 25
(c) 100 (d) 2000

8. The intrinsic semi conductor becomes an insulator at
(a) 0ºC (b) 0 K
(c) 300 K (d) –100ºC

9. In a P -N junction
(a) the potential of P & N sides becomes higher alternately
(b) the P side is at higher electrical potential than N side.
(c) the N side is at higher electric potential than P side.
(d) both P & N sides are at same potential.

10. Barrier potential of a P-N junction diode does not depend on
(a) doping density (b) diode design
(c) temperature (d) forward bias

11. The energy band gap is maximum in
(a) metals
(b) superconductors
(c) insulators
(d) semiconductors.

12. The part of a transistor which is most heavily doped to produce large number of majority carriers is
(a) emmiter
(b) base
(c) collector
(d) can be any of the above three.

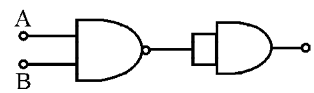
13. When npn transistor is used as an amplifier
(a) electrons move from collector to base
(b) holes move from emitter to base
(c) electrons move from base to collector
(d) holes move from base to emitter

14. In a common base amplifier the phase difference between the input signal voltage and the output voltage is
(a) 0 (b) $\pi/4$
(c) $\pi/2$ (d) π

15. Which one of the following is NOT a correct statement about semiconductors?
(a) The electrons and holes have different mobilities in a semiconductor
(b) In an *n*-type semiconductor, the Fermi level lies closer to the conduction band edge
(c) Silicon is a direct band gap semiconductor
(d) Silicon is has diamond structure

16. The donor level in a semiconductor is placed:
(a) half-way in the forbidden energy gap
(b) in the forbidden energy gap close to the upper edge of the valence band
(c) in the conduction band close to the lower edge to the conduction band
(d) in the forbidden energy gap close to the lower edge of the conduction band

17. Identify the logic operation of the following logic circuit:



(a) NAND (b) AND
(c) NOR (c) OR

18. A transistor amplifier in CE configuration amplifies an input of 0.01 V to 2.5V. The collector resistance R_c and the input resistance R_B are in the ratio of 5 : 1. The current amplication factor β of the transistor is :
(a) 5 (b) 50
(c) 250 (d) 25

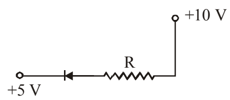
19. A p-n photodiode is made of a material with a band gap of 2.0 eV. The minimum frequency of the radiation that can be absorbed by the material is nearly
(a) 10×10^{14} Hz (b) 5×10^{14} Hz
(c) 1×10^{14} Hz (d) 20×10^{14} Hz

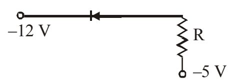
20. Two NOT gates are connected at the two inputs of a NAND gate. This combination will behave like :
(a) NAND gate (b) AND gate
(c) OR gate (d) NOR gate

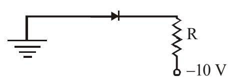
21. When a *p-n* junction diode is reverse biased the flow of current across the junction is mainly due to
(a) diffusion of charges
(b) drift of charges
(c) depends on the nature of material
(d) both drift and diffusion of charges

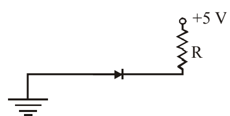
Diagram Based Questions :

1. Of the diodes shown in the following diagrams, which one is reverse biased ?

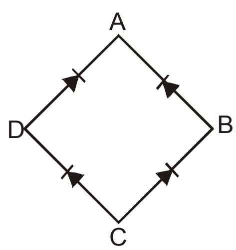
(a) 

(b) 

(c) 

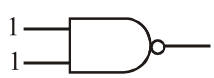
(d) 

2. In bridge rectifier circuit, (see fig.), the input signal should be connected between

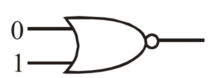


(a) A and D (b) B and C
(c) A and C (d) B and D

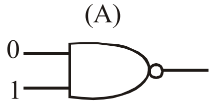
3. Which of the following gates will have an output of 1?



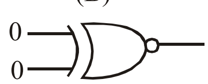
(A)



(B)



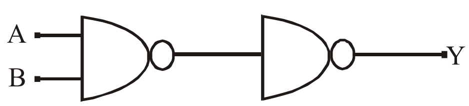
(C)



(D)

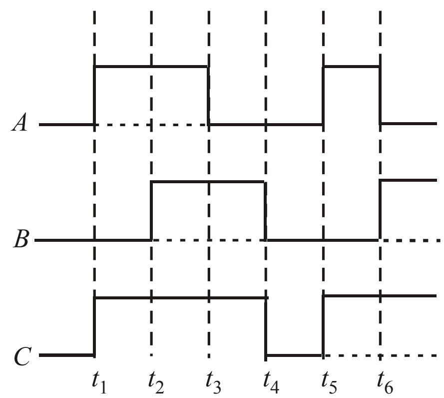
(a) D (b) A
(c) B (d) C

4. Following diagram performs the logic function of



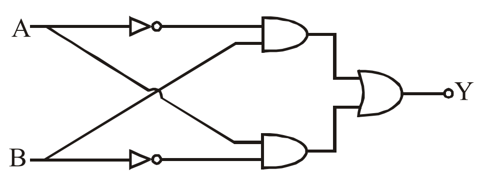
(a) XOR gate (b) AND gate
(c) NAND gate (d) OR gate

5. The figure shows a logic circuit with two inputs *A* and *B* and the output *C*. The voltage wave forms across *A*, *B* and *C* are as given. The logic gate circuit is:



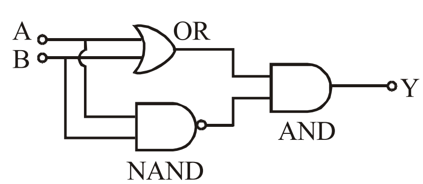
(a) OR gate (b) NOR gate
(c) AND gate (d) NAND gate

6. The following circut represents



(a) OR gate (b) XOR gate
(c) AND gate (d) NAND gate

7. The following configuration of gate is equivalent to



(a) NAND gate (b) XOR gate
(c) OR gate (d) NOR gate

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** A pure semiconductor has negative temperature coefficient of resistance.
Reason : In a semiconductor on raising the temperature, more charge carriers are released, conductance increases and resistance decreases.

2. **Assertion :** If the temperature of a semiconductor is increased then its resistance decreases.
Reason : The energy gap between conduction band and valence band is very small.

3. **Assertion :** A p-type semiconductors is a positive type crystal.
Reason : A p- type semiconductor is an uncharged crystal.

4. **Assertion :** Silicon is preferred over germanium for making semiconductor devices.
Reason : The energy gap in germanium is more than the energy gap in silicon.

5. **Assertion :** When two semi conductor of *p* and *n* type are brought in contact, they form *p-n* junction which act like a rectifier.
Reason : A rectifier is used to convent alternating current into direct current.

6. **Assertion :** The diffusion current in a p-n junction is from the p-side to the n-side.
Reason : The diffusion current in a p-n junction is greater than the drift current when the junction is in forward biased.

7. **Assertion :** A transistor amplifier in common emitter configuration has a low input impedence.
Reason : The base to emitter region is forward biased.

8. **Assertion :** NOT gate is also called invertor circuit.
Reason : NOT gate inverts the input order.

9. **Assertion :** NAND or NOR gates are called digital building blocks.
Reason : The repeated use of NAND (or NOR) gates can produce all the basis or complicated gates.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the column I and Column II

Column I	Column II (Rnge of resistivity, ρ)
(A) Metals	(1) $10^{11} - 10^{19}\,\Omega$ m
(B) Semiconductors	(2) $10^{-5} - 10^{6}\,\Omega$ m
(C) Insulators	(3) $10^{-2} - 10^{-8}\,\Omega$ m
	(4) $10^{-20} - 10^{25}\,\Omega$ m

(a) (A) → (3); (B) → (2); (C) → (1)
(b) (A) → (1,4); (B) → (2); (C) → (3)
(c) (A) → (1); (B) → (2); (C) → (3,4)
(d) (A) → (1); (B) → (2,4); (C) → (3)

2. Match the elements in column I, with their respective energy gaps in column II.

Column I	Column II
(A) Diamond	(1) 1.1 ev
(B) Aluminium	(2) 0.71 ev

(C) Germatium	(3) 0.03 ev
(D) Silicon	(4) 6 ev

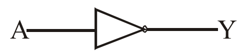
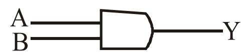
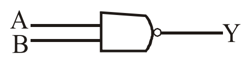
(a) (A) → (1); (B) → (2); (C) → (3); (D) → (4)
(b) (A) → (1); (B) → (2); (C) → (2); (D) → (3)
(c) (A) → (4); (B) → (2); (C) → (3); (D) → (1)
(d) (A) → (4); (B) → (3); (C) → (2); (D) → (1)

3.

Column I	**Column II**
(A) Moderate size and heavily doped	(1) Base
(B) Very thin and lightly doped	(2) Collector
(C) Moderately doped and of large size	(3) Emitter
(D) Dopped with penta valent impurity	(4) N-type semmiconductor

(a) (A) → (2); (B) → (1); (C) → (4); (D) → (3)
(b) (A) → (1); (B) → (2); (C) → (4); (D) → (3)
(c) (A) → (3); (B) → (1); (C) → (2); (D) → (4)
(d) (A) → (2); (B) → (1); (C) → (3); (D) → (4)

4.

Column I	**Column II**
(A) OR gate	(1) 
(B) AND gate	(2) 
(C) NOT gate	(3) 
(D) NAND gate	(4) 

(a) (A) → (3); (B) → (2); (C) → (1); (D) → (4)
(b) (A) → (1); (B) → (2); (C) → (4); (D) → (3)
(c) (A) → (3); (B) → (1); (C) → (2); (D) → (4)
(d) (A) → (2); (B) → (1); (C) → (3); (D) → (4)

Critical Thinking Type Questions :

1. Pure Si at 500K has equal number of electron (n_e) and hole (n_h) concentrations of 1.5×10^{16} m^{-3}. Doping by indium increases n_h to 4.5×10^{22} m^{-3}. The doped semiconductor is of

(a) n–type with electron concentration $n_e = 5 \times 10^{22}\ m^{-3}$
(b) p–type with electron concentration $n_e = 2.5 \times 10^{10}\ m^{-3}$
(c) n–type with electron concentration $n_e = 2.5 \times 10^{23}\ m^{-3}$
(d) p–type having electron concentration $n_e = 5 \times 10^{9}\ m^{-3}$

2. What is the conductivity of a semiconductor if electron density $= 5 \times 10^{12}/cm^3$ and hole density $= 8 \times 10^{13}/cm^3$

($\mu_e = 2.3\ m^2\ V^{-1}\ s^{-1}$, $\mu_h = 0.01\ m^2 V^{-1}\ s^{-1}$)

(a) $5.634\ \Omega^{-1}\ m^{-1}$ (b) $1.968\ \Omega^{-1}\ m^{-1}$
(c) $3.421\ \Omega^{-1}\ m^{-1}$ (d) $8.964\ \Omega^{-1}\ m^{-1}$

3. A diode having potential difference 0.5 V across its junction which does not depend on current, is connected in series with resistance of 20Ω across source. If 0.1 A current passes through resistance then what is the voltage of the source?

(a) 1.5 V (b) 2.0 V
(c) 2.5 V (d) 5 V

4. For a transistor amplifier in common emitter configuration for load impedance of 1k Ω ($h_{fe} = 50$ and $h_{oe} = 25\mu s$) the current gain is

(a) – 24.8 (b) – 15.7
(c) – 5.2 (d) – 48.78

5. The current gain of a transistor in common base mode is 0.995. The current gain of the same transistor in common emitter mode is

(a) 197 (b) 201
(c) 198 (d) 199

6. In a npn transistor 10^{10} electrons enter the emitter in 10^{-6} s. 4% of the electrons are lost in the base. The current transfer ratio will be

(a) 0.98 (b) 0.97
(c) 0.96 (d) 0.94

7. A common emitter amplifier has a voltage gain of 50, an input impedance of 100Ω and an output impedance of 200Ω. The power gain of the amplifier is

(a) 500 (b) 1000
(c) 1250 (d) 50

8. In a *CE* transistor amplifier, the audio signal voltage across the collector resistance of 2kΩ is 2V. If the base resistance is 1kΩ and the current amplification of the transistor is 100, the input signal voltage is

(a) 0.1 V (b) 1.0 V
(c) 1 mV (d) 10 mV

29 Communication Systems

Fill in the Blanks :

1. Telephony is an example of ______ mode of communication.
2. _______ modulation is employed in India for radio transmission.
3. The purpose of _______ is to convert the message signal produced by the source of information into a form suitable for transmission through the channel.
4. There is a need of translating the information contained in our original low frequency baseband signal into _______ or _______ frequencies before transmission.
5. An antenna behaves as _______ circuit when its length is $\lambda/2$ or integral multiple of $\lambda/2$.
6. The cellular mobile radio frequency band is _______ Hz.
7. The process of superimposing signal frequency (i.e., audio wave) on the carrier wave is known as _______ .
8. _______ mode of communication is most suitable for carrier wave of frequencies around 100 MHz.

True/ False :

1. While tuning in a certain broadcast station with a receiver, we are actually tuning the antenna.
2. Optical fibres are subject to electromagnetic interference from outside.
3. Optical fibres have extremely low transmission loss.
4. Digital signals represent values as discrete, values and can utilise decimal as well as binary systems.
5. In statellite communication the frequency used lies between 5 MHz and 1 MHz.
6. The orbit of geostationary satellite lies in the equatorial plane at inclination of 0.
7. Space waves are normally propagated in VHF frequency range.
8. In standard AM broadcast, ground based vertical towers are generally used as transmitting antennas.

Conceptual MCQs :

1. The maximum and minimum amplitude of an AM wave are 90 mV and 30 mV respectively. The depth of modulation is
   (a) 0.6 (b) 0.5
   (c) 0.4 (d) 0.3
2. Which mode of communication is most suitable for carrier wave of frequencies around 100 MHz :
   (a) Satellite (b) Ground wave
   (c) Line of sight (d) Ionospheric
3. Communication on ground is through electromagnetic waves of wavelength :
   (a) larger than 600 m
   (b) between 200 and 600 m
   (c) between 1 and 5 m
   (d) between 10^{-3} and 0.1
4. The maximum range for the tropospheric transmission of radio wave of wavelength 3m using the transmitting antenna and receiving antenna of heights 100 m and 60 m respectively is
   (a) 8m (b) 800m
   (c) 8km (d) 80km
5. Ground waves are polarised
   (a) Parallel to the earth's surface
   (b) normal to the earth's surface
   (c) at an angle 45° from earth's surface
   (d) in any direction.

6. Critical frequency that gets reflected back from ionosphere is
   (a) same for all layers of the ionosphere
   (b) different for different layers of the ionosphere
   (c) not dependent on layers of the ionosphere
   (d) none of these
7. Intensity of electric field obtained at receiver antenna for a space wave propagation is
   (a) directly proportional to the perpendicular-distance from transmitter to antenna
   (b) inversely proportional to the perpendicular-distance from transmitter to antenna
   (c) directly proportional to the square perpendicular-distance from transmitter to antenna
   (d) inversely proportional to the square perpendicular-distance from transmitter to antenna
8. In sky-wave propagation, skip-distance depends on :
   (a) frequency of e.m. waves transmitted
   (b) critical frequency of the layer
   (c) height of layer above earth's surface
   (d) all the above
9. For a single side band transmission a balanced modulator is used to
   (a) increase power of carrier wave
   (b) increase amplitude of carrier wave
   (c) suppress audio signal
   (d) suppress carrier component
10. For 100% modulation (AM), the useful part of the total power radiated is
   (a) $\frac{1}{2}$ of the total power
   (b) $\frac{1}{3}$ of the total power
   (c) $\frac{1}{4}$ of the total power
   (d) $\frac{2}{3}$ of the total power
11. The frequency deviation in a FM transmission is 18.75 KHz. If it broadcasts in 88-108 MHz band, then the percent modulation is
   (a) 10% (b) 25%
   (c) 50% (d) 75%
12. Calculate the power developed by an amplitude modulated wave in a load resistance of 100 Ω, if the peak voltage of carrier wave is 100 V and modulation index is 0.4.
   (a) 50 watt (b) 54 watt
   (c) 104 watt (d) 4 watt
13. A 1000 kHz carrier is simultaneously modulated with 300 Hz, 800 Hz and 2 kHz audio waves. The frequencies present in the output is
   (a) 999.7 kHz, 100.3 kHz, 999.2 kHz
   (b) 1000.8 kHz, 998 kHz, 1002 kHz
   (c) 1002.8 kHz, 996 kHz, 1106 kHz
   (d) both (a) and (b)
14. Array gain of an antenna is
   (a) directly proportional to power radiated by isotropic antenna
   (b) invesely proportional to power radiated by isotropic antenna
   (c) directly proportional to power radiated by practical antenna
   (d) inversely proportional to square of power radiated by practical antenna.
15. Consider the following amplitude modulated (AM) signal , where $f_m < B$
   $x_{AM}(t) = 10(1 + 0.5 \sin 2\pi f_m t) \cos 2\pi f_c t$
   The average side-band power for the AM signal given above is
   (a) 25 (b) 12.5
   (c) 6.25 (d) 3.125
16. The picture signal in TV-broadcast is modulated in
   (a) SSB (b) VSB
   (c) FM (d) DSB
17. In PCM if the transmission path is very long
   (a) pulse spacing is reduced
   (b) pulse amplitude is increased
   (c) pulse width is increased
   (d) repeater stations are used.
18. Field strength of tropospheric TV signal is proportional to
   (a) $\frac{1}{\lambda}$ (b) λ
   (c) $\frac{1}{\lambda^2}$ (d) λ^2

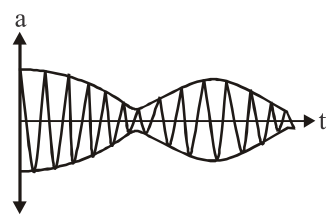
19. Electromagnetic waves with frequencies greater than the critical frequency of ionosphere cannot be used for commu nication using sky wave propagation because:
(a) the refractive index of the ionosphere becomes very high for $f > f_c$
(b) the refractive index of the ionosphere becomes very low for $f > f_c$
(c) the refractive index of the ionosphere very high for $f < fc$
(d) none of the above

20. A 1 kW carrier is modulated to a depth of 80%. The total power (in Kw) in the modulated wave is:
(a) 1.32 (b) 1.56
(c) 1.84 (d) 1.96

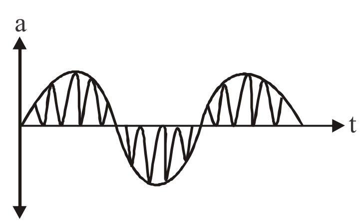
21. For an AM wave, the maximum voltage was found to be 10 V and minimum voltage was 4 V. The modulation index of the wave is
(a) 0.33 (b) 0.43
(c) 0.56 (d) 0.64

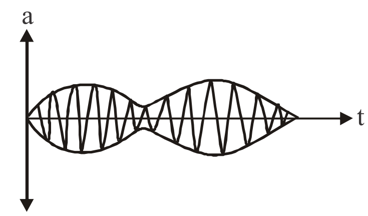
Diagram Based Questions :

1. Which one of the following represents rectified wave?

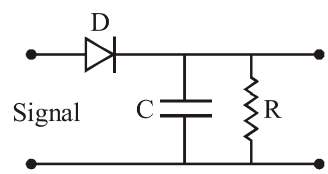
(a)


(b)


(c)


(d)


2. A diode detector is used to detect an amplitude modulated wave of 60% modulation by using a condenser of capacity 250 picofarad in parallel with a load resistance 100 kilo ohm. Find the maximum modulated frequency which could be detected by it.



(a) 10.62 MHz (b) 10.62 kHz
(c) 5.31 MHz (d) 5.31 kHz

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Amplification is necessary to compensate for the attenuation of the signal in communication system.
Reason : Amplification is the process of increasing the amplitude and consequntly the strength of signal using an electronic circuit.

2. **Assertion :** The loss of strength of a signal while propagating through a medium is known as attenuation.
   Reason : Transmitter helps to avoid attenuation.
3. **Assertion :** The information contained in our original low frequency baseband signal is to be translated into high or radio frequencies before transmission.
   Reason : For transmitting a signal, the antenna should have a size comparable to the wavelength of the signal.
4. **Assertion :** When the height of a TV transmission tower is increased by three times, the range covered is doubled.
   Reason : The range covered is proportional to the height of the TV transmission tower.
5. **Assertion :** Microwave communication is preferred over optical communication.
   Reason : Information carrying capacity is directly proportional to bandwidth.
6. **Assertion :** Long distance communication between two points on the earth is achieved by using sky waves.
   Reason : Sky wave propagation takes place above the frequency of 30 MHz.
7. **Assertion :** The television signals are propagated through sky waves.
   Reason : Television signals have frequency in the range of 1000 MHz to 2000 MHz range.
8. **Assertion :** Space waves are used for line-of-sight communication.
   Reason : Space wave travels in a straight line from transmitting anttena to receiving antenna.
9. **Assertion :** The ionosphere layer acts as a reflector for all range of frequencies.
   Reason : Ionosphere does not allow electromagnetic wave to penetrate and escape.
10. **Assertion :** The process of retrival of information from the carrier wave at the receiver is termed as modulation.
    Reason : Repeater helps to modulate the signals.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the Columns I and II.

Column I	Column II
(A) Attenuation	(1) The process of increasing the amplitude
(B) Amplification	(2) The loss of strength of a signal
(C) Bandwidth	(3) The process of retrieval of information from the carrier wave
(D) Demodulation	(4) The frequency range over which an equipment operates

(a) (A) $\rightarrow$ (2); (B) $\rightarrow$ (1); (C) $\rightarrow$ (4); (D) $\rightarrow$ (3)
(b) (A) $\rightarrow$ (4); (B) $\rightarrow$ (2); (C) $\rightarrow$ (1); (D) $\rightarrow$ (3)
(c) (A) $\rightarrow$ (3); (B) $\rightarrow$ (1); (C) $\rightarrow$ (4); (D) $\rightarrow$ (2)
(d) (A) $\rightarrow$ (1); (B) $\rightarrow$ (3); (C) $\rightarrow$ (4); (D) $\rightarrow$ (2)

2.

Column I (Name of the stratum)	Column II (Frequencies most affected)
(A) Troposphere reflects HF	(1) Efficiently waves
(B) Stratosphere	(2) Partially absorbs HF waves
(C) Mesosphere	(3) V H F upto several GHZ
(D) Thermosphere absorbs MF	(4) Reflects LF and HF to some degree

(a) (A) $\to$ (2); (B) $\to$ (1); (C) $\to$ (4); (D) $\to$ (3)
(b) (A) $\to$ (4); (B) $\to$ (2); (C) $\to$ (1); (D) $\to$ (3)
(c) (A) $\to$ (3); (B) $\to$ (4); (C) $\to$ (2); (D) $\to$ (1)
(d) (A) $\to$ (1); (B) $\to$ (3); (C) $\to$ (4); (D) $\to$ (2)

Critical Thinking Type Questions :

1. A transmitter radiates 10 kW of power with the carrier unmodulated and 11.8 kW with the carrier sinusoidally modulated. The modulation factor is

(a) 56% (b) 60% (c) 72% (d) 84%

2. The frequency deviation in a FM transmission is 18.75 KHz. If it broadcasts in 88-108 MHz band, then the percent modulation is

(a) 10% (b) 25% (c) 50% (d) 75%

3. 12 signals each band limited to 5 kHz are to be transmitted by frequency-division multiplexer. If AM-SSB modulation guard band of 1 kHz is used then the bandwidth of multiplexed signal is

(a) 101 kHz (b) 99 kHz (c) 84 kHz (d) 71 kHz

4. The rms value of a carrier voltage is 100 volts. Compute its rms value when it has been amplitude modulated by a sinusoidal audio voltage to a depth of 30%.

(a) 94 V (b) 104.5V (c) 114.4 V (d) 124 V

5. For an AM-system the total power of modulated signal is 600 W and that of carrier is 400 W, the modulation index is

(a) 0.25 (b) 0.36 (c) 0.54 (d) 1

6. For 100% modulation (AM), the useful part of the total power radiated is

(a) $\frac{1}{2}$ of the total power
(b) $\frac{1}{3}$ of the total power
(c) $\frac{1}{4}$ of the total power
(d) $\frac{2}{3}$ of the total power

7. Consider the following amplitude modulated (AM) signal, where $f_m < B$ $x_{AM}(t) = 10(1 + 0.5 \sin 2\pi f_m t) \cos 2\pi f_c t$

The average side-band power for the AM signal given above is

(a) 25 (b) 12.5 (c) 6.25 (d) 3.125

8. A sinusoidal carrier voltage of frequency 10 MHz and amplitude 200 volts is amplitude modulated by a sinusoidal voltage of frequency 10 kHz producing 40% modulation. Calculate the frequency of upper and lower sidebands.

(a) 10010 kHz, 9990 kHz
(b) 1010 kHz, 990 kHz
(c) 10100 Hz, 9990 Hz
(d) 1010 MHz, 990 MHz

9. What will be the image frequency of an FM radio receiver that is tuned to 98.6 MHz broadcast station?

(a) 111.8 MHz (b) 108 MHz
(c) 121.6 MHz (d) 132 MHz

10. A 10 kW carrier is sinusoidally modulated by two carriers corresponding to a modulation index of 30% and 40% respectively then total power radiated by the modulator is

(a) 10.25 kW (b) 11.25 kW
(c) 12.75 kW (d) 17 kW

11. An AM wave varies from 10V to 4V. Its percentage modulation is

(a) 36% (b) 42.8%
(c) 54% (d) 68 %

Solutions

1 Physical World, Units and Measurements

Fill in the Blanks

1. Accuracy
2. $[X] = [C] = [M^{-1} L^{-2} T^2 Q^2]$
$[Z] = [B] = [MT^{-1} Q^{-1}]$
$$\therefore \quad [Y] = \frac{[M^{-1}L^{-2}T^2Q^2]}{[MT^{-1}Q^{-1}]^2} = [M^{-3}L^{-2}T^4Q^4]$$
3. $[a] = [PV^2] = \frac{MLT^{-2}}{L^2} L^6 = ML^5T^{-2}$
4. Relative error
5. $h = \frac{E}{v} = \frac{\left[ML^2T^{-2}\right]}{\left[T^{-1}\right]} = \left[ML^2T^{-1}\right]$
6. Least count error
7. $3\left(\frac{\Delta A}{A}\right)$
8. 2, According to rules of significant figures.

True/ False

1. True 2. True
3. False 4. True
5. False. Light year is used to measure very-very large distances.
6. False. Among ℓ_1, ℓ_2 and ℓ_3, ℓ_3 is the most accurate measurement.

Conceptual MCQs

1. **(c)** Tension is a force $[MLT^{-2}]$
Whereas surface tension
$$= \frac{\text{force}}{\text{length}}\left[ML^0T^{-2}\right]$$
2. **(b)**
3. **(b)**
4. **(d)** Applying dimensional method :
$V_C = \eta^x\rho^yr^z$
$[M^0LT^{-1}] = [ML^{-1}T^{-1}]^x [ML^{-3}T^0]^y [M^0LT^0]^z$
Equating powers both sides
$x + y = 0; -x = -1 \therefore x = 1$
$1 + y = 0 \therefore y = -1$
$-x - 3y + z = 1$
$-1 - 3(-1) + z = 1$
$-1 + 3 + z = 1$
$\therefore z = -1$
5. **(c)** Angular displacement has unit (degree or radian) but it is dimensionless.
Note : vice-versa is not possible.
6. **(b)** γ is ratio of specific heats.
7. **(c)** acceleration $= \frac{V}{T}$,, mass $= [F^1 V^{+1} T^{-1}]$.
8. **(b)** Because by using length, time and velocity we can't find mass.
9. **(d)** 10. **(d)**
11. **(a)**
12. **(b)** Least no. of significant digits are 2, so round off the final answer to two significant digits.
13. **(d)**
14. **(a)**
15. **(c)** $\frac{\Delta T}{T} \times 100 = \frac{0.2}{25} \times 100.$
16. **(a)** Use principle of Homogeneity.
17. **(a)** $\tau = [\text{Force} \times \text{distance}]$
$= [MLT^{-2}] [L] = ML^2T^{-2}$
18. **(c)** Least count = 1MSD – 1 VSD
$$= 1\text{MSD} - \left(\frac{N-1}{N}\right)\text{MSD}$$
$$(\because N \text{ VSD} = (N-1)\text{MSD} \therefore 1 \text{ VSD} = \frac{N-1}{N}\text{MSD})$$
$$= \frac{1}{N}\text{MSD}$$
$$= \frac{1}{N} \times \frac{1}{10}\text{cm} = \frac{1}{10N}$$
19. **(d)** A quantity which has dimensions and a constant value is called dimensional constant. Therefore, gravitational constant (G) is a dimensional constant.
20. **(d)** $\varepsilon_o = \frac{q^2}{(r^2)4\pi F}$
$\Rightarrow$ unit of ε_o is $(\text{coulomb})^2$/ newton-metre^2
21. **(b)** $\frac{\text{Planck's constant}}{\text{Moment of inertia}} = \frac{\frac{2\pi I\omega}{n}}{I}$ [As $\frac{nh}{2\pi} = I\omega$]
$$= \frac{2\pi I(2\pi f)}{nI} = \left(\frac{4\pi^2}{n}.f\right) = [T^{-1}]$$

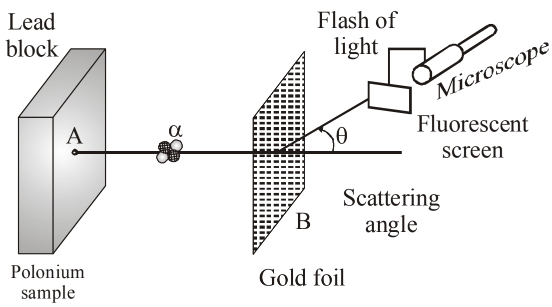
22. **(d)** Pressure = $\frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$

$\Rightarrow$ a = 1, b = – 1, c = – 2.

23. **(c)** Speed, $c = \frac{1}{\sqrt{\mu_0 \in_0}}$, so, dimensions are $[LT^{-1}]$.

Diagram Based Questions

1. **(b)** The alpha particle scattering experiment of Rutherford gave the nuclear model of the atom as shown in figure



2. **(b)** **3.** **(a)**

4. **(c)** Least count = $\frac{0.5}{50} = 0.01\,mm$

Zero error = 5 × $L.C$ = 5 × 0.01 mm = 0.05 mm

Diameter of ball = [Reading on main scale] + [Reading on circular scale × L . C] – Zero error

= 0.5 × 2 + 25 × 0.01 – 0.05 = 1.20 mm

Assertion/ Reason

1. **(c)** Light has well defined relation with length.

2. **(a)** As the distance of star increases, the parallax angle decreases, and great degree of accuracy is required for its measurement. Keeping in view the practical limitation in measuring the parallax angle, the maximum distance of a star we can measure is limited to 100 light year.

3. **(b)** A.U. (Astronomical unit) is used to measure the average distance of the centre of the sun from the centre of the earth, while angstrom is used to measure very short distances. 1 A.U. = 1.5×10^{11}m; 1Å =10^{-10}m.

4. **(c)** We know that $Q = n_1u_1 = n_2u_2$ are the two units of measurement of the quantity Q and n_1, n_2 are their respective numerical values. From relation $Q_1 = n_1u_1 = n_2u_2$, nu = constant $\Rightarrow n \propto 1/u$ *i.e.*, smaller the unit of measurement, greater is its numerical value.

5. **(c)** Angle and strain dimensionless, but angle has unit radian.

6. **(d)** $P = \frac{\text{mass}}{\text{area}} x$

$\therefore \quad x = \frac{P \times \text{area}}{\text{mass}} = \frac{MLT^{-1}}{M} \times L^2 = L^3T^{-1}$

Quantities with different dimensions can be multiplied.

7. **(a)** Addition and subtraction can be done between quantities having same dimensions.

8. **(d)** Let us write the dimension of various quantities on two sides of the given relation.

L.H.S. = T = [T]

R.H.S. = $2\pi\sqrt{g/\ell} = \sqrt{\frac{LT^{-2}}{L}} = [T^{-1}]$

[$\because$ 2π has no dimension]. As dimensions of L.H.S is not equal to dimensions of R.H.S. Therefore according to principle of homogeneity the relation

$T = 2\pi\sqrt{g/\ell}$ is not valid

9. **(d)** Mass × acceleration (ma) = F (force)

Matching Based Questions

1. **(b)** **2.** **(d)** **3.** **(c)** **4.** **(a)** **5.** **(b)**
6. **(c)** **7.** **(a)** **8.** **(b)**

Critical Thinking Type Questions

1. **(d)** As we know, time period of a simple pendulum

$T = 2\pi\sqrt{\frac{L}{g}} \Rightarrow g = \frac{4\pi^2 L}{T^2}$

The maximum percentage error in g

$$\frac{\Delta g}{g} \times 100 = \frac{\Delta L}{L} \times 100 + 2\left(\frac{\Delta T}{T} \times 100\right)$$

= 2% + 2(3%) = 8%

2. **(b)** Least count = $\frac{0.1}{10}$ = 0.01 cm

$d_1 = 0.5 + 8 \times 0.01 + 0.03 = 0.61$ cm
$d_2 = 0.5 + 4 \times 0.01 + 0.03 = 0.57$ cm
$d_3 = 0.5 + 6 \times 0.01 + 0.03 = 0.59$ cm

Mean diameter = $\frac{0.61 + 0.57 + 0.59}{3}$

= 0.59 cm

3. **(c)** $[at] = [F]$ amd $[bt^2] = [F]$

$\Rightarrow [a] = MLT^{-3}$ and $[b] = MLT^{-4}$

4. **(a)**

5. **(b)** [momentum] = $[M][L][T^{-1}] = [MLT^{-1}]$

Planck's constant = $\frac{E}{\nu}$

$$= \frac{[M][LT^{-1}]^2}{T^{-1}} = ML^2T^{-1}$$

6. (a) $F = \dfrac{GMm}{R^2}$

$\therefore G = \dfrac{FR^2}{Mm} \Rightarrow G = [ML^3T^{-2}]$

7. (d) Pressure $= \dfrac{MLT^{-2}}{L^2} = [ML^{-1}T^{-2}]$

$\Rightarrow$ a = 1, b = – 1, c = – 2.

8. (d) Let unit 'u' related with e, a_0, h and c as follows.

$[u] = [e]^a\,[a_0]^b\,[h]^c\,[C]^d$

Using dimensional method,

$[M^{-1}L^{-2}T^{+4}A^{+2}] = [A^1T^1]^a[L]^b[ML^2T^{-1}]^c[LT^{-1}]^d$

$[M^{-1}L^{-2}T^{+4}A^{+2}] = [M^c\,L^{b+2c+d}\,T^{a-c-d}\,A^a]$

$a = 2, b = 1, c = -1, d = -1$

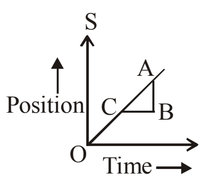
$\therefore \quad u = \dfrac{e^2 a_0}{hc}$

2 Motion in a Straight Line

Fill in the Blanks

1. Displacement
2. Speed

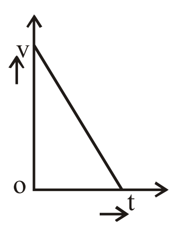
The slope of the tangent drawn on position-time graph at any instant gives instantaneous velocity.



$AC = \dfrac{AB}{BC} = V_{inst}$

3. Velocity
4. Change in velocity
5. Straight line
6. Free fall
7. Straight line

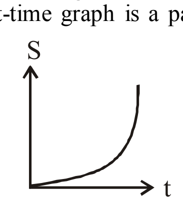
Velocity time curve will be a straight line as shown:



At the highest point v = 0.

8. Parabola

For a particle moving with uniform acceleration the displacement-time graph is a parabola.



True/ False

1. True 2. False 3. True
4. False
5. False. Average velocity can be positive, negative or zero.

Conceptual MCQs

1. (b) In case of uniform circular motion, a body can have a constant speed and still have a verying velocity due to change in direction.

2. (b) $s = 6t^2 - t^3$

$v = \dfrac{ds}{dt} = 12t - 3t^2$

for $v = 0$ $\quad 12t = 3t^2$

$t = \dfrac{12}{3} = 4\,s$

3. (b) 4. (b) 5. (c)

6. (c) $\text{Average speed} = \dfrac{\text{Total distance travelled}}{\text{Total time taken}}$

If L is the total distance travelled.

Time taken to cover half the distance

$= t_1 = \dfrac{\frac{L}{2}}{V_1}$

time taken to cover test half the distance

$= t_2 = \dfrac{\frac{L}{2}}{V_2}$

$\therefore$ Average speed $= \dfrac{\dfrac{L}{2}+\dfrac{L}{2}}{\dfrac{L}{2V_1}+\dfrac{L}{2V_2}}$

$$= \frac{2\dfrac{L}{2}}{\dfrac{L}{2}\left(\dfrac{V_1+V_2}{V_1V_2}\right)} = \frac{2V_1V_2}{V_1+V_2}$$

7. **(c)** **8.** **(d)** **9.** **(a)**

10. **(c)** **Given :** Velocity

$V = At + Bt^2 \Rightarrow \dfrac{dx}{dt} = At + Bt^2$

By integrating we get distance travelled

$$\Rightarrow \int_0^x dx = \int_1^2 \left(At + Bt^2\right)dt$$

Distance travelled by the particle between 1s and 2s

$$x = \frac{A}{2}\left(2^2 - 1^2\right) + \frac{B}{3}\left(2^3 - 1^3\right) = \frac{3A}{2} + \frac{7B}{3}$$

11. **(b)** The slope of velocity-time graph denotes acceleration. For a retarded motion acceleration is negative.

12. **(c)** Area of acceleration-displacement curve

$$A = \int_{x_1}^{x_2} a\,dx = \int_{x_1}^{x_2} \frac{dv}{dt}\,dx \left[a = \frac{dv}{dt},\ v = \frac{dx}{dt}\right]$$

$$A = \int_u^v v\,dv = \frac{1}{2}[v^2 - u^2]$$

$$A = \frac{1}{2}\frac{m[v^2-u^2]}{m}$$

= Change in K.E. per unit mass.

13. **(c)**

14. **(a)** $\dfrac{D_4}{D_3} = \dfrac{0+\dfrac{a}{2}(2\times4-1)}{0+\dfrac{a}{2}(2\times3-1)} = \dfrac{7}{5}$

15. **(c)** The speed of an object, falling freely due to gravity, depends only on its height and not on its mass. Since the paths are frictionless and all the objects fall through the same height, therefore, their speeds on reaching the ground will be in the ratio of 1 : 1 : 1.

16. **(c)** Displacement

$s = 3t^3 + 7t^2 + 5t + 8$;

Velocity $= \dfrac{ds}{dt} = 9t^2 + 14t + 5$

Acceleration $= \dfrac{d^2s}{dt^2} = 18t + 14$

Acceleration at (t = 1s)

$= 18\times1+14 = 18 + 14 = 32$ m/s^2

17. **(a)**

18. **(c)** Let t_1 & t_2 be the time taken by A and B respectively to reach the ground then from the formula,

$h = \dfrac{1}{2}gt^2$,

For first body, $16 = \dfrac{1}{2}g{t_1}^2$

For second body, $25 = \dfrac{1}{2}g{t_2}^2$

$\therefore \dfrac{16}{25} = \dfrac{{t_1}^2}{{t_2}^2} \Rightarrow \dfrac{t_1}{t_2} = \dfrac{4}{5}$.

19. **(a)** $x = \dfrac{1}{t+5}$

$\therefore v = \dfrac{dx}{dt} = \dfrac{-1}{(t+5)^2}$

$\therefore a = \dfrac{d^2x}{dt^2} = \dfrac{2}{(t+5)^3} = 2x^3$

Now $\dfrac{1}{(t+5)} \propto v^{\frac{1}{2}}$

$\therefore \dfrac{1}{(t+5)^3} \propto v^{\frac{3}{2}} \propto a$

20. **(a)** $\because$ $h = \dfrac{1}{2}gt^2$

$\therefore$ $h_1 = \dfrac{1}{2}g(5)^2 = 125$

$h_1 + h_2 = \dfrac{1}{2}g(10)^2 = 500$

$\Rightarrow$ $h_2 = 375$

$h_1 + h_2 + h_3 = \dfrac{1}{2}g(15)^2 = 1125$

$\Rightarrow$ $h_3 = 625$

$h_2 = 3h_1$, $h_3 = 5h_1$

or $h_1 = \dfrac{h_2}{3} = \dfrac{h_3}{5}$

Diagram Based Questions

1. **(d)**
2. **(a)** $v^2 = u^2 + 2as$
$400 > 2a(100) : a < 2$
3. **(c)**
4. **(c)** Let v be velocity of wind and u be velocity of each train.
Rel. vel. of one train w.r.t. wind = 2 × Rel. vel. of other train w.r.t. wind
$u + v = 2(u - v)$
$v + 2v = 2u - u = u.$
i.e., $u = 3v.$
5. **(e)** From displacement-time graph, it is clear that in equal intervals of time displacements are not equal infact, decreases and after 40s displacement constant i.e. the particle stops.
6. **(c)** Speed, V = constant (from question)
Centripetal acceleration,
$$a = \frac{V^2}{r}$$
ra = constant
Hence graph **(c)** correctly describes relation between acceleration and radius.

Assertion/ Reason

1. **(d)** Speedometer measures instantaneous speed of automobile.
2. **(a)** Since velocity is a vector quantity, hence as its direction changes keeping magnitude constant, velocity is said to be changed. But for constant speed in equal time interval distance travelled should be equal.
3. **(c)** Negative slope of position time graph represents that the body is moving towards the negative direction and if the slope of the graph decrease with time then it represents the decrease in speed i.e. retardation in motion.
4. **(c)** If the position-time graph of a body moving uniformly in a straight line parallel to position axis, it means that the position of body is changing at constant time. The statement is abrupt and shows that the velocity of body is infinite.
5. **(c)** In uniform motion the speed is same at each instant of motion.
6. **(a)** In uniform circular motion, there is acceleration of constant magnitude.
7. **(d)** Equation of motion can be applied if the acceleration is in opposite direction to that of velocity and uniform motion mean the acceleration is zero.
8. **(b)** A body having positive acceleration can be associated with slowing down, as time rate of change of velocity decreases, but velocity increases with time.
9. **(d)** When a body falling freely, only gravitational force acts on it in vertically downward direction. Due to this downward acceleration the velocity of a body increases and will be maximum when the body touches the ground.
10. **(a)** A body has no relative motion with respect to itself. Hence, if a frame of reference of body is fixed, then the body will be always at relative rest in this frame of reference.

Matching Based Questions

1. **(c)** 2. **(a)** 3. **(d)** 4. **(a)** 5. **(c)**
6. **(a)** 7. **(c)**

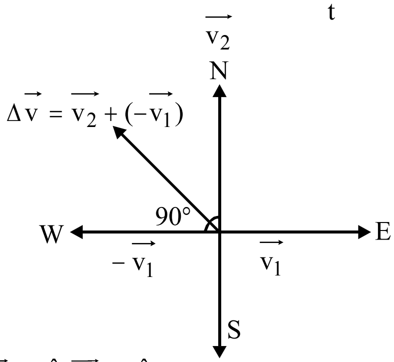
Critical Thinking Type Questions

1. **(d)** Let the total distance be d. Then for first half distance, time = $\frac{d}{2v_0}$, next distance. = $v_1 t$
and last half distance = $v_2 t$
$$\therefore \ v_1 t + v_2 t = \frac{d}{2}; \quad t = \frac{d}{2(v_1 + v_2)}$$
Now average speed
$$t = \frac{d}{\frac{d}{2v_0} + \frac{d}{2(v_1+v_2)} + \frac{d}{2(v_1+v_2)}}$$
$$= \frac{2v_0(v_1+v_2)}{(v_1+v_2)+2v_0}$$
2. **(c)** When particle comes to rest,
$$V = 0 = \frac{dx}{dt} = \frac{d}{dt}(40 + 12t - t^3)$$
$\Rightarrow \ 12 - 3t^2 = 0$
$$\Rightarrow \ t^2 = \frac{12}{3} = 4 \ \therefore t = 2 \text{ sec}$$
Therefore distance travelled by particle before coming to rest,
$x = 40 + 12t - t^3 = 40 + 12 \times 2 - (2)^3 = 56m$
3. **(a)** $\frac{dv}{dt} = -kv^3$ or $\frac{dv}{v^3} = -k\ dt$
Integrating we get, $-\frac{1}{2v^2} = -kt + c$ ...(1)
At t = 0, v = v_0 $\therefore -\frac{1}{2v_0^2} = c$
Putting in (1)
$$-\frac{1}{2v^2} = -kt - \frac{1}{2v_0^2} \text{ or } \frac{1}{2v_0^2} - \frac{1}{2v^2} = -kt$$
$$\text{or} \left[\frac{1}{2v_0^2} + kt\right] = \frac{1}{2v^2} \text{ or } \left[1 + 2v_0^2\ kt\right] = \frac{v_0^2}{v^2}$$

or $v^2 = \dfrac{v_0^2}{1+2v_0^2 kt}$ or $v = \dfrac{v_0}{\sqrt{1+2v_0^2 kt}}$

4. **(c)** Average acceleration $= \dfrac{\text{change in velocity}}{\text{time interval}}$

$$= \frac{\Delta \vec{v}}{t}$$



$\vec{v_1} = 5\hat{i}, \vec{v_2} = 5\hat{j}$

$\Delta\vec{v} = (\vec{v}_2 - \vec{v}_1) = \sqrt{v_1^2 + v_2^2 + 2v_1 v_2 \cos 90}$

$= \sqrt{5^2 + 5^2 + 0}$ [As $|v_1| = |v_2| = 5$ m/s]

$= 5\sqrt{2}$ m/s

Avg. acc. $= \dfrac{\Delta\vec{v}}{t} = \dfrac{5\sqrt{2}}{10} = \dfrac{1}{\sqrt{2}}$ m/s^2

$\tan\theta = \dfrac{5}{-5} = -1$

which means θ is in the second quadrant. (towards north-west)

5. **(a)** $\dfrac{dv}{dt} = -2.5\sqrt{v} \Rightarrow \dfrac{dv}{\sqrt{v}} = -2.5\,dt$

Integrating,

$$\int_{6.25}^{0} v^{-1/2} dv = -2.5\int_0^t dt \Rightarrow \left[\frac{v^{+1/2}}{(1/2)}\right]_{6.25}^{0} = -2.5[t]_0^t$$

$\Rightarrow -2(6.25)^{1/2} = -2.5t \Rightarrow t = 2$ sec

6. **(a)** $h = ut_1 - \dfrac{1}{2}gt_1^2$

Also $h = ut_2 - \dfrac{1}{2}gt_2^2$

After simplify above equations, we get

$$h = \frac{1}{2}gt_1t_2.$$

7. **(d)** Let the car accelerates for a time t_1 and travels a distance s_1. Suppose the maximum velocity attained by the car be v. Then

$s_1 = \dfrac{1}{2}\alpha t_1^2$ and $v = \alpha t_1$, $t_1 = v/\alpha$,

$\therefore s_1 = \dfrac{1}{2} \times \alpha \times (v^2/\alpha^2) = \dfrac{v^2}{2\alpha}$ ...(1)

Let the car decelerates for a time t_2 and travels a distances s_2. Then

$s_2 = vt_2 - \dfrac{1}{2}\beta t_2^2$ and $0 = v - \beta t_2$ or $t_2 = \dfrac{v}{\beta}$

$\therefore s_2 = v \times \left(\dfrac{v}{\beta}\right) - \dfrac{1}{2}\beta\left(\dfrac{v^2}{\beta^2}\right)$

or $s_2 = \dfrac{v^2}{\beta} - \dfrac{v^2}{2\beta} = \dfrac{v^2}{2\beta}$ ...(2)

As per question,

Let max. velocity is v

then $v = \alpha t_1$ & $v - \beta t_2 = 0$, where $t = t_1 + t_2$

Now $t_1 + t_2 = t$ or $\dfrac{v}{\alpha} + \dfrac{v}{\beta} = t$

$\therefore v = \dfrac{t}{\left(\dfrac{1}{\alpha} + \dfrac{1}{\beta}\right)} = \left(\dfrac{\alpha\beta}{\alpha+\beta}\right)t$ and

$s = s_1 + s_2 = \dfrac{v^2}{2\alpha} + \dfrac{v^2}{2\beta} = \dfrac{v^2}{2}\left(\dfrac{1}{\alpha} + \dfrac{1}{\beta}\right)$

8. **(a)** According to question,

$V(x) = bx^{-2n}$

So, $\dfrac{dv}{dx} = -2nb\,x^{-2n-1}$

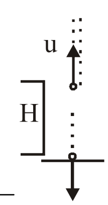
Acceleration of the particle as function of x,

$a = v\dfrac{dv}{dx} = bx^{-2n}\left\{b(-2n)x^{-2n-1}\right\}$

$= -2nb^2x^{-4n-1}$

9. **(c)** Speed on reaching ground

$v = \sqrt{u^2 + 2gh}$



Now, $v = u + at \Rightarrow \sqrt{u^2 + 2gh} = -u + gt$

Time taken to reach highest point is $t = \dfrac{u}{g}$,

$\Rightarrow t = \dfrac{u + \sqrt{u^2 + 2gH}}{g} = \dfrac{nu}{g}$ (from question)

$\Rightarrow 2gH = n(n-2)u^2$

3 Motion in a Plane

Fill in the Blanks

1. Three;
The resultant of any three vectors will be cancel out.
2. $V_y = u \sin\theta - gt_m = 0$
$\therefore t_m = \dfrac{u_y \sin\theta}{g}$ (time to reach the maximum height)
Total time of flight $T_f = \dfrac{2(u \sin\theta)}{g}$
$\therefore T_f = 2t_m$
3. ($u \cos\theta$) Only horizontal component of velocity
4. At the highest point of trajectory, the acceleration is equal to g.
5. Centripetal force
6. Perpendicular to each other.
In uniform circular motion speed is constant. So, no tangential acceleration.
It has only radial acceleration $a_R = \dfrac{v^2}{R}$ [directed towards center] and its velocity is always in tangential direction. So these two are perpendicular to each other.
7. Kinetic energy.

True/ False

1. True,
When the two balls are thrown vertically upwards with the same speed u then their final speed v at the point of projection is $v^2 - u^2 = 2 \times g \times s$
Here, $s = 0$
$\therefore$ $v = u$ for both the cases
2. True,
T.E. = P.E. + K.E.
T.E. = Constant
At top, K.E. is minimum and P.E. is maximum. Since K.E. is minimum speed is also minimum.
3. False, The pressure exerted will be different because one train is moving in the direction of earth's rotation and other in the opposite direction.
4. Flase, In projectile motion, the horizontal range is independent of the mass
5. False, Depends on the angle of projection according to the relation: $R = \dfrac{u^2 \sin 2\theta}{g}$
6. True
7. True, Centripetal acceleration has a constant magnitude and is always directed towards the centre.

Conceptual MCQs

1. **(c)** The acceleration of the particle must be in the plane of motion of a two dimensional motion if speed is a positive constant.
2. **(b)** Given, $u_1 = u_2 = u$, $\theta_1 = 60°, \theta_2 = 30°$
In 1st case, we know that range
$$R_1 = \frac{u^2 \sin 2(60°)}{g} = \frac{u^2 \sin 120°}{g}$$
$$= \frac{u^2 \sin(90° + 30°)}{g}$$
$$= \frac{u^2 (\cos 30°)}{g} = \frac{\sqrt{3}u^2}{2g}$$
In 2nd case, when $\theta_2 = 30°$, then
$$R_2 = \frac{u^2 \sin 60°}{g} = \frac{u^2\sqrt{3}}{2g} \Rightarrow R_1 = R_2$$
[we get same value of ranges].
3. **(b)**
4. **(a)** Minimum speed with which the string is rotating in a vertical circle (v) = $\sqrt{gr}$
The minimum speed of stone is independent of mass of stone.
5. **(d)** 6. **(b)**
7. **(a)** Horizontal velocity of a projectile is not affected by gravity.
8. **(b)** $\omega = \dfrac{2\pi n}{t} = \dfrac{2\pi \times 120}{60\text{ s}}$
9. **(a)** Velocity at A, $\vec{v} = v\,\hat{j}$
Velocity at B, $\vec{v}_2 = -v\,\hat{i}$
Change in velocity,
$$\Delta\vec{v} = \vec{v}_2 - \vec{v}_1 = -v\,\hat{i} - v\,\hat{j}$$
$$|\Delta\vec{v}| = \sqrt{(-v)^2 + (-v)^2} = v\sqrt{2}.$$
10. **(c)** $\sqrt{0.5^2 + 0.8^2 + c^2} = 1$
or $c = \sqrt{1 - 0.89} = \sqrt{0.11}$
11. **(c)** For two perpendicular vectors,
$\vec{A}.\vec{B} = AB\cos 90° = 0.$

12. (c) Initially, both particles have zero vertical velocity. So, both particles take same time to fall through same height.

13. (c) The resultant of $\vec{A} \times 0$ is a vector of zero magnitude. The product of a vector with a scalar gives a vector.

14. (c) $|\vec{a}+\vec{b}|^2 = |\vec{a}-\vec{b}|^2$

$\Rightarrow |a|^2+|b|^2+2\vec{a}.\vec{b} = |a|^2+|b|^2-2\vec{a}.\vec{b}$

15. (b) Scalar product is distributive over addition.

16. (a) In circular motion of a particle with constant speed, particle repeats its motion after a regular interval of time but does not oscillate about a fixed point. So, motion of particle is periodic but not simple harmonic.

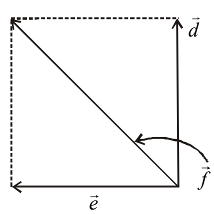
17. (b) $v_r = \sqrt{v_R{}^2 - v_B^2} = \sqrt{10^2-8^2} = 6\ \text{km h}^{-1}$

18. (c) **19. (b)** **20. (c)**

21. (d) (45° – θ) & (45° + θ) are complementary angles as 45° – θ + 45° + θ = 90°. We know that if angle of projection of two projectiles make complementary angles, their ranges are equal. In this case also, the range will be same. So the ratio is 1 : 1.

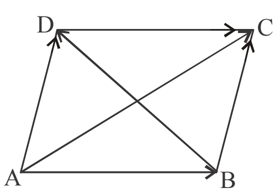
Diagram Based Questions

1. (c) Using the law of vector addition, $(\vec{d}+\vec{e})$ is as shown in the fig.



$\therefore\ \vec{d}+\vec{e}=\vec{f}$

2. (a)



$\overrightarrow{AC}+\overrightarrow{BD}=(\overrightarrow{AB}+\overrightarrow{BC})+(\overrightarrow{BC}+\overrightarrow{CD})$

$= \overrightarrow{AB}+2\overrightarrow{BC}+\overrightarrow{CD}$

$= \overrightarrow{AB}+2\overrightarrow{BC}-\overrightarrow{AB}$

$= 2\overrightarrow{BC}$

3. (b) Two bodies will collide at the highest point if both cover the same vertical height in the same time.

So $\dfrac{V_1^2\sin^2 30°}{2\cancel{g}} = \dfrac{V_2^2}{2\cancel{g}} \Rightarrow \dfrac{V_2}{V_1} = \sin 30° = \dfrac{1}{2}$

$\therefore\quad V_2 = \dfrac{1}{2}V_1$

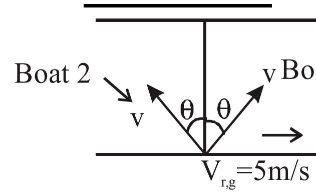
4. (b) At point B the direction of velocity component of the projectile along Y - axis reverses.

Hence, $\vec{V}_B = 2\hat{i}-3\hat{j}$

5. (c) $a = \dfrac{v^2}{r}$ = 1 cm/s. Centripetal acceleration is directed towards the centre. Its magnitude = 1. Unit vector at the mid point on the path between P and Q is $-(\hat{x}+\hat{y})/\sqrt{2}$.

Assertion/ Reason

1. (b)



If component of velocities of boat relative to river is same normal to river flow (as shown in figure) both boats reach other bank simultaneously.

2. (b) $h = ut - \dfrac{1}{2}gt^2$ and $v^2 = u^2 - 2gh$;

These equations are independent of mass.

3. (b) When a body is projected up making an angle θ the velocity component along-axis remains constant.

∴ Momentum along x-axis is constant.

Along horizontal, mass and velocity both are constant.

4. (a) $R = \dfrac{u^2\sin 2\theta}{g}$ If θ = 45° + α then

$R_1 = \dfrac{u^2\sin 2(45°+\alpha)}{g} = \dfrac{u^2\sin(90°+\alpha)}{g}$

$= \dfrac{u^2\cos\alpha}{g}$

If θ = 45° – α then

$R_2 = \dfrac{u^2\sin^2(45°-\alpha)}{g} = \dfrac{u^2\sin(90°-\alpha)}{g}$

$= \dfrac{u^2\cos\alpha}{g}$ $\therefore R_1 = R_2$

5. **(c)** If gravitational force is zero, then $a_y = 0$.
So, $x = u \cos\theta \, t$ and $y = u \sin\theta \, t$
$\therefore \quad y = x \tan\theta$.
It represent straight line.
The resultant path of the body depends on initial velocities and acceleration.

6. **(a)** For maximum height $\theta = 90°$, or body must be projected straight upwards. Then
$$0 = u^2 - 2gh,$$
$$\therefore \quad h = \frac{u^2}{2g}.$$

7. **(d)** $T = \dfrac{2u\sin\theta}{g}$, it will maximum, when $\theta = 0°$.
$$R_{max} = \frac{u^2}{g}, \text{ for } \theta = 45°.$$

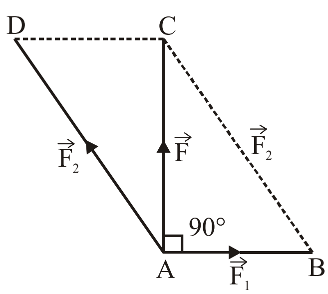
8. **(d)** At the highest point of the trajectory,
$v_y = 0$, and
so, $\vec{P}_y = 0$.
For the two pieces, it is
$$\vec{P}_{1y} + \vec{P}_{2y} = 0.$$

Matching Based Questions

1. **(a)** **2.** **(b)** **3.** **(a)** **4.** **(b)** **5.** **(c)**
6. **(a)**

Critical Thinking Type Questions

1. **(d)**



In ΔABC,
$$F_2^2 = F^2 + F_1^2 \text{ or } F^2 = F_2^2 - F_1^2$$
$$\left(8\sqrt{3}\right)^2 = F_2^2 - F_1^2$$
$192 = (F_2 + F_1)(F_2 - F_1)$
$$F_2 - F_1 = \frac{192}{16} = 12\text{N} \quad [\because F_1 + F_2 = 16\text{N}]$$
On solving we get,
$F_1 = 2\text{N}$, $F_2 = 14$ N

2. **(b)** $y = bx^2$
Differentiating w.r.t to t an both sides, we get
$$\frac{dy}{dx} = b2x\frac{dx}{dt}$$
$v_y = 2bxv_x$
Again differentiating w.r.t to t on both sides we get
$$\frac{dv_y}{dt} = 2bv_x\frac{dx}{dt} + 2bx\frac{dv_x}{dt} = 2bv_x^2 + 0$$
$[\dfrac{dv_x}{dt} = 0$, because the particle has constant acceleration along y-direction]
$$\text{Now, } \frac{dv_y}{dt} = a = 2bv_x^2; \; v_x^2 = \frac{a}{2b}$$
$$v_x = \sqrt{\frac{a}{2b}}$$

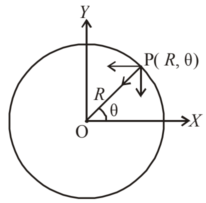
3. **(c)** For projectile A
$$\text{Maximum height, } H_A = \frac{u_A^2 \sin^2 45°}{2g}$$
For projectile B
$$\text{Maximum height, } H_B = \frac{u_B^2 \sin^2\theta}{2g}$$
As we know, $H_A = H_B$
$$\frac{u_A^2 \sin^2 45°}{2g} = \frac{u_B^2 \sin^2\theta}{2g}$$
$$\frac{\sin^2\theta}{\sin^2 45°} = \frac{u_A^2}{u_B^2}$$
$$\sin^2\theta = \left(\frac{u_A}{u_B}\right)^2 \sin^2 45°$$
$$\sin^2\theta = \left(\frac{1}{\sqrt{2}}\right)^2\left(\frac{1}{\sqrt{2}}\right)^2 = \frac{1}{4}$$
$$\sin\theta = \frac{1}{2} \Rightarrow \theta = \sin^{-1}\left(\frac{1}{2}\right) = 30°$$

4. **(a)** Horizontal range $= \dfrac{u^2\sin 2\theta}{g}$ so $g \propto u^2$
$$\text{or} \quad \frac{g_{planet}}{g_{earth}} = \frac{(u_{planet})^2}{(u_{earth})^2}$$
$$\text{Therefore } g_{planet} = \left(\frac{3}{5}\right)^2 (9.8 \text{ m/s}^2)$$
$= 3.5$ m/s^2

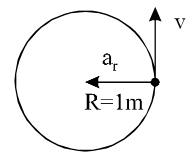
5. **(c)** Clearly

$$\vec{a} = a_c \cos\theta(-\hat{i}) \;\; + a_c \sin\theta(-\hat{j})$$

$$= \quad \frac{-v^2}{R}\cos\theta\,\hat{i} - \frac{v^2}{R}\sin\theta\,\hat{j}$$



6. **(a)** $a_r \;\; = \omega^2 R$



$$a_r = (2\pi 2)^2 R = 4\pi^2 2^2 R = 4\pi^2\left(\frac{22}{44}\right)^2 (1)$$

$$\left[\because v = \frac{22}{44}\right]$$

$$a_t = \frac{dv}{dt} = 0$$

$a_{net} = a_r = \pi^2$ ms^{-2} and direction along the radius towards the centre.

4 Laws of Motion

Fill in the Blanks

1. Change in momentum
Impulse = Force × time duration.
According to Newton's second law

$$\text{Force} = \frac{\text{Change in momentum}}{\text{time duration}}$$

∴ Force × time = change in momentum
i.e., Impulse = change is momentum.

2. Impulse

3. Third law of motion,
Swimming is a result of pushing water in the opposite direction of the motion.

4. Velocity,

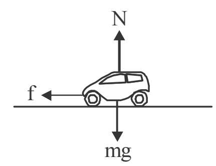
5. Conservation of linear momentum.

6. Normal reaction, and force of friction

$$\text{Coefficient of static friction} = \frac{\text{force of friction}}{\text{normal reaction}}$$

7. Unchanged,
Coefficient of friction is independent of normal force.

8. Component of force of friction between road and tyres.
Normal reaction N = weight mg thus the centripetal force required by the car for circular motion is provided by the component of the force of friction b/w the road and the car tyres.



True/ False

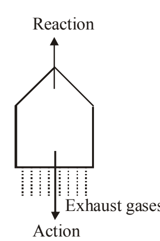
1. False,
Newton's laws of motion are applicable only for inertial frames. All refrence frames present on surface of earth are supposed to be inertial frame of refrence.

2. True **3.** True

4. True,
According to third law of motion bullet experiences a force F then, gun experiences an equal and opposite force F. According to second law, FΔt is change in momentum of the bullet, then – FΔt is change in momentum of the gun. Since initially both are at rest, the final momentum = 0. ∴ $P_b + P_g = 0$. Thus the total momentum of (bullet + gun) is conserved.

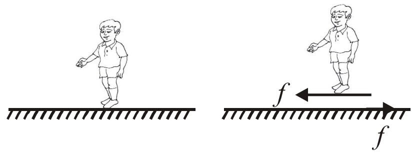
5. True

6. False,
The rocket moves forward when the exhaust gases are thrown backward.
Here exhaust gases thrown backwards is action and rocket moving forward is reaction.



This phenomenon takes place in the absence of air as well.

7. True,
Friction force opposes the relative motion of the surface of contact.
When a person walks on a rough surface, the foot is the surface of contact. When he pushes the foot backward, the motion of surface of contact tends to be backwards. Therefore the frictional force will act forward (in the direction of motion of the person)

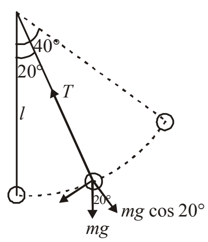


8. True,
As the angular amplitude of the pendulum is 40°, the bob will be in the mid of the equilibrium position and the extreme position as shown in the figure

For equilibrium of the bob, $T - mg\cos 20° = \frac{mv^2}{l}$,

where l is the length of the pendulum and is the velocity of the bob.

$\therefore \quad T = mg\cos 20° + \frac{mv^2}{l}$

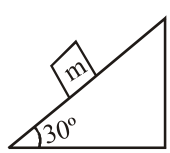


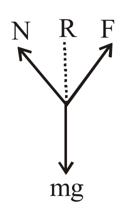
$\frac{mv^2}{l}$ is always a positive quantity.

Hence, $T > mg\cos 20°$.

Conceptual MCQs

1. **(a)** As the block is at rest, the net contact force on the block i.e. resultant of friction and normal reaction must balance the weight of the block. Hence R = mg = 20N





2. **(c)** Centrifugal force is a pseudo force which appears to act on an object when observed from a rotating frame of reference. It always acts away from the centre of circular path.

3. **(c)** Friction does not depend on the area of contact.

4. **(c)** Velocity of the rocket (u) = 300 m/s and force (F) = 345N. Rate of combustion of fuel

$$\left(\frac{dm}{dt}\right) = \frac{F}{u} = 1.15\,\text{kg/sec}$$

5. **(c)** On increasing smoothness, friction first decreases and then increases.

6. **(b)** Centripetal force always acts perpendicular to the direction of motion, hence it can change direction of motion, of the body but not its speed. Again as direction of centripetal force is different at different positions, it is never constant.

7. **(d)** The horse exerts a backward force on the earth as a result, earth exerts a forward force on the horse and cause horse to move forward.

8. **(c)** Action and reaction always act on different bodies.

9. **(a)** Action and reaction forces are always of same nature.

10. **(a)** Static friction is self adjusting in nature.

11. **(c)** Friction always apposes relative motion between surfaces in contact and hence can act in any direction to oppose the relative motion.

12. **(c)** As the net force acting on the body is zero, either no force should act on the body or at least two forces should be acting on it.

13. **(a)** Direction of impulse is same as that of the net force.

14. **(a)** By Newton's third law of motion, the tension in the rope must be equal to the force applied by the monkey on the rope.

15. **(c)** Friction provides centripetal force to the coin, hence acts towards the centre of the disc.

16. **(b)** Net force experienced $= \frac{\text{Total Impulse}}{\text{Time taken}}$

$$= \frac{m\Delta v}{t} = 0.15 \times \frac{20}{0.1} = 30N$$

17. **(c)** $a = \frac{F - \mu R}{m} = \frac{100 - 0.5 \times (10 \times 10)}{10} = 5\,\text{ms}^{-2}$

18. **(a)** Net force, F = T – mg

ma = T – mg

2000 a = 28000 – 20000 = 8000

$$a = \frac{8000}{2000} = 4\,\text{ms}^{-2} \uparrow$$

19. **(d)** Given; speed = 10 m/s; radius r = 10 m
Angle made by the wire with the vertical

$$\tan\theta = \frac{v^2}{rg} = \frac{10^2}{10 \times 10} = 1$$

$$\Rightarrow \theta = 45° = \frac{\pi}{4}$$

20. **(a)** $F = \frac{d(Mv)}{dt} = M\frac{dv}{dt} + v\frac{dM}{dt}$

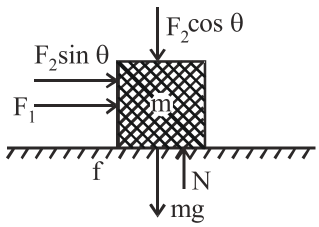
$\therefore$ v is constant,

$\therefore\ F = v\frac{dM}{dt}$ But $\frac{dM}{dt} = Mkg/s$

$\therefore$ F = vM newton.

Diagram Based Questions

1. **(a)** Here, on resolving force F_2 and applying the concept of equilibrium



$N = mg + F_2\cos\theta$, and $f = \mu N$

$\therefore\ f = \mu[mg + F_2\cos\theta]$ ... (i)

Also $f = F_1 + F_2\sin\theta$ ... (ii)

From (i) and (ii)

$\mu[mg + F_2\cos\theta] = F_1 + F_2\sin\theta$

$\Rightarrow \mu = \frac{F_1 + F_2\sin\theta}{mg + F_2\cos\theta}$

2. **(d)** Case **(a)**

$(P_x)_i = mu$

P_y(initial) = 0

$(P_x)_f = f = -mu$

P_y(final) = 0

Impulse = $\Delta P = -2mu$ (along x –axis)

Impulse = 0 along y–axis

parallaly in case **(b)**

$(P_x)_i = mu\cos30°$

$(P_y)_i = -mu\sin30°$

$(P_x)_f = f = -mu\cos30°$

$(P_y)_f = -mu\sin30°$

$\therefore$ Impulse = $-2mu\cos 30°$(along x-axis)

Impulse = 0 (along y–axis)

Force and impulse are in the same direction the force on wall due to the ball is normal to the wall along positive x–direction in both **(a)** & **(b)** case.

3. **(c)** Common acceleration of system is

$a = \frac{F}{m_1 + m_2 + m_3}$

$\therefore$ Force on m_3 is $F_3 = m_3 \times a$

$= \frac{m_3F}{m_1 + m_2 + m_3}$

4. **(c)** Acceleration

$= \frac{\text{Net force in the direction of motion}}{\text{Total mass of system}}$

$= \frac{m_1g - \mu(m_2 + m_3)g}{m_1 + m_2 + m_3} = \frac{g}{3}(1 - 2\mu)$

($\because$ $m_1 = m_2 = m_3 = m$ given)

5. **(c)** Change in momentum,

$\Delta p = \int F dt$

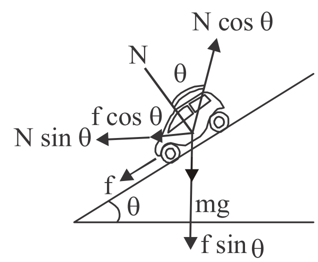
= Area of F-t graph

= ar of Δ – ar of ▭ + ar of ▭

$= \frac{1}{2} \times 2 \times 6 - 3 \times 2 + 4 \times 3$

= 12 N-s

6. **(a)**



Clearly form the figure, N sinθ and f cosθ contribute to the centripetal force.

$\therefore$ N sinθ + f cosθ = $\frac{mv^2}{R}$

Assertion/ Reason

1. **(a)** The force acting on the body of mass M are its weight *Mg* acting vertically downward and air resistance *F* acting vertically upward.

$\therefore$ Acceration of the body , $a = g - \frac{F}{M}$

Now M > m, therefore, the body with larger mass will have great acceleration and it will reach the ground first.

2. **(a)** On a rainy day, the roads are wet. Wetting of roads lowers the coefficient of friction between the types and the road. Therefore, grip on a road of car reduces and thus chances of skidding increases.

3. **(a)** Friction causes wear & tear and loss of energy, so it is an evil but without friction walking. Stopping a vehicle etc. would not be possible. So it is necessary for us.

4. **(c)** The assertion is true for a reason that when the car is driven at optimum speed. Then the normal reaction component is enough to provide the centripetal force.

5. **(b)** When a body is moving in a circle, its speed remains same but velocity changes due to change in the direction of motion of body. According to first law of motion, force is required to change the state of a body. As in circular motion the direction of velocity of body is changing so the acceleration cannot be zero. But for a uniform motion acceleration is zero (for rectilinear motion).

6. **(c)** In uniform circular motion, the direction of motion changes, therefore velocity changes. As P = mv therefore momentum of a body also changes uniform circular motion.

7. **(c)** The purpose of bending is to acquire centripetal force for circular motion. By doing so component of normal reaction will counter balance the centrifugal force.

Matching Based Questions

1. **(b)** **2.** **(a)** **3.** **(d)** **4.** **(b)** **5.** **(c)**

Critical Thinking Type Questions

1. **(d)** Angle of banking is $\tan\theta = \dfrac{v^2}{rg} = \dfrac{20^2}{40\sqrt{3}\times 10}$

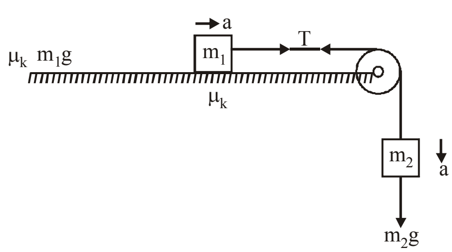
$$\tan\theta = \frac{1}{\sqrt{3}}$$

$\therefore \quad \theta = 30^\circ$

2. **(b)** For the motion of both the blocks

$m_1 a = T - \mu_k m_1 g$

$m_2 g - T = m_2 a$



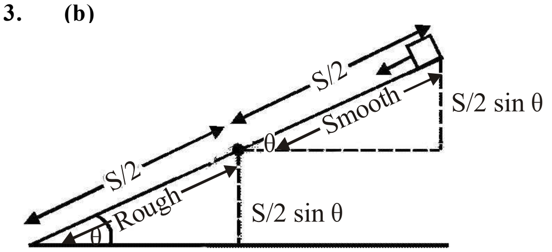
$$a = \frac{m_2 g - \mu_k\, m_1 g}{m_1 + m_2}$$

$$m_2 g - T = (m_2)\left(\frac{m_2 g - \mu_k\, m_1 g}{m_1 + m_2}\right)$$

solving we get tension in the string

$$T = \frac{m_1 m g\,(1 + \mu_k) g}{m_1 + m_2}$$

3. **(b)**



For upper half of inclined plane

$v^2 = u^2 + 2a\, S/2 = 2\,(g \sin\theta)\, S/2 = gS \sin\theta$

For lower half of inclined plane

$0 = u^2 + 2\,g\,(\sin\theta - \mu\cos\theta)\, S/2$

$\Rightarrow\; -gS\sin\theta = gS\,(\sin\theta - \mu\cos\theta)$

$\Rightarrow 2\sin\theta = \mu\cos\theta \Rightarrow \mu = \dfrac{2\sin\theta}{\cos\theta} = 2\tan\theta$

4. **(c)** Change in momentum of the ball

$= mv\sin\theta - (-\,mv\sin\theta)$

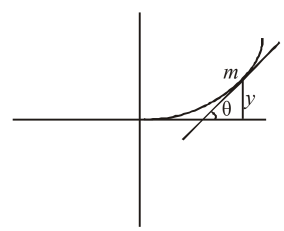
$= 2\,mv\sin\theta = mg \times \dfrac{2v\sin\theta}{g}$

= weight of the ball × total time of flight

5. **(a)** At limiting equilibrium,

$\mu = \tan\theta$

$\tan\theta = \mu = \dfrac{dy}{dx} = \dfrac{x^2}{2}$



(from question)

$\because$ Coefficient of friction $\mu = 0.5$

$\therefore \quad 0.5 = \dfrac{x^2}{2} \Rightarrow x = \pm 1$

Now, $y = \dfrac{x^3}{6} = \dfrac{1}{6} m$

6. **(c)** Tension at the highest point

$T_{top} = \dfrac{mv^2}{r} - mg = 2mg \quad (\because v_{top} = \sqrt{3gr}\,)$

Tension at the lowest point

$T_{bottom} = 2mg + 6mg = 8mg$

$\therefore \quad \dfrac{T_{top}}{T_{bottom}} = \dfrac{2mg}{8mg} = \dfrac{1}{4}.$

7. **(d)** $\because$ v = constant

so, a = 0, Hence, $F_{net} = ma = 0$

5 Work, Energy and Power

Fill in the Blanks

1. Kinetic energy; This is according to work-energy theorem i.e., Δ K.E. = W
2. Negative
3. Conservative force is negative gradient of potential

$$F(x) = \frac{-dV(x)}{dx}$$

4. Potential energy, The energy stored in spring in the form of elastic potential energy. i.e.,

$$(P.E)_{elastic} = \frac{1}{2}kx^2$$

Where x is compression or elongation of spring & k is spring constant.

5. F V
6. **1,** Since

$$e = \frac{-(v_1 - v_2)}{(u_2 - u_1)} = \frac{\text{velocity of separation}}{\text{velocity of approach}}$$

(i) For perfectly elastic collision e =1
(ii) For perfectly inelastic collision e = 0
(iii) For other collision 0 < e < 1

7. Perfectly inelastic, When the two bodies stick together after collision, then it is perfectly inelastic collision and in this case, the coefficient of restitution e is equal to zero.
8. At right angle to each other.

True/ False

1. True, If there were no friction, moving vehicles could not be stopped by looking the brakes.
2. False
3. True, When a bomb explodes; momentum is conserved K.E. changes and in uniform circular motion , K.E remains constant but momentum changes due to change in directions of motion.
4. True, In elastic collision, total momentum and kinetic energy will remain conserved.
5. True
6. True

Conceptual MCQs

1. **(a)** The magnitude of work done by a force depends on frame of reference.
2. **(c)** $W = \int_0^s F dx = \int_0^s (7 - 2x + 3x^2) dx$

$$= [7x - x^2 + x^3]_0^5 = 135J$$

3. **(b)** Work done by a conservative force is negative of change in P.E. of the body. Hence if work done by a conservative force is positive, its P.E. must decrease.
4. **(d)** $P = Fv$
as v = constant, $f = 0$
$\therefore\ P = 0$
5. **(a)** Friction force is non-conservative while all elastic forces are conservative.
6. **(c)** Work done by a non-conservative force in a round trip may be positive, negative or zero.
7. **(c)** By work-energy theorem
$W = \Delta k$
or $-Fs = -k$

or $S = \dfrac{k}{F}$

as both kinetic energy and retarding force are equal for the car and the truck, they must cover equal distance before coming to rest.
8. **(c)** K.E. at the highest point of trajectory,
$k' = k\cos^2\theta$
will be equal for both the balls hence their P.E will also be equal.
9. **(c)** During collision, the P.E of the colliding bodies increases due to deformation in the bodies, hence their K.E. decreases during the collision.
10. **(d)** Velocity of A after the collision is given by

$$V_1 = \frac{(m_1 - em_2)u_1}{m_1 + m_2} + \frac{(1+e)m_2 u_2}{m_1 + m_2}$$

Here e is coefficient of restitution.
Here, $m_1 = m_p = m_2 = m_3\ u = n\ u_2 = 0$

$$\therefore\ \frac{(m_A - em_B)u}{m_A + m_B} = 0$$

or $m_A = em_B$
but $e \le 1$
$\therefore\ m_A \le m_B$

11. **(d)** If the surface is rough, friction will act along the horizontal and hence horizontal component of its velocity will change.
12. **(c)** In inelastic collision, K.E. does not remain conserved. Also bodies may or may not stick to each other if the collision is obrtque but the total momentum remains conserved.

13. **(a)** $P = Fv$
For the inclined plane,
$F = mg\,(\sin\theta + m\cos\theta)$ is constant, hence P = constant.

14. **(b)** Common normal component of velocity of the ball will become zero, hence the ball will move along the incline.

15. **(d)** $$\frac{(\text{K.E})_1}{(\text{K.E})_2} = \frac{\frac{1}{2}m_1v_1^2}{\frac{1}{2}m_2v_2^2} = \frac{4}{1} \Rightarrow \frac{m_1v_1^2}{m_2v_2^2} = \frac{4}{1}$$

$$\Rightarrow \frac{(m_1v_1)^2}{(m_2v_2)^2}\frac{m_2}{m_1} = \frac{4}{1} \Rightarrow \frac{p_1^2}{p_2^2}\times\frac{m_2}{m_1} = \frac{4}{1}$$

$$\frac{m_2}{m_1} = \frac{4\times p_2^2}{1\times p_1^2} = \frac{4}{1}\times 1 \Rightarrow \frac{m_1}{m_2} = \frac{1}{4}$$

[Given: $p_1 = p_2$]

16. **(b)** From conservation of linear momentum
$m_1v_1 + m_2v_2 = 0$

$$v_2 = \left(\frac{-m_1}{m_2}\right)v_1 = \left(\frac{-18}{12}\right)6 = -9\text{ms}^{-1}$$

$$\text{K.E.} = \frac{1}{2}m_2v_2^2 = \frac{1}{2}\times 12\times 9^2 = 486\text{ J}$$

17. **(a)** Given, h = 60m, g = 10 ms^{-2},
Rate of flow of water = 15 kg/s
∴ Power of the falling water
= 15 kgs^{-1} × 10 ms^{-2} × 60 m = 900 watt.
Loss in energy due to friction

$$= 9000\times\frac{10}{100} = 900\text{ watt.}$$

∴ Power generated by the turbine
= (9000 – 900) watt = 8100 watt = 8.1 kW

18. **(a)** Clearly $v_1 = 2$ ms^{-1}, $v_2 = 0$
$m_1 = m$ (say), $m_2 = 2m$
$v_1' = ?$, $v_2' = ?$

$$e = \frac{v_1' - v_2'}{v_2 - v_1} \qquad \text{....(i)}$$

By conservation of momentum,
$2m = mv_1' + 2mv_2'$ ... (ii)
From (i),

$$0.5 = \frac{v_2' - v_1'}{2}$$

∴ $v_2' = 1 + v_1'$
From (ii),
$2 = v_1' + 2 + 2v_1'$
⇒ $v_1 = 0$ and $v_2 = 1$ ms^{-1}

19. **(d)** As the particle is moving in a potential energy region.
∴ Kinetic energy ≥ 0
And, total energy E = K.E. + P.E.
⇒ $U(x) \le E$

20. **(b)** From conservation law of momentum, before collision and after collision linear momentum (p) will be same. That is,
initial momentum = final momentum.
⇒ $0 = m_1v_1 - m_2v_2 \Rightarrow m_1v_1 = m_2v_2$
$p_1 = p_2$

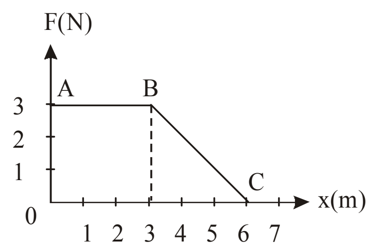
Now, $E = \dfrac{p^2}{2m}$

$$\therefore \frac{E_1}{E_2} = \frac{p_1^2}{2m_1}\times\frac{2m_2}{P_2^2}$$

$$\Rightarrow \frac{E_1}{E_2} = \frac{m_2}{m_1} \quad [p_1 = p_2]$$

Diagram Based Questions

1. **(b)**



Work done = area under F-x graph

= area of trapezium OABC = $\dfrac{1}{2}(3+6)(3)$

= 13.5 J

2. **(a)** $\vec{F} = -5\hat{i} + 9\cos 60°\hat{i} + 9\sin 60°\hat{j} - 3\hat{j}$

$$= -5\hat{i} + \frac{9}{2}\hat{i} + \frac{9\sqrt{3}}{2}\hat{j} - 3\hat{j}$$

$$= -\frac{\hat{i}}{2} + \left(\frac{9\sqrt{3}}{2} - 3\right)\hat{j}$$

$\vec{s} = -3\hat{i}$.

$$W = \vec{F}.\vec{s} = \left[-\frac{\hat{i}}{2} + \left(\frac{9\sqrt{3}}{2} - 3\right)\hat{j}\right].(-3\hat{i})$$

= 1.5 J.

3. **(a)** $U = -\int_0^x Fdx = -\int_0^x kxdx = -\frac{1}{2}kx^2$.
It is correctly drawn in **(a)**

4. **(a)** As the floor exerts a force on the ball along the normal, & no force parallel to the surface, therefore the velocity component along the parallel to the floor remains constant. Hence V sin θ = V' sin θ'.

5. **(b)** When $m_1 > m_2$ & m_2 at rest then the bodies collide in elastically and move together as one body without changing the direction.

6. **(d)** Work done $= \int Fdx$

Assertion/ Reason

1. **(a)** Both reason and assertion are true and reason is the correct explanation of the assertion.

2. **(a)** Power $= \dfrac{W}{t} = \dfrac{K}{1/n} = nK$

3. **(d)** Work done and power developed one-zero in uniform circular motion only.

4. **(d)** Total momentum and total energy both are conserved in an inelastic collision. It is the K.E. which changes.

5. **(d)** Maximum energy loss $= \dfrac{P^2}{2m} - \dfrac{P^2}{2(m+M)}$

$$\left[\because \text{K.E.} = \frac{P^2}{2m} = \frac{1}{2}mv^2\right]$$

$$= \frac{P^2}{2m}\left[\frac{M}{(m+M)}\right] = \frac{1}{2}mv^2\left\{\frac{M}{m+M}\right\}$$

Reason is a case of perfectly inelastic collision. By comparing the equation given in Assertion with above equation, we get

$$f = \left(\frac{M}{m+M}\right) \text{ instead of } \left(\frac{m}{M+m}\right)$$

Hence Assertion is wrong and Reason is correct.

6. **(d)** The billiard balls in an elastic collision are in a deformed state. Their total energy is partly kinetic and partly potential. So K.E. is less than the total energy. The energy spent against friction is dissipated as heat which is not available for doing work.

7. **(c)** K.E. can be increased or decreased without applying any external force, as internal forces can do work e.g., explosion of a bomb.

8. **(d)** Potential energy $U = \dfrac{1}{2}kx^2$ *i.e.* $U \propto x^2$

This is a equation of parabola, so graph between U and x is a parabola not a straight line.

Matching Based Questions

1. **(b)** 2. **(b)** 3. **(a)** 4. **(c)** 5. **(d)**

Critical Thinking Type Questions

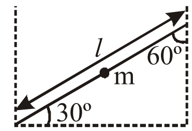
1. **(d)** For any uniform rod, the mass is supposed to be concentrated at its centre.

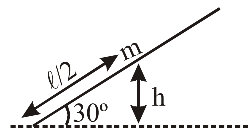
∴ height of the mass from ground is, h = (*l*/2) sin 30º

∴ Potential energy of the rod

$$= m \times g \times \frac{\ell}{2} \sin 30^\circ$$

$$= m \times g \times \frac{\ell}{2} \times \frac{1}{2} = \frac{mg\ell}{4}$$





2. **(b)** According to principle of conservation of energy

Potential energy = kinetic energy

$$\Rightarrow mgh = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{2gh}$$

If h_1 and h_2 are initial and final heights, then

$$\Rightarrow v_1 = \sqrt{2gh_1}, v_2 = \sqrt{2gh_2}$$

Loss in velocity,

$$\Delta v = v_1 - v_2 = \sqrt{2gh_1} - \sqrt{2gh_2}$$

∴ fractional loss in velocity

$$= \frac{\Delta v}{v_1} = \frac{\sqrt{2gh_1} - \sqrt{2gh_2}}{\sqrt{2gh_1}} = 1 - \sqrt{\frac{h_2}{h_1}}$$

$$= 1 - \sqrt{\frac{1.8}{5}} = 1 - \sqrt{0.36} = 1 - 0.6 = 0.4 = \frac{2}{5}$$

3. **(c)** Let *E* be the total energy then

$$\frac{P.E}{K.E} = \frac{mgh}{E - mgh} = \frac{2}{3} \Rightarrow E = \frac{5}{2}mgh$$

When velocity is double then inital energy becomes 4*E*.

So, $\dfrac{mgh}{4E - mgh} = NL = \dfrac{mgh}{10mgh - mgh}$

On solving we get $\dfrac{P.E}{K.E} = \dfrac{1}{9}$.

4. **(c)** Work done in stretching the rubber-band by a distance *dx* is

$$dW = F\,dx = (ax + bx^2)dx$$

Integrating both sides,

$$W = \int_0^L ax\,dx + \int_0^L bx^2\,dx = \frac{aL^2}{2} + \frac{bL^3}{3}$$

5. **(a)** In an elastic collision

$$V_1 = \frac{(m_1 - m_2)}{m_1 + m_2} u_1 \; ; V_2 = \frac{2m_1 u_1}{m_1 + m_2}$$

$\therefore$ if $m_1 = m_2$, then $V_1 = 0$; and

$$V_2 = \frac{2\cancel{m_1} v_1}{2\cancel{m_1}} = u_1$$

6. **(a)** Clearly $v_1 = 2$ ms^{-1}, $v_2 = 0$
$m_1 = m$ (say), $m_2 = 2m$
$v_1' = ?$, $v_2' = ?$

$$e = \frac{v_1' - v_2'}{v_2 - v_1} \quad \text{....(i)}$$

By conservation of momentum,
$2m = mv_1' + 2mv_2'$ ... (ii)

From (i), $0.5 = \frac{v_2' - v_1'}{2}$
$\therefore$ $v_2' = 1 + v_1'$
From (ii), $2 = v_1' + 2 + 2\,v_1'$
$\Rightarrow$ $v_1 = 0$ and $v_2 = 1$ ms^{-1}

7. **(a)** As $u_2 = 0$ and $m_1 = m_2$, therefore from $m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$
we get $u_1 = v_1 + v_2$
Also,

$$e = \frac{v_2 - v_1}{u_1} = \frac{v_2 - v_1}{v_2 + v_1} = \frac{1 - v_1/v_2}{1 + v_1/v_2},$$

which gives $\frac{v_1}{v_2} = \frac{1-e}{1+e}$

6 System of Particles and Rotational Motion

Fill in the Blanks

1. Inverse $m_1 r_1 = m_2 r_2$

$\therefore r \propto \frac{1}{m}$

2. Torque, In analogy to Newton's second law of motion in linear motion,
Force = rate of charge of linear momentum, in angular motion
Torque = rate of change of angular momentum

3. Angular momentum

4. Torque, force in linear motion corresponds to torque in rotational motion.

5. $\frac{1}{2} mr^2$

6. The axis of rotation.

7. Increases, As L = I ω = constant, therefore, when I decreases, ω will increase.

True/ False

1. True; For two particles of equal mass, the centre of mass lies exactly midway between them.

2. True, Centre of mass does not necessarily lie only where there is mass. It can lie outside the body as well. For e.g. Centre of mass of circular ring lies in the centre of the ring where there is no mass.

3. False, Centre of mass depends on the distribution of mass not on gravity.

4. False, A body in translatory motion shall have angular momentum unless the fixed point about which angular momentum is taken lies on the line of motion of the body.

5. False, If $\vec{A}$ points vertically upwards and $\vec{B}$ points towards east then $\vec{A} \times \vec{B}$ points towards north.

6. False, If Earth shrinks suddenly, its radius R would decrease and $I = \frac{2}{5} MR^2$ would decrease. Thus, ω increases to keep angular momentum constant. Hence the length of the day will decrease.

Conceptual MCQs

1. **(a)** Centre of mass of a two particle system always lies closer to the heavier particle.

2. **(b)** COM will lie on diagonal AC, i.e. COM will be equidistant from B and D if $m_2 = m_4$.

3. **(c)** If COM lies the origin x-coordinate of all the particles may be zero.

4. **(c)** M.I of uniform circular disc about its diameter = I
According to theorem of perpendiclar axes,

M.I. of disc about its axis $= \frac{1}{2} mr^2 = 2I$

Applying theorem of | | axes, $\left(\because I = \frac{1}{4} mr^2\right)$

M.I of disc about the given axis
$= 2\,I + mr^2 = 2\,I + 4\,I = 6\,I$

5. **(c)** Distance of COM from centre of sphere A,

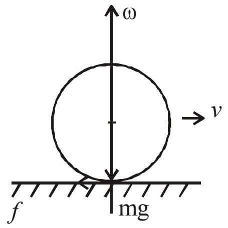
$$r_1 = \frac{m_B r}{m_A + m_B} = \frac{2m \times 3R}{m + 2m} = 2R$$

6. **(c)** Moment of inertial depends on distribution of mass and the axis of rotation.

7. **(d)** $\tau = \dfrac{dL}{dt}$

$\therefore$ If L = constant, $\tau = 0$

8. **(b)** Situation is shown in the figure.



Here line of action of all the forces passes through the point of contact hence, net force about point of contact is zero. So, the angular momentum about point of contact is conserved.

9. **(d)** On smooth inclined plane, the speed of body will change due to gravity but there is not torque to change angular velocity of the body. Hence a body cannot roll without slipping on a smooth inclined surface.

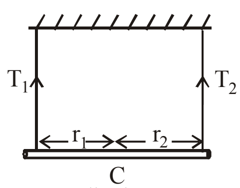
10. **(d)** The equation $\tau = I\alpha$ is valid about COM or axis of rotation but not about any other point.

11. **(d)** As friction is absent at the point of contact,

$$\text{Acceleration} = \frac{\text{Force}}{\text{Mass}}$$

It is independent of h

12. **(b)** $T_1 r_1 = T_2 r_2$ but $r_1 < r_2 \;\therefore\; T_1 > T_2$



13. **(c)** For no slipping.

$\omega_1 R_1 = \omega_2 R_2$

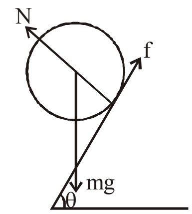
or $\dfrac{\omega_1}{\omega_2} = \dfrac{R_2}{R_1}$

but $R_1 > R_2 \;\therefore\; \omega_1 < \omega_2$

14. **(b)** $\vec{\tau} = \vec{r} \times \vec{F} \Rightarrow \vec{r}\,.\,\vec{\tau} = 0 \qquad \vec{F}\,.\,\vec{\tau} = 0$

Since, $\vec{\tau}$ is perpendicular to the plane of $\vec{r}$ and $\vec{F}$, hence the dot product of $\vec{\tau}$ with $\vec{r}$ and $\vec{F}$ is zero.

15. **(d)** The forces are not concurrent, hence a finite torque will act about any of the point and hence angular momentum is not conserved about any point.



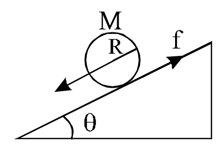
16. **(c)** Speeds of centre of wheels act hence that of topmost points must be equal.

17. **(b)** When the person stretches his hands, his moment of inertia increase, hence by conservation of angular momentum, its angular speed decreases.

18. **(d)** Direction of angular momentum is perpendicular to the orbital plane.

19. **(d)** Net work done by frictional force when drum rolls down without slipping is zero.

$W_{net} = 0$



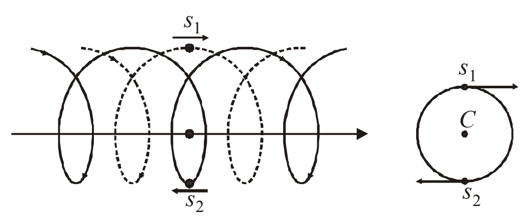
$W_{trans.} + W_{rot.} = 0;\; \Delta K_{trans.} + \Delta K_{rot.} = 0$

$\Delta K_{trans} = -\Delta K_{rot}.$

i.e., converts translation energy to rotational energy.

Diagram Based Questions

1. **(a)** When no external force acts on the binary star, its CM will move like a free particle [Fig. **(a)**]. From the CM frame, the two stars will seems to move in a circle about the CM with diametrically opposite positions.



(i) (ii)

(i) Trajectories of two stars. S_1 (dotted line) and S_2 (solid line) forming a binary system with their centre of mass C in uniform motion

(ii) The same binary system, with the centre of mass C at rest.

So, to understand the motion of a complicated system, we can separate the motion of the system into two parts. So, the combination of the motion of the CM and motion about the CM could described the motion of the system.

2. **(a)** According to parallel axis theorem of the moment of Inertia

$$I = I_{cm} + md^2$$

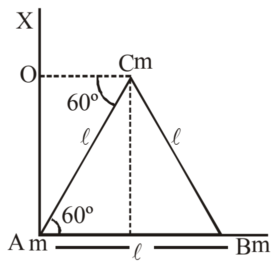
d is maximum for point B so I_{max} about B.

3. **(b)**

4. **(d)** $I_{AX} = m(AB)^2 + m(OC)^2$

$= m\ell^2 + m\,(\ell \cos 60°)^2$

$= m\ell^2 + m\ell^2/4 = 5/4\, m\ell^2$

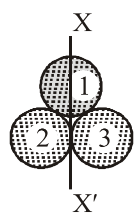


5. **(c)** Moment of inertia of shell 1 along diameter

$$I_{diameter} = \frac{2}{3}MR^2$$

Moment of inertia of shell 2 = m. i of shell 3

$$= I_{tengential} = \frac{2}{3}MR^2 + MR^2 = \frac{5}{3}MR^2$$



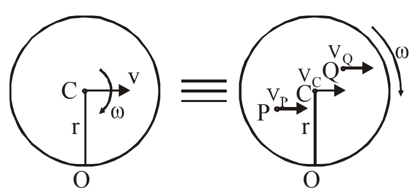
So, I of the system along x x[1]

$= I_{diameter} + (I_{tengential}) \times 2$

or, $I_{total} = \frac{2}{3}MR^2 + \left(\frac{5}{3}MR^2\right) \times 2$

$$= \frac{12}{3}MR^2 = 4MR^2$$

6. **(a)**



(I) (II)

From Fig. (I), we have OC = r (radius)

Therefore, $v = r\omega$

Since , ω = constant, therefore $v \propto r$

Now, form Fig (II), it is clear that the distance, $OP < OC < OQ \Rightarrow V_P < V_C < V_Q$ or $V_Q > V_C > V_P$.

Assertion/ Reason

1. **(c)** The position of centre of mass of a body depends on shape, size and distribution of mass of the body. The centre of mass does not lie necessarily at the centre of the body.

2. **(d)** When particle moves with constant velocity $\vec{v}$ then its linear momentum has some finite value $(\vec{P} = m\vec{v})$.

Angular momentum (L) = Linear momentum (P) × Perpendicular distance of line of action of linear momentum form the point of rotation **(d)** So if $d \neq 0$ then $L \neq 0$, but if d = 0 then L may be zero. So we can conclude that angular momentum of a particle moving with constant velocity is not always zero.

3. **(c)** Torque = Force × perpendicular distance of line of action of force from the axis of rotation **(d)**. Hence for a given applied force, torque or true tendency of rotation will be high for large value of d. If distance d is smaller, then greater force is required to cause the same torque, hence it is harder to open or shut down the door by applying a force near the hinge.

4. **(d)** The moment of inertia of a rigid body reduces to its minimum value, when the axis of rotation passes through its centre of gravity because the weight of a rigid body always acts through its centre of gravity.

5. **(c)** An ice-skater stretches out arms and legs during performance to take advantage of principle of conservation of angular momentum. As on doing so, their moment of inertia increases or decreases respectively and hence the angular velocity of spin motion decreases or increases accordingly.

6. **(c)** As the polar ice melts, water so formed flows towards the equator. The moment of inertia of the earth increases. To conserve angular momentum, angular velocity decreases. This increases the length ($T = 2\,\pi/\omega$) of the day.

7. **(d)** The moment of inertia of a particle about an axis of rotation is given by the product of the mass of the particle and the square of the perpendicular distance of the particle from the axis of rotation. For different axis, distance would be different, therefore moment of inertia of a particle changes with the change in axis of rotation.

8. **(d)** Radius of gyration of body is not a constant quantity. Its value changes with the change in location of the axis of rotation. Radius of gyration of a body about a given axis is given as

$$K = \sqrt{\frac{r_1^2 + r_2^2 + \ldots.. r_n^2}{n}}$$

9. **(d)** For a disc rolling without slipping on a horizontal rough surface with uniform angular velocity, the acceleration of lowest point of disc is directed vertically upwards and is not zero (Due to translation part of rolling, acceleration of lowest point is zero. Due to rotational part of rolling, the tangential acceleration of lowest point is zero and centripetal acceleration is non-zero and upwards). Hence assertion is false.

Matching Based Questions

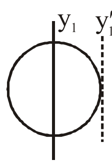
1. **(a)** **2.** **(c)** **3.** **(a)** **4.** **(d)** **5.** **(d)**
6. **(a)**

Critical Thinking Type Questions

1. **(a)** Tube may be treated as a particle of mass M at distance L/2 from one end.

Centripetal force $= Mr\omega^2 = \dfrac{ML}{2}\omega^2$

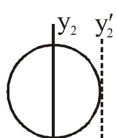
2. **(d)**



Circular disc(1)

$$I_{y_1} = \frac{MR^2}{4}$$

$$\therefore I'_{y_1} = \frac{MR^2}{4} + MR^2 = \frac{5}{4}MR^2$$



Circular ring (2)

$$I_{y_2} = \frac{MR^2}{2}$$

$$\therefore I'_{y_2} = \frac{MR^2}{2} + MR^2 = \frac{3}{2}MR^2$$

$I'_{y_1} = MK_1^2$, $I'_{y_2} = MK_2^2$

$$\therefore \frac{K_1^2}{K_2^2} = \frac{I'_{y_1}}{I'_{y_2}} \Rightarrow K_1 : K_2 = \sqrt{5} : \sqrt{6}$$

3. **(b)** By theorem of parallel axes,
$I = I_{cm} + Md^2$
$I = I_0 + M\,(L/2)^2 = I_0 + ML^2/4$

4. **(d)** According to law of conservation of angular momentum,

$$I_1\omega_1 + I_2\omega_2 = (I_1 + I_2)\omega$$

Substituting the values of $\omega_1 = 2$ rad s^{-1}

$\omega_2 = 5$ rad s^{-1}

$I_2 = I \times 10^{-3}$ kg m^2
$I_1 \times 2 + 1 \times 10^{-3}, \times 5 = (I_1 + 1 \times 10^{-3}) \times 4$
$\Rightarrow 2I_1 + 5 \times 10^{-3} = 4I_1 + 4 \times 10^{-3}$
$\Rightarrow 2I_1 = 1 \times 10^{-3}$

$$\Rightarrow I_1 = \frac{1 \times 10^{-3}}{2} = 0.5 \times 10^{-3}\,\text{kg m}^2$$

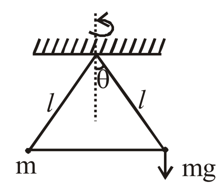
5. **(a)** From the relation, angular momentum,
$L = mvr$

$$v = \frac{L}{mr}$$

$\therefore$ Centripetal force acting on the particle

$$F = \frac{mv^2}{r} = \frac{m\left(\frac{L}{mr}\right)^2}{r} = \frac{L^2}{mr^3}$$

6. **(c)** Torque working on the bob of mass m is, $\tau = mg \times \ell \sin\theta$. (Direction parallel to plane of rotation of particle)



As τ is perpendicular to $\vec{L}$, direction of L changes but magnitude remains same.

7 Gravitation

Fill in the Blanks

1. Equator,
The gravitational force of attraction on a body of mass m is given by

$$F = \frac{GMm}{R^2}$$

Therefore, $F \propto \frac{1}{R^2}$

The radius of earth is maximum at equator, therefore, gravitational force of attraction is least at equator.

2. Zero, there is no gravitational field in the shell.

3. 129 days,
From Kepler's law of periods,

$$T_2 = T_1\left(\frac{R_2}{R_1}\right)^{3/2} = 365\left(\frac{\cancel{R}/2}{\cancel{R}}\right)^{3/2}$$

$$= 365 \times \frac{1}{2\sqrt{2}} = 129 \text{ days.}$$

4. Infinite, since $T = 2\pi\sqrt{\frac{l}{g}}$

but inside the satellite g = 0
So T = ∞

5. 36,000 km.

6. 11.2 km/sec, the escape velocity of projectile from earth is $v_e = \sqrt{2gR_e}$, where R_e is radius of earth since $g = 9.8\text{m/sec}^2$, $R_e = 6.4\times10^6$ metre
$\Rightarrow v_e = 11.2$ km/sec

7. Smaller, Since 'g' on moon is smaller than earth and radius of moon is also smaller, therefore escape velocity on moon is just 2.3 km/s, which is approximately five times smaller than earth 11.2 km/s.

8. $V_e = 2V_p$ Escape speed, $V_e = R\sqrt{\frac{8}{3}\pi G s}$
$\therefore V_e \propto R$.

True/ False

1. True, weight of body will change but not mass.

2. True, Kepler's second law of motion.

3. True, orbital velocity $V_0 = \sqrt{\frac{GM}{R}}$

4. False; $V_e = \sqrt{2gR}$

5. False, $T = 2\pi\sqrt{\frac{(R+h)^3}{GM}}$

6. True **7.** True

Conceptual MCQs

1. **(b)** Gravitational force of the sun provides necessary centripetal force to the earth.

2. **(a)** $mg = 72$ N (body weight on the surface)

$$g = \frac{GM}{R^2}$$

At a height $H = \frac{R}{2}$,

$$g' = \frac{GM}{\left(R + \frac{R}{2}\right)^2} = \frac{4}{9}\frac{GM}{R^2}$$

Body weight at height $H = \frac{R}{2}$,

$$mg' = m \times \frac{4}{9}\frac{GM}{R^2}$$

$$= m \times \frac{4}{9} \times g = \frac{4}{9}mg$$

$$= \frac{4}{9} \times 72 = 32 \text{ N}$$

3. **(d)** Kepler's second law is based on the principle of conservation of angular momentum.

4. **(b)** $V \alpha \frac{1}{\sqrt{r}}$

where r is distance from the sun. As distance of Jupiter from the sun is more than that of the earth, its orbital speed is less than that of the earth.

5. **(d)** Escape velocity from the surface of the moon is much less than the rms velocity of gas molecules, hence there is no atmosphere on the moon.

6. **(c)** Escape velocity is independent of mass.

7. **(c)** The ball will have velocity equal to that of the satellite hence will revolve around the earth in the same orbit.

8. **(a)** Speed of the planet is maximum when it is nearest to the sun.

9. **(c)** If the radius of the earth is reduced, its moment of inertia will decrease, hence by conservation of angular momentum, angular speed of the earth will increase causing a decrease in the time period of its rotation.

10. **(c)** When the satellite revolves close to the surface of the planet,

$$V_o = \frac{V_e}{\sqrt{2}} = \frac{2}{\sqrt{2}} = \sqrt{2}\ \text{km/s.}$$

11. **(b)** The value of acceleration due to gravity is more at poles than at equator.

12. **(d)** $T^2 \,\alpha\, R^3$

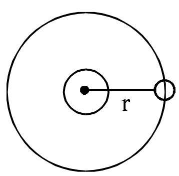
$$\therefore \frac{T^2}{R^3} = \text{constant}$$

13. **(a)** Escape velocity is independent of angle of projection.

14. **(d)** A man waves his arms while walking so that the moment of weights remains zero i.e. to balance the effect of earth is gravity.

15. **(b)** If the velocity of an object is less than the escape velocity, the total energy of the object must be negative.

16. **(a)** K.E. of satellite moving in an orbit around the earth is



$$K = \frac{1}{2}mv^2 = \frac{1}{2}m\left(\sqrt{\frac{GM}{r}}\right)^2 = \frac{GMm}{2r}$$

P.E. of satellite and earth system is

$$U = \frac{GMm}{r} \Rightarrow \frac{K}{U} = \frac{\frac{GMm}{2r}}{\frac{GMm}{r}} = \frac{1}{2}$$

17. (c) According to Kelpner's law of period $T^2 \propto R^3$

$$\frac{T_1^2}{T_2^2} = \frac{R_1^3}{R_2^3} = \frac{(6R)^3}{(3R)^3} = 8$$

$$\frac{24 \times 24}{T_2^2} = 8$$

$$T_2^2 = \frac{24 \times 24}{8} = 72 = 36 \times 2$$

$$T_2 = 6\sqrt{2}$$

18. **(a)** Let T_A and T_B be time period of A and B about sun.

$T_A = 8T_B$

$$\frac{T_A}{T_B} = 8 \qquad \text{...(1)}$$

According to Kepler's Law $T^2 \propto r^3$

$$\frac{T_A}{T_B} = \frac{(r_A)^3}{(r_B)^3} \Rightarrow \left(\frac{r_A}{r_B}\right)^3 = 8 \Rightarrow \frac{r_A}{r_B} = 2$$

19. **(c)** Gravitational force is independent of medium, Hence, this will remain same.

20. **(c)** Escape velocity, $V_e = R\sqrt{\frac{8}{3}\pi GP}$

$$\Rightarrow V_e \propto R \Rightarrow \frac{V_P}{V_E} = \frac{R_P}{R_E} = 2 \Rightarrow V_P = 2V_E.$$

Diagram Based Questions

1. **(c)** As m_2 attracts m_1 towards itself, $\therefore$ force is along r .

2. **(b)** Acceleration due to gravity with height h varies as

$$g \propto \frac{1}{r^2}$$

(when r = R + h). Thus variation of g and r is a parabolic curve.

3. **(c)** $F = \frac{GM(3m)}{d^2} = \frac{3GMm}{d^2}$.

4. **(b)** According to Kepler's law, the areal velocity of a planet around the sun always remains constant.

SCD : $A_1 - t_1$ (areal velocity constant)

SAB : $A_2 - t_2$

$$\frac{A_1}{t_1} = \frac{A_2}{t_2},$$

$$t_1 = t_2 \cdot \frac{A_1}{A_2}, \qquad \text{(given } A_1 = 2A_2)$$

$$= t_2 \cdot \frac{2A_2}{A_2} \qquad \therefore \quad t_1 = 2t_2$$

5. **(c)**

$$F_{\min} = \frac{GMm}{r^2} - \frac{GM(2m)}{(2r)^2}$$

$$= \frac{GMm}{2r^2}$$

$$\text{and } F_{\max} = \frac{GMm}{r^2} + \frac{GM(2m)}{(2r)^2}$$

$$= \frac{3}{2}\frac{GMm}{r^2}.$$

$$\therefore \frac{F_{\min}}{F_{\max}} = \frac{1}{3}.$$

Assertion/ Reason

1. **(b)** For two electron $\frac{F_g}{F_e} = 10^{-43}$ i.e., gravitational force is negligible in comparison to electrostatic force of attraction.
2. **(c)** Work done in raising the body

$$= \int_R^{2R} \frac{GMm}{x^2} dx = \int_R^{2R} \frac{gR^2}{x^2} m dx$$

$$= mgR^2 . \left[\frac{-1}{x}\right]_R^{2R} = mgR^2\left[\frac{-1}{2R} + \frac{1}{R}\right]$$

$$= mgR^2\left[\frac{-1+2}{2R}\right] = \frac{1}{2} mgR$$

3. **(d)** The tidal effect is due to the gravitation effect of moon and earth both. $g' = \frac{g}{\left(1+\frac{h}{R}\right)^2}$, for h = 0, $g' = g$.
4. **(a)** According to Kepler's third law $T^2 \propto r^3$ if r is small then T will also be small.
5. **(a)** Because gravitational force is always attractive in nature and every body is bound by this gravitational force of attraction of earth.
6. **(d)** Escape velocity on the moon is five times smaller than on the earth 11.2 km/s.
7. **(b)** Space rocket are usually launched from west to east to take the advantage of rotation of earth. Also $g' = g - \omega^2 R \cos^2 \lambda$, at equator $\lambda = 0$, and so $\cos \lambda = 1$, and g' is least.
8. **(d)** If the orbital path of a satellite is circular, then its speed is constant and if the orbital path of a satellite is elliptical, then its speed in its orbit is not constant. In that case its areal velocity is constant.
9. **(c)** Gravitational force on the person in satellite is not zero, but normal reaction of the satellite on the person is zero.

Matching Based Questions

1. **(d)** 2. **(b)** 3. **(c)** 4. **(b)** 5. **(a)**
6. **(c)**

Critical Thinking Type Questions

1. **(c)** According to Kepler's law of period $T^2 \propto R^3$

$$\frac{T_1^2}{T_2^2} = \frac{R_1^3}{R_2^3} = \frac{(6R)^3}{(3R)^3} = 8$$

$$\frac{24 \times 24}{T_2^2} = 8$$

$$T_2^2 = \frac{24 \times 24}{8} = 72 = 36 \times 2$$

$$T_2 = 6\sqrt{2}$$

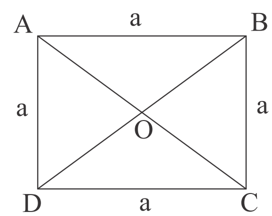
2. **(d)** We know that $\frac{g'}{g} = \frac{R^2}{(R+h)^2}$

$$\therefore \frac{g/9}{g} = \left[\frac{R}{R+h}\right]^2$$

$$\therefore \frac{R}{R+h} = \frac{1}{3}$$

$\therefore h = 2R$

3. **(c)**



$$OA = OB = OC = OD = \frac{a\sqrt{2}}{2} = \frac{a}{\sqrt{2}}$$

Total gravitational potential at the centre of the square $= \frac{-Gm \times 4}{OA}$

$$= \frac{-4Gm}{a/\sqrt{2}} = \frac{-4\sqrt{2}Gm}{a}$$

4. **(a)** $W_r = mg = GMm/R^2$; at a height h,

$$W_h = \frac{GMm}{(R+R)^2}$$

$$= \frac{GMm}{(2R)^2} = \frac{1}{4} W_E \; . \therefore \; w_h^1 = \frac{w}{4}$$

5. **(a)** Potential at the given point = Potential at the point due to the shell + Potential due to the particle

$$= -\frac{GM}{a} - \frac{2GM}{a} = -\frac{3GM}{a}$$

6. **(a)** The velocity u should be equal to the escape velocity. That is, $u = \sqrt{2gR}$

But $g = \frac{GM}{R^2}$

$$\therefore u = \sqrt{2 \cdot \frac{GM}{R^2} \cdot R} \Rightarrow \sqrt{\frac{2GM}{R}}$$

7. **(b)** Orbital velocity of a satellite in a circular orbit of radius a is given by

$$v=\sqrt{\frac{GM}{a}} \Rightarrow v\,\alpha\,\sqrt{\frac{1}{a}} \Rightarrow \frac{v_2}{v_1}=\sqrt{\frac{a_1}{a_2}}$$

$$\therefore \quad v_2=v_1\sqrt{\frac{4R}{R}}=2\,v_1=6V$$

8. **(a)** As we know,

Gravitational potential energy $= \dfrac{-GMm}{r}$

and orbital velocity, $v_0 = \sqrt{GM/R+h}$

$$E_f=\frac{1}{2}mv_0^2-\frac{GMm}{3R}=\frac{1}{2}m\frac{GM}{3R}-\frac{GMm}{3R}$$

$$=\frac{GMm}{3R}\left(\frac{1}{2}-1\right)=\frac{-GMm}{6R}$$

$$E_i=\frac{-GMm}{R}+K$$

$$E_i=E_f$$

Therefore minimum required energy,

$$K=\frac{5GMm}{6R}$$

8 Mechanical Properties of Solids

Fill in the Blanks

1. Stress
2. Shape
3. Yield point,
   It is the point, beyond which the wire starts showing increase in strain without any increase in stress.
4. Modulus of elasticity
5. Young's modulus
6. Bulk modulus
7. Compressibility $= \dfrac{1}{\text{Bulk modulus}}$
8. zero
9. Remains constant,
   The ratio of stress to strain is always constant. If stress is increased, strain will also increase so that their ratio remains constant.

True/ False

1.	True	**2.**	True	**3.**	True $r_{steel} > \gamma_{copper}$
4.	False	**5.**	True	**6.**	False
7.	True	**8.**	False		

Conceptual MCQs

1. **(c)** Young's modulus of a given material is constant and does not depend on dimensions of the wire.
2. **(a)** Liquids do not have finite shape hence their modulus of rigidity is zero.
3. **(b)** Gases & liquids possess only Bulk modulus.
4. **(d)** $U=\dfrac{1}{2}\times T\times\Delta l$

   but $\Delta l \propto T$

   $\therefore\ U \propto T^2$

   $\therefore$ If tension is doubled, elastic P.E. stored in the wire will becomes four times.
5. **(c)** Elastomers do not obey Hooke's law.
6. **(c)** Shear modulus is given by

   $\eta=\dfrac{F}{A\theta}$

   for a perfectly rigid body,
   $\theta=0$

   $\therefore\ \eta=\infty$
7. **(c)** We have, $U=\dfrac{F^2}{2k}$

   where $k=\dfrac{Yl}{A}=\dfrac{Yl}{\frac{1}{4}\pi d^2}$ $\quad\therefore\ U\propto\dfrac{d^2}{l}$
8. **(c)** Shape of a body charges when a tangential stress is applied on it.
9. **(b)** Poisson's ratio is the ratio of lateral strain to longitudinal strain.
10. **(d)** Steel may behave as perfectly elastic, perfectly plastic or partially elastic depending on the stress developed in the steel wire object.
11. **(d)** All these factor affect elasticity of a substance.
12. **(c)** Among the given materials steeel is most elastic.
13. **(a)**
14. **(a)**
15. **(c)** We know that Young's modulus

    $Y=\dfrac{F}{\pi r^2}\times\dfrac{L}{\ell}$

Since Y, F are same for both the wires, we have,

$$\frac{1}{r_1^2}\frac{L_1}{\ell_1}=\frac{1}{r_2^2}\frac{L_2}{\ell_2}$$

or, $\frac{\ell_1}{\ell_2}=\frac{r_2^2\times L_1}{r_1^2\times L_2}=\frac{(D_2/2)^2\times L_1}{(D_1/2)^2\times L_2}$

or, $\frac{\ell_1}{\ell_2}=\frac{D_2^2\times L_1}{D_1^2\times L_2}=\frac{D_2^2}{(2D_2)^2}\times\frac{L_2}{2L_2}=\frac{1}{8}$

So, $\ell_1:\ell_2=1:8$

16. **(c)** Energy stored per unit volume

$$=\frac{1}{2}\times\text{stress}\times\text{strain}$$

$$=\frac{1}{2}\times\text{stress}\times(\text{stress}/\text{Young's modulus})$$

$$=\frac{1}{2}\times(\text{stress})^2/(\text{Young's modulus})=\frac{S^2}{2Y}$$

17. **(a)** $K=\frac{1}{B}=\frac{\Delta V/V}{P}$. Here, P = 100 atm,
$K = 4\times10^{-5}$ and $V = 100\ cm^3$.
Hence, $\Delta V = 0.4\ cm^3$

18. **(a)**

19. **(c)** According to Hooke's Law, within the elastic limit, stress $\propto$ strain

or $Y=\frac{F/A}{\Delta x/x_0}$

$\Rightarrow F=\frac{YA\Delta x}{x_0}$

or, $F\propto\Delta x$

20. **(c)** $Y=\frac{Fl}{A\Delta l}\Rightarrow\Delta l=\frac{Fl}{YA}=\frac{mgl}{YA}$

Diagram Based Questions

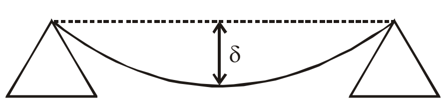
1. **(c)**

2. **(c)** The given graph does not obey Hooke's law. and there is no well defined plastic region. So the graph represents elastomers.

3. **(c)** Since OE is a straight line so, stress $\propto$ strain. $\therefore$ Hooke's law is obeyed in the region OE of the graph.

4. **(a)**

5. **(c)**



For a beam, the depression at the centre is given by,

$$\delta=\left(\frac{fL}{4Ybd^3}\right)$$

[f, L, b, d are constants for a particular beam]

i.e. $\delta\propto\frac{1}{Y}$

6. **(a)** From the graph $l = 10^{-4}$m, $F = 20$ N
$A = 10^{-6}m^2$, L = 1m

$$\therefore\ Y=\frac{FL}{Al}=\frac{20\times1}{10^{-6}\times10^{-4}}$$

$$=20\times10^{10}=2\times10^{11}N/m^2$$

7. **(a)** When same stress is applied at two different temperatures, the increase in length is more at higher temperature. Thus $T_1 > T_2$.

Assertion/ Reason

1. **(b)** The incompressibility of solids is primarily due to the tight coupling between the neighbouring atoms. Molecules in gases are very poorly coupled to their neighbours.

2. **(d)** Lead is more elastic than rubber because for same load strain produced is much less in lead than rubber.

3. **(a)** Torque required to produce a given twist in hollow cylinder is greater than solid cylinder thus both are true.

4. **(b)** Stress is defined as internal force (restoring force) per unit area of a body. Also, rubber is less elastic than steel, because restoring force is less for rubber than steel.

5. **(a)** Young's modulus of a material, $Y=\frac{\text{stress}}{\text{strain}}$

Here, $\text{stress}=\frac{\text{restoring force}}{\text{area}}$

As restoring force is zero $\therefore\ Y = 0$.

6. **(a)** Work done

$$=\frac{1}{2}\times\text{Stress}\times\text{Strain}=\frac{1}{2}\times Y\times(\text{Strain})^2.$$

Since, elasticity of steel is more than copper, hence more work has to be done in order to stretch the steel.

7. **(b)** The most effective method to reduce depression in a beam of given length & material is to make depth of the beam large as compared to its breadth. But on increasing the depth too much, the beam bends. To check this buckling, a compromise between breadth & depth of a beam is made by using I-shaped girder.

8. **(d)**

Matching Based Questions

1. **(b)** **2.** **(a)** **3.** **(d)** **4.** **(a)**

Critical Thinking Type Questions

1. **(c)** According to Hooke's law

Stress $\propto$ strain i.e., $\dfrac{F}{A} \propto \dfrac{\Delta l}{l}$

$\Rightarrow$ For same F & l, $\Delta l \propto \dfrac{1}{A}$

2. **(c)** We know that

$$Y = \frac{mg/A}{\Delta\ell/\ell} = \frac{mg\ell}{A\Delta\ell} \qquad ....(1)$$

Also $\Delta\ell = \ell\,\alpha\,\Delta T$ ...(2)

From (1) and (2)

$$Y = \frac{mg\ell}{A\ell\,\alpha\,\Delta T} = \frac{mg}{A\,\alpha\,\Delta T}$$

$$\therefore \; m = \frac{YA\alpha\Delta T}{g} = \frac{10^{11} \times \pi(10^{-3})^2 \times 10^{-5} \times 10}{10}$$

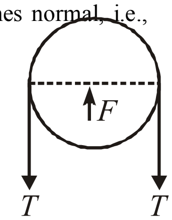
$$= \pi \approx 3$$

3. **(d)** Elongation due to change in temperature,

$\Delta l = L\alpha\Delta T$

Which is compensated by elastic strain,
When temperature becomes normal, i.e.,

$$\Delta l = \frac{TL}{YS}$$



Thus, $\dfrac{TL}{YS} = L\alpha\Delta T$

$\Rightarrow \; T = VS\alpha\Delta T$

At equilibrium force exerted by one half on other,

$F = 2T = 2YS\alpha\Delta T$

4. **(b)** Let V be the volume of the load and ρ its relative density

So, $Y = \dfrac{FL}{A\,\ell_a} = \dfrac{V\rho g L}{A\,\ell_a}$ .....(1)

When the load is immersed in the liquid, then

$Y = \dfrac{F'L}{A\,\ell_w} = \dfrac{(V\rho g - V \times 1 \times g)L}{A\,\ell_w}$ ....(2)

($\because$ Now net weight = weight – upthrust)

From eqs. (1) and (2), we get

$$\frac{\rho}{\ell_a} = \frac{(\rho - 1)}{\ell_w} \text{ or } \rho = \frac{\ell_a}{(\ell_a - \ell_w)}$$

5. **(c)** Young's modulus of rubber, Y_{rubber}

$= \dfrac{F}{A} \times \dfrac{\ell}{\Delta\ell} \Rightarrow F = YA.\dfrac{\Delta\ell}{\ell}$

On putting the values from question,

$$F = \frac{5 \times 10^8 \times 25 \times 10^{-6} \times 5 \times 10^{-2}}{10 \times 10^{-2}}$$

$$= 25 \times 25 \times 10^{2-1} = 6250\text{N}$$

kinetic energy = potential energy of rubber

$$\frac{1}{2}mv^2 = \frac{1}{2}F\Delta\ell$$

$$v = \sqrt{\frac{F\Delta\ell}{m}} = \sqrt{\frac{6250 \times 5 \times 10^{-2}}{5 \times 10^{-3}}} = \sqrt{62500}$$

= 25 × 10 = 250 m/s

6. **(c)** If ℓ is the original length of wire, then change in length of first wire,

$\Delta\ell_1 = (\ell_1 - \ell)$

Change in length of second wire,

$\Delta\ell_2 = (\ell_2 - \ell)$

Now, $Y = \dfrac{T_1}{A} \times \dfrac{\ell}{\Delta\ell_1} = \dfrac{T_2}{A} \times \dfrac{\ell}{\Delta\ell_2}$

or $\dfrac{T_1}{\Delta\ell_1} = \dfrac{T_2}{\Delta\ell_2}$ or $\dfrac{T_1}{\ell_1 - \ell} = \dfrac{T_2}{\ell_2 - \ell}$

or $T_1\ell_2 - T_1\ell = T_2\ell_1 - \ell T_2$

or $\ell = \dfrac{T_2\ell_1 - T_1\ell_2}{T_2 - T_1}$

7. **(b)** $\Delta\ell = \dfrac{F(L/2)}{AY} = \dfrac{(AL\rho g)(L/2)}{AY}$

$$= \left(\frac{1}{2}\right)\rho g L^2 / Y$$

8. **(d)** $K = \dfrac{\Delta P}{\Delta V/V} = \dfrac{h\rho g}{\Delta V/V}$

$$= \frac{200 \times 10^3 \times 10}{0.1/100} = 2 \times 10^9$$

9 Mechanical Properties of Fluids

Fill in the Blanks

1. Pressure and density
2. Pascal's law, Hydraulic machines & lifts are based on Pascal's Law

$$P_1 = P_2 \Rightarrow \frac{F_1}{A_1} = \frac{F_2}{A_2}$$

3. Relative density of body, Specific gravity of a body is defined as ratio of weight of body in air to the loss of weight of body in water at 4°C.

$$= \frac{Vsg}{Vswg} = \frac{s}{sw} = \text{Relative density of the body.}$$

4. Pascal's law
5. 1 torr
6. venturimeter
7. Zero, when terminal velocity is reached then body moves with constant velocity hence, accelesation is zero.
8. Capillary action, If the surface tension of oil is zero, then it will not rise, so oil rises up in a wick of a lantern due to surface tension.

True/ False

1. True
2. False; On increasing temperature, the rate of diffusion increases.
3. False
4. True if spread properly over wound.
5. False, surface tension decreases with rise in temperature
6. False 7. True

Conceptual MCQs

1. **(d)** Let V_i be the volume of the iceberg inside sea water and V is the total volume of iceberg.
Total weight of iceberg
= weight of water displaced by iceberg.

$$V.\rho_{ice}\,g = V_i.\rho_{water}.g$$

$$\Rightarrow \frac{V_i}{V} = \frac{\rho_{ice}}{\rho_{water}} = \frac{0.92}{1.03}$$

Thus the fraction of total volume of iceberg above the sea level

$$= \left(\frac{V - V_i}{V}\right) \times 100\%$$

$$= \frac{\left[V - \left(\frac{0.92}{1.03}\right)V\right]}{V} \times 100\%$$

$$= \left(1 - \frac{0.92}{1.03}\right) \times 100\% = \frac{0.11}{1.03} \times 100\% \approx 11\%$$

2. **(b)** When a body falls through a viscous medium, it attains a constant velocity called terminal velocity.
3. **(c)** When the train crosses the platform, velocity of air molecules near the train become greater hence the passenger standing on the platform experience a pull towards the train as fast moving air molecules exert less pressure.
4. **(a)** Both friction and viscosity depend on nature of material but friction does not depend on area of contact.
5. **(c)** water shows anamalous expansion and it sticks to glass as well.
6. **(d)** Angle of contact depends on temperature, nature of liquid and the container and on the presence of impuraties.
7. **(c)** Terminal velocity, $v_T = \frac{2r^2(d_1 - d_2)g}{9\eta}$

$$\frac{v_{T_2}}{0.2} = \frac{(10.5 - 1.5)}{(19.5 - 1.5)} \Rightarrow v_{T_2} = 0.2 \times \frac{9}{18}$$

$$\therefore v_{T_2} = 0.1\ m/s$$

8. **(c)** Wetability of a surface by a liquid primarily depends on angle of contact between the surface and liquid.
If angle of contact is acute liquids wet the solid and vice-versa.
9. **(a)** Thickness of the surface film is equal to the radius of influence.
10. **(c)** As surface area decreases so energy is released.
Energy released = $4\pi R^2 T[n^{1/3} - 1]$
where $R = n^{1/3} r$

$$= 4\pi R^3 T\left[\frac{1}{r} - \frac{1}{R}\right] = 3VT\left[\frac{1}{r} - \frac{1}{R}\right]$$

11. **(a)** Toricelli's theorem is used to find velocity of efflux of an ideal liquid through on orifice.

12. **(c)** A pin of density greater than that of water can float on the surface of water due to surface tension.

13. **(a)** with increase in temperature, the viscosity of gases increases while those of liquids decreases.

14. **(b)** $(h\rho g + H \times 1 \times g)\frac{4}{3}\pi r^3 = h\rho g \times \frac{4}{3}\pi(2r)^3$

This gives $H = 7h\rho$

15. **(a)** Hydraulic lift is based on the principle of Pascal's law.

16. **(a)** Paint gun is based on Bernoulli's theorem.

17. **(b)** By equation of continuity, the velocity of liquid will be more at narrower portion and less at wider portion, hence pressure will be more at the wider portion, as according to Bernoulli's theorem, pressure is more at a point where velocity is less.

18. **(a)** We know that angle of contact is the angle between the tangent to liquid surface at the point of contact and solid surface inside the liquid. In case of pure water and pure glass, the angle of contact is zero.

19. **(a)** Some of the work done by the force of surface tension is used in change in P.E. of the liquid and remaining is loss in the form of heat.

20. **(a)** fevicol increases adhesive force between paint and wall molecules.

21. **(c)** Note that according to Stoke's law

$6\pi\eta r v_T = mg$

Hence, the valid relation is $v_T \propto mg / r\eta$

Diagram Based Questions

1. **(d)** From the figure it is clear that liquid 1 floats on liquid 2. The lighter liquid floats over heavier liquid. Therefore we can conclude that

$\rho_1 < \rho_2$

Also $\rho_3 < \rho_2$ otherwise the ball would have sink to the bottom of the jar.

Also $\rho_3 > \rho_1$ otherwise the ball would have floated in liquid 1. From the above discussion we conclude that

$\rho_1 < \rho_3 < \rho_2$.

2. **(d)** Pressure = $h\rho g$ i.e. pressure at the bottom is independent of the area of the bottom of the tank. It depends onthe height of water upto which the tank is filled with water. As is both the tanks, the levels of water are the same, pressure at the bottom is also the same.

3. **(a)** Mass of liquid in horizontal portion of U-tube $= Ad\rho$

Pseudo force on this mass $= Ad\rho a$

Force due to pressure difference in the two limbs

$= (h_1\rho g - h_2\rho g)\, A$

Equating both the forces

$(h_1 - h_2)\,\rho g A = Ad\rho a$

$\Rightarrow \quad (h_1 - h_2) = \dfrac{Ad\rho a}{\rho g A} = \dfrac{ad}{g}$

4. **(b)** The candle floats on the water with half its length above and below water level. Let its length be 10 cm. with 5 cm. below the surface and 5 cm. above it. If its length is reduced to 8 cm, it will have 4 cm. above water surface. So we see tip going down by 1 cm. So rate of fall of tip = 1 cm/hour.

5. **(d)** At equilibrium, weight of the given block is balanced by force due to surface tension, i.e.,

$2L.\, S = W$

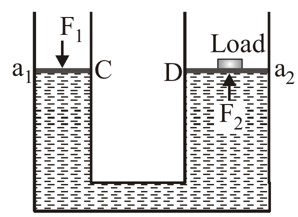
or $S = \dfrac{W}{2L} = \dfrac{1.5 \times 10^{-2}\, N}{2 \times 0.3\ m} = 0.025\, Nm^{-1}$

Assertion/ Reason

1. **(b)** Since mercury is a most dense liquid available therefore by using it, barometric arrangement will be of very convinient size.

2. **(c)** In case of iron needle, the weight of water displaced by the needle is much less than the weight of the needle, hence it sinks but in case of a large iron ship the weight of water displaced by the ship is higher than the weight of the ship, hence it floats in water.

3. **(b)** According to Pascal's law, if gravity effect is neglected, the pressure at every point of liquid in equilibrium of rest is same



$P_1 = P_2$ i.e., $\dfrac{F_1}{a_1} = \dfrac{F_2}{a_2}$ or $F_2 = \dfrac{a_2}{a_1} F_1$

As $a_2 >> a_1 \;\therefore\; F_2 >> F_1$

This shows that small force (F_1) applied on the smaller piston (of area a_1) will be appearing as a very large force on the larger piston.

4. **(a)** Since the net buoyant force on the brick completely submerged in water is independent of its depth below the water surface, the man will have to exert same force on both the bricks.

5. **(a)** Height of the blood column in the human body is more at feet than at the brain. As $P = h\rho g$. therefore the blood exerts more pressure at the feet than at the brain.

6. **(d)** Since due to applied force on liquid, the pressure is transmitted equally in all directions inside the liquid. That is why there is no fixed direction for the pressure due to liquid. Hence hydrostatic pressure is a scalar quantity.

7. **(a)** Since, the fluid move from higher pressure to lower pressure and in a fluid, the pressure increase with increase of depth. Hence, the pressure p_0 will be lesser at the top than that at the bottom ($p_0 + h\rho g$). So, the air bubble moves from the bottom to the top and does not move sideways, since the pressure is same at the same level. Further in coming from bottom to top the pressure decreases. According to Boyle's law pV = constant.
Therefore, if pressure decreases the volume increses, it means radius increases

8. **(a)** $h = \dfrac{2T}{Rdg} \Rightarrow hR = \dfrac{2T}{dg} \quad \therefore hR = \text{constant}$
Hence when the tube is of insufficient length, radius of curvature of the liquid meniscus increases, so as to maintain the product hR a finite constant.
i.e., as h decreases, R increases and the liquid meniscus becomes more and more flat, but the liquid does not overflow.

9. **(d)** Surface tension of oils and paints is kept low so that it can spread over larger area.

10. **(d)** The soap solution, has less surface tension as compared to ordinary water and its surface tension decreases further on heating. The hot soap solution can, therefore spread over large surface area and also it has more wetting power. It is on account of this property that hot soap solution can penetrate and clean the clothes better than the ordinary water.

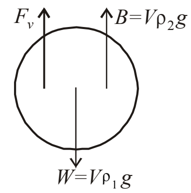
Matching Based Questions

1.	(a)				
2.	(c)	3.	(a)	4.	(d)
5.	(c)	6.	(b)	7.	(b)

Critical Thinking Type Questions

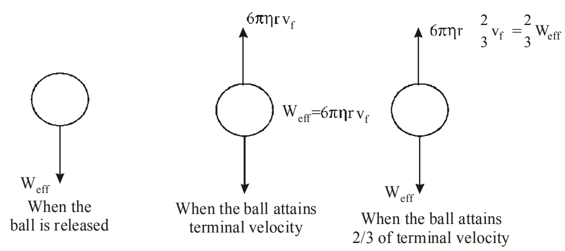
1. **(b)** The volume of liquid displaced by floating ice
$$V_D = \frac{M}{\sigma_L}$$
Volume of water formed by melting ice,
$$V_F = \frac{M}{\sigma_w}$$
If $\sigma_L > \sigma_w$, then $\dfrac{M}{\sigma_L} < \dfrac{M}{\sigma_w}$ i.e., $V_D < V_F$
i.e., volume of liquid displaced by floating ice will be lesser than water formed and so the level if liquid will rise.

2. **(a)** The condition for terminal speed (v_t) is
Weight = Buoyant force + Viscous force



$$\therefore\ V\rho_1 g = V\rho_2 g + kv_t^2$$
$$\therefore\ v_t = \sqrt{\frac{Vg(\rho_1 - \rho_2)}{k}}$$

3. **(b)**



When the ball is just released, the net force on ball is
W_{eff} (= mg – buoyant force)
The terminal velocity v_f of the ball is attained when net force on the ball is zero.
$\therefore$ Viscous force $6\pi\eta r\, v_f = W_{eff}$
When the ball acquires $\dfrac{2}{3}$rd of its maximum velocity v_f the viscous force is = $\dfrac{2}{3} W_{eff}$
Hence net force is $W_{eff} - \dfrac{2}{3} W_{eff} = \dfrac{1}{3} W_{eff}$
$\therefore$ required acceleration is a/3

4. **(d)** Using the formula of the terminal velocity of a body falling through a viscous medium,
$$V = \frac{2r^2(\rho - \sigma)g}{9\eta} \Rightarrow \eta = \frac{2r^2(\rho - \sigma)g}{9v}$$
Where ρ is the density of material of body and σ is the density of medium.
In case of the air bubble $\rho = 1$ and $\sigma = 1.47 \times 10^3$ kg/ms and the air bubble rises up.

$$\eta = \frac{2r^2\sigma g}{9V} = \frac{2\times(10^{-2})^2\times1.47\times10^3\times9.8}{9\times0.21\times10^{-2}}$$

$$= \frac{2\times1.47\times9.8\times10}{9\times0.21}$$

$= 1.52 \times 10^3$ decapoise $= 1.52 \times 10^4$ Poise

5. **(d)** From stoke's law, $F = 6\pi\eta R_1 v$, and

$$V = \frac{4}{3}\pi R^3$$

$$F' = 6\pi\eta R_2 v, \left(\text{volume } 8\text{ V} = \frac{4}{3}\pi(2R)^3\right)$$

$= 6\pi\eta(2R)v = 2F$

6. **(d)** For rise in capillary, the formula is $h = \frac{2T}{r\rho g}$

So, for first capillary tube $h_1 = \frac{2T}{r_1\rho g}$

For second, $h_2 = \frac{2T}{r_2\rho g}$

$$\frac{h_1}{h_2} = \frac{r_2}{r_1} \Rightarrow \frac{3}{h_2} = \frac{r_1}{3\times r_1} \left[r_2 = \frac{r_1}{3}\right]$$

$h_2 = 9\text{mm}$

7. **(b)** For capillary rise, according, to zurin's law

$h_1 r_1 = h_2 r_2$

$6 \times 1 = h_2 \times 2 \Rightarrow h_2 = 3$ cm

8. **(c)** As surface area decreases so energy is released.

Energy released $= 4\pi R^2 T[n^{1/3} - 1]$

where $R = n^{1/3} r$

$$= 4\pi R^3 T\left[\frac{1}{r} - \frac{1}{R}\right] = 3VT\left[\frac{1}{r} - \frac{1}{R}\right]$$

10 Thermal Properties of Matter

Fill in the Blanks

1. 273.16 K

2. $\gamma = 3\alpha$

$V + \Delta V = (L + \Delta L)^3 = (L + \alpha L\Delta T)^3$

$= L^3 + (1 + 3\alpha\Delta T + 3\alpha^2\Delta T^2 + \alpha^3\Delta T^3)$

$\Rightarrow$ α^2 and α^3 terms are neglected.

$\therefore$ $V(1 + \gamma\Delta T) = V(1 + 3\alpha\Delta T)$

$1 + \gamma\Delta T = 1 + 3\alpha\Delta T$

$\therefore$ $\gamma = 3\alpha$.

3. regelation

4. Infinity, At constant temperature molar heat capacity

$$C_T = \frac{\Delta Q}{n\Delta T}$$

T is const. $\Rightarrow \Delta T = 0$

$$\therefore \quad C_T = \frac{\Delta Q}{0} = \infty$$

5. Latent heat of fusion

6. Water, Water has highest specific heat capacity and hence it is used as a coolant in car radiators as well as heater in hot water bags.

7. Convection

8. 98%

9. $e_\lambda = a_\lambda$

True/ False

1. True

2. False, Thermal conductivity of copper is more than that of steel, hence stainless steel cooking pans are provided with extra copper bottoms.

3. True, Gases are poor thermal conductors while liquids have conductive intermediate between solids and gases.

4. True **5.** True

6. False, Convection is mode of heat transfer by actual motion of matter. Convection can be natural or forced. In natural convection, gravity plays an important part. Conduction - Heat transfer without actual motion of matter.

Conceptual MCQs

1. **(c)** Coefficient of thermal conductivity depends only on the material of the plate.

2. **(a)** From question,

Rise in temperature $\Delta t = 40°C$

Fractional change in the density $\frac{\Delta\rho}{\rho_0} = ?$

Coefficient of volume expansion

$\gamma = 5 \times 10^{-4} K^{-1}$

$\rho = \rho_0 (1 - \gamma\Delta t)$

$$\Rightarrow \frac{\Delta\rho}{\rho_0} = \gamma\Delta T = (5 \times 10^{-4})(40) = 0.02$$

3. (c) Wool is a bad conductor hence it does not allow heat from our body to lose to the surroundings.

4. (a) Convection cannot take place in weightlessness, hence the heat is transmitted only through conduction.

5. (d) A cooking utensil must heat up quickly and must transmit heat rapidly. Hence, it must have low specific heat and high thermal conductivity.

6. (a) At 4°C, density of water is maximum, hence

$$\frac{dv}{v} = 0 \text{ or } \alpha = \frac{1}{T}\frac{dv}{v} = 0 .$$

7. (a) Let the temperature of surroundings be θ_0

By Newton's law of cooling

$$\frac{\theta_1 - \theta_2}{t} = k\left[\frac{\theta_1 + \theta_2}{2} - \theta_0\right]$$

$$\Rightarrow \frac{70 - 60}{5} = k\left[\frac{70 + 60}{2} - \theta_0\right]$$

$$\Rightarrow 2 = k\,[65 - \theta_0] \quad ...(i)$$

Similarly, $$\frac{60 - 54}{5} = k\left[\frac{60 + 54}{2} - \theta_0\right]$$

$$\Rightarrow \frac{6}{5} = k\,[57 - \theta_0] \quad ...(ii)$$

By dividing (i) by (ii) we have

$$\frac{10}{6} = \frac{65 - \theta_0}{57 - \theta_0} \Rightarrow \theta_0 = 45°$$

8. (d)

9. (b) $Q_1 = 4Q_2$ (Given)

$$\Rightarrow \frac{K_1 A_1 \Delta t}{L} = 4\frac{K_2 A_2 \Delta t}{L}$$

$\Rightarrow K_1 A_1 = 4K_2 A_2$.

10. (d) Rate of flow of heat through a rod,

$$H = \frac{kA}{2}\Delta T$$

11. (a) Wein's displacement law

According to this law

$$\lambda_{max} \propto \frac{1}{T}$$

or, $\lambda_{max} \times T$ = constant

So, as the temperature increases λ decreases.

12. (d) Liquid does not over flow on heating, when apparent value of coefficient of volume expansion,

$\gamma_a = \gamma - 3\alpha \le 0$

or $\gamma \le 3\alpha$

13. (c) When ice is added to water, the equilibrium temperature may be zero or positive depending on amount of ice and water and their initial temperatures.

14. (d) Triple point is the temperature where three states of matter can exist simultaneously.

15. (a) From Wein's displacement law

$\lambda_m T$ = constant

$\Rightarrow \lambda_m \propto T^{-1}$

16. (c) A body at higher temperature emits radiation of all wavelengths absorbed by it a lower temperature.

17. (b) $\frac{C}{5} = \frac{F - 32}{9}$ or $\frac{C}{5} = \frac{C - 32}{9}$

4C = – 160 or C = F = – 40°.

18. (b) As heat flows from higher temperature to lower temperature, so a temperature gradient is required.

19. (a) The temperatures of the block and wood are equal to the temperature of the body as both feel equally hot or cold.

20. (d) According to the principle of calorimetry.

Heat lost = Heat gained

$mL_v + ms_w\Delta\theta = m_w s_w \Delta\theta$

$\Rightarrow m \times 540 + m \times 1 \times (100 - 80)$

$= 20 \times 1 \times (80 - 10)$

$\Rightarrow m = 2.5$ g

Therefore total mass of water at 80°C

= (20 + 2.5) g = 22.5 g

21. (c) Water has a large latent heat of vaporisation. When it is sprinked over a large area, its evaporation occurs which, in turn, causes cooling.

22. (a) $$E = \frac{S}{S_0}\sigma T^4 = \frac{4\pi r^2}{4\pi R^2}\sigma T^4 = \sigma\frac{r^2}{R^2}T^4$$

23. (d) $$\frac{dH}{dt} \propto (\theta_2 - \theta_1) = (\Delta\theta)^n \Rightarrow n = 1$$

Diagram Based Questions

1. (b) Material expands outward and so *x*, *r* increases. Due to linear expansion diameter of rod will increase.

2. (c) The three curves AB, CD and EF meet at point P which is called the triple point of water. It is the point where all three states solid, liquid and gas of water co-exists.

3. (b) $\frac{dQ}{dt} = KA\frac{\Delta T}{L}$

For the first rod, $\left(\frac{dQ}{dt}\right)_1 = \frac{3KA}{L}(100-\theta)$

Similarly, $\left(\frac{dQ}{dt}\right)_2 = 2K\frac{A}{L}(\theta-50)$

$\left(\frac{dQ}{dt}\right)_3 = K\frac{A}{L}(\theta-20)$

Now, $\left(\frac{dQ}{dt}\right)_1 = \left(\frac{dQ}{dt}\right)_2 + \left(\frac{dQ}{dt}\right)_3$

$\Rightarrow$ 3 (100 – θ) = 2 (θ – 50) + (θ – 20)

$\Rightarrow$ θ = 70°

4. (a) $r_{eff} = \sqrt{r_1 r_2}$

$\frac{dQ}{dt} = \frac{KA(T_2 - T_1)}{L} = \frac{K\pi r_1 r_2 (T_2 - T_1)}{L}$

5. (d) The thermal resistance is given by

$\frac{x}{KA} + \frac{4x}{2KA} = \frac{x}{KA} + \frac{2x}{KA} = \frac{3x}{KA}$

$\therefore \frac{dQ}{dt} = \frac{\Delta T}{\frac{3x}{KA}} = \frac{(T_2 - T_1)KA}{3x}$

$= \frac{1}{3}\left\{\frac{A(T_2 - T_1)K}{x}\right\} \quad \therefore f = \frac{1}{3}$

Assertion/ Reason

1. (c) 2. (c)

3. (c) Heat is carried away from a fire sideways mainly by radiations. Above the fire, heat is carried by both radiation and by convection of air. The latter process carries much more heat.

4. (a) Metals generally have higher coefficient of linear expansion. Since copper has 1.7 K^{-1} and glass has 0.32 K^{-1} coefficient of linear expansion so, copper expands five times more than glass.

5. (d) Rate of cooling a body at a temperature is defined as the fall in temperature per second at that temperature, while rate of loss of heat from a body is the quantity of heat lost per second from the body.

6. (d) 7. (d)

Matching Based Questions

1. (b) 2. (b) 3. (c) 4. (c) 5. (a)

6. (a)

Critical Thinking Type Questions

1. (c) $L = L_0(1 + \alpha\Delta\theta) \Rightarrow \frac{L_1}{L_2} = \frac{1+\alpha(\Delta\theta)_1}{1+\alpha(\Delta\theta)_2}$

$\Rightarrow \frac{10}{L_2} = \frac{1+11\times10^{-6}\times20}{1+11\times10^{-6}\times19} \Rightarrow L_2 = 9.99989$

$\Rightarrow$ Length is shorten by

10 – 9.99989 = 0.00011 = 11 × 10^{-5} cm.

2. (a) $\gamma_{real} = \gamma_{app.} + \gamma_{vessel}$

So $(\gamma_{app.} + \gamma_{vessel})_{glass} = (\gamma_{app} + \gamma_{vessel})_{steel}$

$\Rightarrow 153\times10^{-6} + (\gamma_{vessel})_{glass} = 144\times10^{-6} + (\gamma_{vessel})_{steel}$

Further,

$(\gamma_{vessel})_{steel} = 3\alpha = 3\times(12\times10^{-6}) = 36\times10^{-6}/°C$

$\Rightarrow 153\times10^{-6} + (\gamma_{vessel})_{glass} = 144\times10^{-6} + 36\times10^{-6}$

$\Rightarrow (\gamma_{vessel})_{glass} = 3\alpha = 27\times10^{-6}/°C$

$\Rightarrow \alpha = 9\times10^{-6}/°C$

3. (d) Radius of small sphere = r

Thickness of small sphere = t

Radius of bigger sphere = 2r

Thickness of bigger sphere = t/4

Mass of ice melted = (volume of sphere) × (density of ice)

Let K_1 and K_2 be the thermal conductivities of larger and smaller sphere.

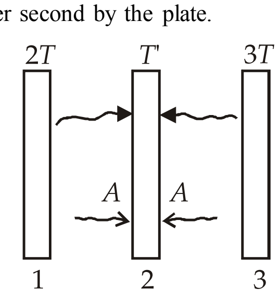
For bigger sphere,

$\frac{K_1 4\pi(2r)^2 \times 100}{t/4} = \frac{\frac{4}{3}\pi(2r)^3\rho L}{25\times60}$

For smaller sphere,

$\frac{K_2 \times 4\pi r^2 \times 100}{t} = \frac{\frac{4}{3}\pi r^3 \rho L}{16\times60} \quad \therefore \frac{K_1}{K_2} = \frac{8}{25}$

4. (c) Under steady conditions, the heat gained per second by a plate is equal to the heat released per second by the plate.



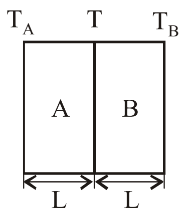
$\frac{\text{Heat gained}}{\text{Second}}$ [by (2) from (1)] + $\frac{\text{Heat gained}}{\text{Second}}$

[(by ((2) from (3)] = $\frac{\text{Heat gained}}{\text{Second}}$ (by 2)

$\therefore \quad \sigma A(2T)^4 + \sigma A(3T)^4 = \sigma(2A)(T')^4$

$\therefore \quad T' = \left[\frac{97}{2}\right]^{1/4} T$

5. **(c)**



Let T be temperature of the junction

Here, $K_A = 2K_B, \quad T - T_B = 50K$

At the steady state,

$$H_A = H_B$$

$$\therefore \frac{K_A A(T_A - T)}{L} = \frac{K_B A(T - T_B)}{L}$$

$$2K_B(T_A - T) = K_B(T - T_B)$$

$$T_A - T = \frac{T - T_B}{2} = \frac{50K}{2} = 25K$$

6. **(c)** Rate of cooling $\frac{\Delta\theta}{t} = \frac{A\varepsilon\sigma(T^4 - T_0^4)}{mc}$

$\Rightarrow t \propto \frac{m}{A}$

[$\Delta\theta, t, \sigma, (T^4 - T_0^4)$ are constant]

$$\Rightarrow t \propto \frac{m}{A} \propto \frac{\text{Volume}}{\text{Area}} \propto \frac{a^3}{a^2} \Rightarrow t \propto a \Rightarrow \frac{t_1}{t_2} = \frac{a_1}{a_2}$$

$$\Rightarrow \frac{100}{t_2} = \frac{1}{2} \Rightarrow t_2 = 200\,\text{sec}$$

7. **(a)** Initially at $t = 0$
Rate of cooling (R) $\propto$ Fall in temperature of body $(\theta - \theta_0)$

$$\Rightarrow \frac{R_1}{R_2} = \frac{\theta_1 - \theta_0}{\theta_2 - \theta_0} = \frac{100 - 40}{80 - 40} = \frac{3}{2}$$

11 Thermodynamics

Fill in the Blanks

1. Law of conservation of energy. According to first law of thermodynamics $\Delta H = \Delta u + \Delta w$

2. Infinite, In isothermal process temperature remains constnat.
i.e., $\Delta T = 0$. Hence according to

$$C = \frac{Q}{m\Delta T} \Rightarrow C_{iso} = \infty$$

3. Change in temperature, In adiabatic process, no heat is taken or given by the system i.e.,
$\Delta Q = 0 \Rightarrow \Delta U = -\Delta W$
If ΔW is negative (work done on system), then ΔU increases & temperature increases and vice-versa. So work done in adiabatic change in particular gas (ideal gas) depends on change in temperature.

4. remains constant

5. adiabatic

6. Adiabatic process $\Delta Q = 0$.

7. isothermal expansion

8. entropy

9. Second law of thermodynamics, External amount of work must be done in order to flow heat from lower temperature to higher temperature.

True/ False

1. True **2.** False

3. True, It is Kelvin-Planck's statement

4. False, No heat engine working between the same two temperatures can have efficiency greater than that of Carnot engine.

5. True **6.** True

7. False. It depends upon temperature

Conceptual MCQs

1. **(c)** The concept of entropy is introduced by the second law of thermodynamics.

2. **(b)** For an isochoric process, $W = 0$
$\therefore \Delta Q = \Delta U$.

3. (a) Efficiency = $\frac{T_1 - T_2}{T_1}$

$T_1 = 227 + 273 = 500$ K
$T_2 = 127 + 273 = 400$ K

$$\eta = \frac{500-400}{500} = \frac{1}{5}$$

Hence, output work

$$= (\eta) \times \text{Heat input} = \frac{1}{5} \times 6 = 1.2 \text{ kcal}$$

4. (c) In isoboric process, volume of system changes, hence heat supplied is used to increase temperature and also in work done. Hence **(c)** is incorrect.

5. (b) $\Delta Q = \Delta U + \Delta W$
$\Rightarrow \Delta W = \Delta Q - \Delta U = 110 - 40 = 70$ J

6. (c) According to question P $\propto$ T^3
But as we know for an adiabatic process the pressure P $\propto$ $T^{\frac{\gamma}{\gamma-1}}$.

So, $\frac{\gamma}{\gamma-1} = 3 \Rightarrow \gamma = \frac{3}{2}$ or, $\frac{C_p}{C_v} = \frac{3}{2}$

7. (b) Internal energy of an ideal gas
$U = nWT$
depends of temperature number of moles and atomicity (as C_v depends on atomicity) of the gas, but it does not depend on pressure of the gas.

8. (c) For a cyclic process, work done can be positive as well as negative.

9. (d) Change in entropy is given by

$$dS = \frac{dQ}{T} \text{ or } \Delta S = \frac{\Delta Q}{T} = \frac{mL_f}{273}$$

$$\Delta S = \frac{1000 \times 80}{273} = 293 \text{ cal/K.}$$

10. (a) During isothermal expansion, the slope of P.V graph,

$$\frac{dP}{dP} = -\frac{p}{V}, \text{ always decreases.}$$

11. (c) For isothermal process,
PV^γ = constant.
Differentiating both sides,
$\gamma P v^{\gamma-1}\, dv + V^\gamma dP = 0$

or $\frac{dP}{dV} = -\gamma \frac{p}{V}$

Now, Bulk modulus,

$$B = -V\frac{dP}{V} = \gamma p$$

$\therefore$ Compressibility = $\frac{1}{B} = \frac{1}{\gamma P}$

12. (c) We know that ratio of specific heats,

$$\gamma = 1 + \frac{2}{n} \text{ or } n = \frac{2}{\gamma - 1}$$

[where n = Degree of freedom]

13. (c) According to first law of thermodynamics
Q = ΔU + W
ΔU = Q – W
= 2 × 4.2 × 1000 – 500 = 8400 –500
= 7900 J

14. (d) $C_P = \frac{7}{2}R;\ C_V = C_P - R = \frac{7}{2}R - R = \frac{5}{2}R$

$$\frac{C_P}{C_V} = \frac{7/2\,R}{5/2\,R} = \frac{7}{5}$$

15. (a) Entropy of matter in solid state is less than that in liquid state.

16. (b) Bursting of tyre is an adiabatic process as it is very fast process.

17. (c) $\eta = 1 - \frac{T_2}{T_1}$ or $\frac{50}{100} = 1 - \frac{500}{T_1}$

$\Rightarrow T_1 = 1000\ K$

Also, $\frac{60}{100} = 1 - \frac{T_2}{1000} \Rightarrow T_2 = 400\ K$

18. (b) At a given temperature, the entropy of a substance in liquid state is less than that in gaseous state.

19. (b) Air conditioner is based on the principle of refrigerator.

20. (d) We know that in adiabatic process,
PV^γ = constant ....(1)
From ideal gas equation, we know that
$PV = nRT$

$V = \frac{nRT}{P}$ ....(2)

Puttingt the value from equation (2) in equation (1),

$$P\left(\frac{nRT}{P}\right)^\gamma = \text{constant}$$

$P^{(1-\gamma)}\, T^\gamma$ = constant

Diagram Based Questions

1. (a) $\because$ Internal energy is the state function.
$\therefore$ In cyclie process; $\Delta U = 0$
According to 1st law of thermodynamics

$$\boxed{\Delta Q = \Delta U + W}$$

So heat absorbed
$\Delta Q = W$ = Area under the curve
= – (2V) (P) = – 2PV
So heat rejected = 2PV

2. **(a)** Initial and final condition is same for all process
$\Delta U_1 = \Delta U_2 = \Delta U_3$
from first law of thermodynamics
$\Delta Q = \Delta U + \Delta W$
Work done
$\Delta W_1 > \Delta W_2 > \Delta W_3$ (Area of P.V. graph)
So $\Delta Q_1 > \Delta Q_2 > \Delta Q_3$

3. **(d)** Work done by the system in the cycle
= Area under P-V curve and V-axis

$$= \frac{1}{2}(2P_0 - P_0)(2V_0 - V_0) + \left[-\left(\frac{1}{2}\right)(3P_0 - 2P_0)(2V_0 - V_0)\right]$$

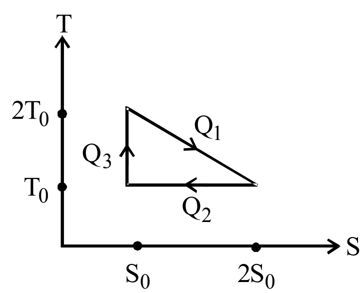
$$= \frac{P_0V_0}{2} - \frac{P_0V_0}{2} = 0$$

4. **(b)** In cyclic process ABCA
$Q_{cycle} = W_{cycle}$
$Q_{AB} + Q_{BC} + Q_{CA}$ = ar. of ΔABC

$$+400 + 100 + Q_{C\to A} = \frac{1}{2}(2 \times 10^{-3})(4 \times 10^4)$$

$\Rightarrow \quad Q_{C\to A} = -460$ J
$\Rightarrow \quad Q_{A\to C} = +460$ J

5. **(d)**



$$Q_1 = T_0S_0 + \frac{1}{2}T_0S_0 = \frac{3}{2}T_0S_0$$

$$Q_2 = T_0(2S_0 - S_0) = T_0S_0 \text{ and } Q_3 = 0$$

$$\eta = \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q_1}$$

$$= 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_0S_0}{\frac{3}{2}T_0S_0} = \frac{1}{3}$$

Assertion/ Reason

1. **(d)** Zeroth law of thermodynamics tells about thermal equilibrium.

2. **(b)** On heating a body it absorbs energy, so, its mass will increase accordingly as per the equation
$E = mc^2$

3. **(d)** Heat can be added to a system without increasing its temperature e.g. melting and boiling.

4. **(d)** According to first law of thermodynamics, $\Delta Q = \Delta U + \Delta W = \Delta U + P\Delta V$. If heat is supplied in such a manner that volume does not change $\Delta V = 0$,i.e., isochoric process, then whole of the heat energy supplied to the system will increase internal energy only. But, in any other process it is not possible.
Also heat may be adsorbed or evolved when state of thermal equilibrium changes.

5. **(d)** In isothermal process, $\Delta T = 0$ and so $\Delta U = 0$.
Thus $Q = 0 + W = W$.

6. **(c)** First law of thermodynamics is restatement of the principal of conservation of energy as applied to heat energy.

7. **(a)** The opening of bottle is the rapid or adiabatic process. In the process temperature falls.

8. **(e)** As isothermal processes are very slow and so the different isothermal curves have different slopes so they cannot intersect each other.

9. **(d)** According to second law of thermodynamics, this is not possible to transfer heat from a body at lower temperature to a body at higher temperature without the aid of an external agent. Since, the given information produces a contradiction in second law of thermodynamics, therefore it is not possible to produce temperature of 8000 K by collecting the sun rays with a lens.

10. **(b)** When milk cools, its energy content decreases.

11. **(a)** $\eta = 1 - \frac{T_2}{T_1}$; clearly when T_2 is decreases η will increase.

Matching Based Questions

1. **(a)** 2. **(a)** 3. **(b)** 4. **(b)**

Critical Thinking Type Questions

1. **(b)** $n = \frac{PV}{RT}$

$$= \left[\frac{1.6 \times 10^6 \times 0.0083}{8.31 \times 300}\right] = 5.33$$

$$Q = nC_v\Delta T$$

or $\quad 2.49 \times 10^4 = 5.33 \times \left(\frac{3 \times 8.31}{2}\right) \times \Delta T$

or $\quad \Delta T = 375$ K
$\therefore \quad T_f = T_i + 375 = 675$ K.

2. **(c)** $T_1 = 273 + 27 = 300$K
$T_2 = 273 + 927 = 1200$K
For adiabatic process,
$P^{1-\gamma}\, T^{\gamma}$ = constant

$\Rightarrow P_1^{1-\gamma} T_1^{\gamma} = P_2^{1-\gamma} T_2^{\gamma}$

$$\Rightarrow \left(\frac{P_2}{P_1}\right)^{1-\gamma} = \left(\frac{T_1}{T_2}\right)^{\gamma}$$

$$\Rightarrow \left(\frac{P_1}{T_2}\right)^{1-\gamma} = \left(\frac{T_2}{T_1}\right)^{\gamma}$$

$$\left(\frac{P_1}{P_2}\right)^{1-1.4} = \left(\frac{1200}{300}\right)^{1.4}$$

$$\left(\frac{P_1}{P_2}\right)^{-0.4} = (4)^{1.4}$$

$$\left(\frac{P_2}{P_1}\right)^{0.4} = 4^{1.4}$$

$$P_2 = P_1\, 4^{\left(\frac{1.4}{0.4}\right)} = P_1\, 4^{\left(\frac{7}{2}\right)}$$

$= P_1\,(2^7) = 2 \times 128 = 256$ atm

3. (b) Initial temperature (T_1) = 18°C = 291 K
Let Initial volume (V_1) = V

Final volume (V_2) = $\dfrac{V}{8}$

According to adiabatic process,
$TV^{\gamma-1}$ = constant

According to question, $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

$$\Rightarrow T_2 = 293\left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$\Rightarrow T_2 = 293(8)^{\frac{7}{5}-1} = 293 \times 2.297 = 668.4\text{K}$$

$$\left[\text{For diatomic gas } \gamma = \frac{C_p}{C_v} = \frac{7}{5}\right]$$

4. (c) For isothermal process $P_1V_1 = P_2V_2$

$$\Rightarrow \quad PV = P_2(2V) \;\Rightarrow\; P_2 = \frac{P}{2}$$

For adiabatic process

$$P_2V_2^{\gamma} = P_3V_3^{\gamma}$$

$$\Rightarrow \quad \left(\frac{P}{2}\right)(2v)^{\gamma} = P_3 16v)^{\gamma}$$

$$\Rightarrow \quad P_3 = \frac{3}{2}\left(\frac{1}{8}\right)^{5/3} = \frac{P}{64}$$

5. (c) As we know, energy stored in a spring

$$U = \frac{1}{2}kx^2$$

x = extension (or compression) in the spring.
k = spring constant of the spring
As per question, for x = 1mm = $1 \times 10^{-3\text{m}}$

$$U = \frac{1}{2}k(1\times10^{-3}\,\text{m})^2 = 1\,\text{J} \qquad ....(i)$$

If spring is further compressed by 1 mm then

$$U' = \frac{1}{2}k(2\times10^{-3}\,\text{m})^2 \qquad ....(ii)$$

Dividing eqn. (ii) by (i), we get

$$\frac{U'}{U} = 4 \text{ or } U' = 4U$$

Work done
$W = U' - U = 4U - U$
$= 3U = 3 \times 1$ J = 3J

6. (b) The efficiency of cycle is

$$\eta = 1 - \frac{T_2}{T_1}$$

For adiabatic process
$T\,V^{\gamma-1}$ = constant

For diatomic gas $\gamma = \dfrac{7}{5}$

$$T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$$

$$T_1 = T_2\left(\frac{V_2}{V_1}\right)^{\gamma-1}$$

$$T_1 = T_2(32)^{\frac{7}{5}-1} = T_2(2^5)^{2/5} = T_2 \times 4$$

$$T_1 = 4T_2$$

$$\therefore \quad \eta = \left(1 - \frac{1}{4}\right) = \frac{3}{4} = 0.75$$

7. (a) As we know $\eta = \dfrac{W}{Q_1} = 1 - \dfrac{T_2}{T_1}$

$$\Rightarrow \quad \eta = 1 - \frac{300\,\text{K}}{1200\text{K}} = \frac{3}{4}$$

$$\frac{3}{4} = \frac{W}{Q_1} \Rightarrow Q_1 = W \times \frac{4}{3} \Rightarrow Q_1 = 12.6 \times 10^6 \times \frac{4}{3}$$

$Q_1 = 16.8 \times 10^6$J.

8. (d) Efficiency $\eta = \dfrac{W_{\text{output}}}{\text{Heat}_{\text{input}}} = \dfrac{w}{3w} = \dfrac{1}{3}$

$$\eta = 1 - \frac{Q_2}{Q_1} = \frac{1}{3}$$

$$\therefore \quad \frac{Q_2}{Q_1} = \frac{2}{3}$$

12 Kinetic Theory

Fill in the Blanks

1. Kinetic theory of matter
2. Boyle's law
3. $\frac{3}{2}k_BT$, In equilibrium, the average kinetic energy of molecules of different gases will be equal. That is

$$\frac{1}{2}m_1\bar{v}_1^2 = \frac{1}{2}m_2\bar{v}_2^2 = \left(\frac{3}{2}k_BT\right)$$

4. Perfectly elastic,
According to kinetic theory of gases there is no loss of energy during the collisions between the molecules. Therefore, collision between the molecules is perfectly elastic.
5. $\frac{5}{3}$, For a monoatomic gas, the average energy of a molecule at temperature T is $\frac{3}{2}k_BT$.

$\therefore$ Internal energy $U = \frac{3}{2}RT$

$$C_V = \frac{dU}{dT} = \frac{3}{2}R$$

For an ideal gas, $C_P - C_V = R$

$\therefore \quad C_P = \frac{5}{2}R$ and $\gamma = \frac{C_P}{C_V} = \frac{5}{3}$

6. Total K.E.
7. 3, A fly moving in a room has three degrees of freedom, because it is free to move in space.
8. Increases

True/ False

1. True,
2. False, The average transnational K.E. is same for molecules of all gases and for each molecules it is $\frac{3}{2}kT$
3. True, Mean free path $\lambda = \frac{kT}{\sqrt{2}\,\pi d^2 P}$
4. True
5. False
6. False, $C_P - C_V = R$ is true for any gas.
7. True, In all the three directions x, y and z gas possess equal energies.

Conceptual MCQs

1. **(d)** All the given phenomena are explained by kinetic theory of gases.
2. **(b)** $\gamma = 1 + \frac{2}{F}$
where F is number of degree of freedom.
As F is least for a monoatomic gas molecules, γ is maximum for monoatomic gas molecule.
3. **(b)** According to the law of equipartition of energies, the gas possesses equal energies in all the three direction x, y and z-axis.
4. **(d)** There is no interaction among the molecules of a gas, hence potential energy of an ideal gas is zero.
5. **(c)** CO_2 gases a linear molecule, hence for CO_2, F = 5.
6. **(c)** Velocity of sound $(C_S) = \sqrt{\frac{\gamma P}{\rho}}$

R.M.S. velocity of gas molecules = $\sqrt{\frac{3P}{\rho}}$

$$\frac{C_s}{C} = \sqrt{\frac{\gamma P}{\rho} \times \frac{\rho}{3P}} = \sqrt{\frac{\gamma}{3}}$$

$$\Rightarrow C_s = C \times \sqrt{\frac{\gamma}{3}}$$

7. **(d)** $c_{rms} \propto \sqrt{T}$
As temperature increases from 300 K to 1200 K that is four times, so, c_{rms} will be doubled.
8. **(b)** $\gamma = \frac{C_P}{C_V} = \frac{15}{10} = \frac{3}{2} \Rightarrow C_V = \frac{2}{3}C_P$

$$C_P - C_V = \frac{R}{J} \Rightarrow C_P - \frac{2}{3}C_P = \frac{R}{J}$$

$$\Rightarrow \frac{C_P}{3} = \frac{R}{J} \Rightarrow C_P = \frac{3R}{J}$$

9. **(d)**
10. **(d)** In kinetic theory of gas, it is assumed that molecules/ atoms have negligible volume.

11. **(d)** From first law of thermodynamics
$\Delta Q = \Delta U + \Delta W$
$= \frac{3}{2} \cdot \frac{1}{4} R (T_2 - T_1) + 0$
$= \frac{3}{8} N_a K_B (T_2 - T_1)$ $[\because K = \frac{R}{N}]$

12. **(b)** $\because P = \frac{1}{3}\frac{mn}{V}V_{rms}^2$
When mass is halved and speed is doubled then
Resultant pressure, $P' = \frac{1}{3} \times \frac{m}{2} \times \frac{n}{V}(2v_{rms})^2$
$= 2P$.

13. **(a)** $P = \frac{1}{3}Nmc^2 = \frac{2}{3} \times \left(\frac{1}{2}Nm\right)c^2 = \frac{2}{3}K.E$

14. **(d)** In a gas molecules move randomly in all possible directions, hence their average velocity is zero.

15. **(b)** As both the gases have equal volume, they must have equal number of moles, hence (i) is correct.
R.M.S. velocity depends on molar mass, hence is different for both the gases (ii) is incorrect. Both the gases are diatomic, hence, they must have some internal energy. (iii) is correct. Average velocity of molecules is zero for both the gases. (iv) is correct.

16. **(b)** $n = \frac{5}{32}$ $\therefore PV = \frac{5}{32}RT$ $[\because PV = nRT]$

17. **(d)** Let the mass of the gas be m.
At a fixed temperature and pressure, volume is fixed.

Density of the gas, $\rho = \frac{m}{V}$

Now $\frac{\rho}{P} = \frac{m}{PV} = \frac{m}{nRT}$
$\Rightarrow \frac{m}{nRT} = x$ (By question)
$\Rightarrow xT = \text{constant} \Rightarrow x_1T_1 = x_2T_2$

$$\Rightarrow x_2 \Rightarrow \frac{x_1T_1}{T_2} = \frac{283}{383}x \begin{bmatrix} \therefore & & \\ T_1 & = & 283K \\ T_2 & = & 383K \end{bmatrix}$$

18. **(c)** $C_{v_{mix}} = \frac{n_1C_{v_1} + n_2C_{v_2}}{n_1 + n_2}$

$$\Rightarrow \frac{13R}{6} = \frac{n_1C_{v_1} + 2n_1C_{v_2}}{n_1 + 2n_1} \quad \left[\because \frac{n_1}{n_2} = \frac{1}{2}\right]$$

$$\Rightarrow \frac{13R}{2} = C_{v_1} + 2C_{v_2}$$

Possible values are,

$C_{v_1} = \frac{3R}{2}$, $C_{v_2} = \frac{5R}{2}$

$\therefore$ Gases are monatomic (like He) and diatomic (like N_2)

19. **(d)** $C_p = \frac{5}{2}R$ and $C_v = \frac{3}{2}R$
We know that $Q_v = nC_v\Delta T$ and $Q_p = nC_p\Delta T$
$\Rightarrow \frac{Q_v}{Q_p} = \frac{3}{5}$.

Given $Q_p = 207$ J $\Rightarrow Q_v \cong 124$ J

20. **(c)** Total K.E. $= \frac{1}{2}fkT = \frac{1}{2}(5)k\left(\frac{mv^2}{3k}\right) = \frac{5}{6}mv^2$

and rotational K.E. $= \frac{1}{2} \times 2 \times k\,k = \frac{1}{3}mv^2$.

Diagram Based Questions

1. **(b)** According to ideal gas equation
$PV = nRT$

$PV = \frac{m}{M}RT$, $P = \frac{\rho}{M}RT$ or $\frac{\rho}{P} = \frac{M}{RT}$

or $\frac{\rho}{P} \propto \frac{1}{T}$

Here, $\frac{\rho}{P}$ represent the slope of graph

Hence $T_2 > T_1$

2. **(a)**

3. **(a)** Change in internal energy from $A \to B$

$\Delta U = \frac{f}{2}nR\Delta T = \frac{f}{2}nR(T_f - T_i)$

$= \frac{5}{2}\{P_fV_f - P_iV_i\}$

(As gas is diatomic $\therefore$ f = 5)

$= \frac{5}{2}\{2 \times 10^3 \times 6 - 5 \times 10^3 \times 4\}$

$= \frac{5}{2}\{12 - 20\} \times 10^3$ J $= 5 \times (-4) \times 10^3$ J

$\Delta U = -20$ KJ

4. **(a)** $\because \theta_1 < \theta_2 \Rightarrow \tan\theta_1 < \tan\theta_2$

$$\Rightarrow \left(\frac{V}{T}\right)_1 < \left(\frac{V}{T}\right)_2$$

From $PV = \mu RT$; $\frac{V}{T} \propto \frac{1}{P}$

Hence $\left(\frac{1}{P}\right)_1 < \left(\frac{1}{P}\right)_2 \Rightarrow P_1 > P_2$.

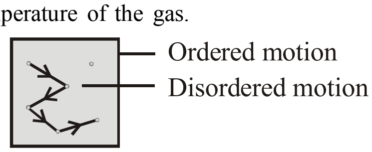
Assertion/ Reason

1. **(d)** The real gases obey the gas equation at low pressure and high temperature as, at high temperature the intermolecular force is negligible due to increased volume of the gas.
2. **(c)** The number 6.02×10^{23} is Avogadro's number and one mole of a substance contains Avogadro's number of molecules.
3. **(b)** Total translational kinetic energy

$$= \frac{3}{2}nRT = \frac{3}{2}PV$$

In an ideal gas all molecules moving randomly in all direction collide and their velocity changes after collision.
4. **(c)** Internal energy can be increased when molecules of gas will get greater velocity w.r.t. container.
5. **(a)** The motion of the container is known as the ordered motion of the gas and zigzag motion of gas molecules within the container is called disordered motion

When the container suddenly stops, ordered kinetic energy gets converted into disordered kinetic energy which is turn increases the temperature of the gas.

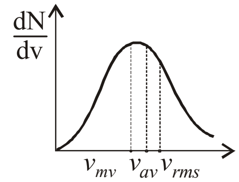


6. **(c)** By law of equipartition of energy, the energy for each degree of freedom in thermal equilibrium is $\frac{1}{2}k_BT$. Each quadratic term form in the total energy expression of a molecules is to be counted as a degree of freedom. Thus each vibrational mode gives 2 degree of freedom i.e, kinetic and potential energy modes, corresponding to the energy

$$2\left(\frac{1}{2}k_BT\right) = k_BT .$$

7. **(d)** Maxwell speed distribution graph is asymmetric graph, because it has a long 'tail' that extends to infinity.

Also U_{rms} depends upon nature of gas and it's temperature.



8. **(a)** The mean free path of a gas molecule is the averge distance between two successive collisions. It is represented by λ.

$$\lambda = \frac{1}{\sqrt{2}}\frac{kT}{\pi\sigma^2 P} \text{ and } \lambda = \frac{m}{\sqrt{2}\cdot\pi\sigma^2 d}$$

Here, σ = 0 diameter of molecule and k = Boltzmann's constant.

$\Rightarrow \lambda \propto 1/d,\ \lambda \propto T$ and $\lambda \propto 1/P$.

Hence, mean free path varies inversely as density of the gas. It can easily proved that the mean free path varies directly as the temperature and inversely as the pressure of the gas.
9. **(d)** A vapour above the critical temperature is a gas and gas below the critical temperature for the substance is a vapour. As gas cannot be liquidfied by the application of pressure alone, how so ever large the pressure may be while vapour can be liquified under pressure alone. To liquify a gas it must be cooled upto or below its critical temperature.

Matching Based Questions

1. **(c)** 2. **(a)** 3. **(c)** 4. **(d)**

Critical Thinking Type Questions

1. **(d)** $V_A = 2V_B$; $T_A = 2T_B$; $P_A = 2P_B$

$$\frac{P_AV_A}{TA} = \frac{P_BV_B}{T_B} = n_AR = n_BR$$

$$\therefore \frac{\eta_A}{\eta_B} = \frac{P_AV_AT_B}{P_BV_BT_A}$$

$$= \frac{(2P_B)(2V_B)(T_B)}{P_B\ V_B\ (2T_B)} = 2$$

2. **(b)** Let n_1 and n_2 be the number of moles of each gas. Then

$$n_1 = \frac{PV}{RT} \text{ and } n_2 = \frac{PV}{RT}$$

When the two gases are mixed, total number of moles,

$$n = n_1 + n_2$$

$$\Rightarrow \frac{P'V}{RT} = \frac{PV}{RT} + \frac{PV}{RT}$$

(where P' is the pressure of the mixture.)

$\Rightarrow \quad P' = 2P$

3. **(d)** Molar mass of the gas = 4g/mol

Speed of sound

$$V = \sqrt{\frac{\gamma RT}{m}} \Rightarrow 952 = \sqrt{\frac{\gamma \times 3.3 \times 273}{4 \times 10^{-3}}}$$

$$\Rightarrow \gamma = 1.6 = \frac{16}{10} = \frac{8}{5}$$

Also, $\gamma = \dfrac{C_P}{C_V} = \dfrac{8}{5}$

So, $C_P = \dfrac{8 \times 5}{5} = 8JK^{-1}mol^{-1}$ [$C_V = 5.0\ JK^{-1}$ given]

4. **(c)** According to given problem

$$(v_{rms})_{O_2} = (v_{rms})_{H_2}$$

$$\sqrt{\frac{3RT_{O_2}}{M_{O_2}}} = \sqrt{\frac{3R(300)}{M_{H_2}}}$$

$$T_{O_2} = 300 \times \frac{M_{O_2}}{M_{H_2}} = 300 \times \frac{32}{2} = 4800\ K$$

5. **(b)** $\dfrac{n_1 + n_2}{\gamma - 1} = \dfrac{n_1}{\gamma_1 - 1} + \dfrac{n_2}{\gamma_2 - 1}$

or $\dfrac{2}{\gamma - 1} = \dfrac{1}{\frac{5}{3} - 1} + \dfrac{1}{\frac{7}{5} - 1}$

$\therefore \quad \gamma = \dfrac{3}{2}$.

6. **(a)** $C_p - C_v = R \Rightarrow C_p = C_v + R$

$$\because \gamma = \frac{C_p}{C_v} = \frac{C_v + R}{C_v} = \frac{C_v}{C_v} + \frac{R}{C_v}$$

$$\Rightarrow \gamma = 1 + \frac{R}{C_v} \Rightarrow \frac{R}{C_v} = \gamma - 1 \Rightarrow C_v = \frac{R}{\gamma - 1}$$

7. **(c)** As no heat is lost,

Loss of kinetic energy

= gain of internal energy of gas

$$\frac{1}{2}mv^2 = nC_V \Delta T \Rightarrow \frac{1}{2}mv^2 = \frac{m}{M} \cdot \frac{R}{\gamma - 1} \Delta T$$

$$\Rightarrow \quad \Delta T = \frac{mv^2(\gamma - 1)}{2R} K$$

13 Oscillation

Fill in the Blanks

1. Oscillatory motion

2. $\dfrac{20}{2\pi}$, $y = 10 \sin (20\ t + 0.5)$

$y\ (t) = a \sin (\omega t + \theta)$

$\therefore \quad$ Frequency, $v = \dfrac{\omega}{2\pi} = \dfrac{20}{2\pi}$

3. decrease

4. ellipse

5. 1 : 4, $\dfrac{E_1}{E_2} = \dfrac{\frac{1}{2}m\omega^2 r_1^2}{\frac{1}{2}m\omega^2 r_2^2} = \left(\dfrac{r_1}{r_2}\right)^2 = \left(\dfrac{5}{10}\right)^2 = 1 : 4$

6. Maximum

7. Forced oscillations, the body oscillates at the angular frequency of the driving force.

8. Maximum

True/ False

1. False, In SHM, acceleration of particle is always directed towards mean position but velocity is either towards or away from mean position.

2. False, In one vibration the particle goes twice to extreme positions and twice crosses the mean position. So does the PE and KE.

3. True, In most of the musical instruments either string or some memberane oscillates to produce pleasant sound.

4. True

5. True, $T \propto \sqrt{m} \Rightarrow T \propto \frac{1}{\sqrt{k}}$

So, T does not depends on the amplitude of the oscillation T depend on m, k.

6. True

Conceptual MCQs

1. **(b)** As the child stands up, centre of mass of the system shifts up decreasing the effective length of the pendulum, hence time period of the swing will decrease.

2. **(c)** The resonance becomes sharp when dramping force is small

3. **(d)** In a satellite, effective value of acceleration due to gravity.

$g' = 0$

$$\therefore T' = 2\pi\sqrt{\frac{l}{g'}} = \infty$$

4. **(a)** Amplitude (A) = 0.01 m, Frequency = 60 Hz

Maximum acceleration

$= A\omega^2 = 0.01 \times (2\pi n)^2$

$= 0.01 \times 4\pi^2 \times 60 \times 60 = 144\pi^2$ m/sec^2

5. **(d)** At equilibrium position, net force and hence acceleration of particle executing simple harmonic motion is zero.

6. **(c)** Time period of a simple pendulum is independent of mass of the bob.

7. **(d)** $x = A\cos(\omega t + \delta)$

$$y = A\cos(\omega t + \alpha) \qquad ....(1)$$

When $\delta = \alpha + \frac{\pi}{2}$

$$x = A\cos\left(\frac{\pi}{2} + \omega t + \alpha\right)$$

$$x = -A\sin(\omega t + \alpha) \qquad ....(2)$$

Squaring (1) and (2) and then adding

$x^2 + y^2 = A^2 [\cos^2(\omega t + \alpha) + \sin^2(\omega t + \alpha)]$

or $x^2 + y^2 = A^2$, which is the equation of a circle. The present motion is anticlockwise.

8. **(d)** $T = 2\pi\sqrt{\frac{\ell}{g}} \qquad T \propto \sqrt{\ell}$

If ℓ is increased by 4 times, time period will increase by two times.

9. **(b)** $y = 3\sin\frac{\pi}{2}(50t - x)$

$y = 3\sin\left(25\pi t - \frac{\pi}{2}x\right)$ on comparing with the standard wave equation

$y = a\sin(\omega t - kx)$

Wave velocity $v = \frac{\omega}{k} = \frac{25\pi}{\pi/2} = 50$ m/sec.

The velocity of particle

$$v_p = \frac{\partial y}{\partial t} = 75\pi\cos\left(25\pi t - \frac{\pi}{2}x\right)$$

$v_{p\,max} = 75\pi$

then $\frac{v_{p\max}}{v} = \frac{75\pi}{50} = \frac{3\pi}{2}$

10. **(c)** We have, $U + K = E$

where, U = potential energy, K = Kinetic energy, E = Total energy.

Also, we know that, in S.H.M., when potential energy is maximum, K.E. is zero and vice-versa.

$\therefore U_{max} + 0 = E \Rightarrow U_{max} = E$

Further,

$$K.E. = \frac{1}{2}m\omega^2 a^2 \cos^2 \omega t$$

But by question, $K.E. = K_0 \cos^2 \omega t$

$$\therefore K_0 = \frac{1}{2}m\omega^2 a^2$$

Hence, total energy, $E = \frac{1}{2}m\omega^2 a^2 = K_0$

$\therefore U_{max} = K_0$ & $E = K_0$.

11. **(b)** The particles of wave moving through a string fixed at both ends execute simple harmonic motion.

12. **(c)** $n = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

$$n' = \frac{1}{2\pi}\sqrt{\frac{k}{4m}} = \frac{1}{2} \times \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

On putting the value of n we get $n' = \frac{n}{2}$

13. **(b)** A second's pendulum crosses mean position at the interval of is, hence its time period is 2s.

14. **(b)** The potential energy of a spring $= \frac{1}{2}kx^2$

$$U = \frac{1}{2}k.(2)^2 = 4 \times \frac{1}{2}k$$

For x = 8 cm,

Energy stored $= \frac{1}{2}k.(8)^2 = 64 \times \frac{1}{2}k$

$$= 64 \times \frac{U}{4} = 16U$$

15. **(c)** Let the S.H.M is described by the equation $x = A \sin \omega t$

$$v = \frac{dx}{dt} = \omega A \cos \omega t$$

$\therefore$ kinetic energy

$$k = \frac{1}{2}mv^2 = \frac{1}{2}m\omega^2 A^2 \cos^2 \omega t$$

$$= \frac{1}{4}m\omega^2 A^2 (1 + \cos 2\omega t)$$

$\therefore$ K.E. of simple harmonic oscillator, oscillates with frequency $2f$.

16. **(a)** At resonance, the frequency of periodic force must be equal to the frequency of oscillations.

17. **(d)** The oscillations of the rod are simple harmonic for small amplitude only.

18. **(a)** Let the two SHM's are described

$x = A \sin \omega t$ ...(1)

and $y = A \sin (\omega t + \frac{\pi}{2}) = A \cos \omega t$...(2)

Squaring and adding,

$x^2 + y^2 = A^2$, which is equation of circle.

19. **(d)** The necessary and sufficient condition for simple harmonic motion is :

F = – kx

i.e. a restoring force proportional to displacement.

20. **(d)** Let $y = A \sin \omega t$

$$v_{inst} = \frac{dy}{dt} = A\omega \cos \omega t = A\omega \sin(\omega t + \pi/2)$$

$$\text{Acceleration} = -A\omega^2 \sin \omega t$$
$$= A\omega^2 \sin(\pi + \omega t)$$

$$\therefore \phi = \frac{\pi}{2} = 0.5\pi$$

Diagram Based Questions

1. **(a)** For $x = (-A)$, we have

$$-A = A\sin(\omega \times 0 + \phi_0)$$

or $\phi_0 = -\frac{\pi}{2}$.

So for $x < (-A)$, $\phi_0 < (-\pi/2)$.

2. **(a)** At point 2, the acceleration of the particle is maximum, which is at the extreme position. At extreme position, the velocity of the particle will be zero.

3. **(b)** $\frac{y}{a} = \sin \theta$

$\therefore$ $y = a \sin \theta$

$\theta = \angle XOP = \omega t - \phi_0$

$\therefore$ $y = a \sin (\omega t - \phi_0)$

4. **(c)**

5. **(a)** t = 0, v maximum. The motion begins from mean position. So it represents S.H.M.

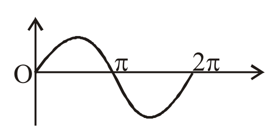
6. **(a)** In $x = A\cos\omega t$, the particle starts oscillating from extreme position. So at t = 0, its potential energy is maximum.

7. **(a)** KE and PE completes two vibration in a time during which SHM completes one vibration. Thus frequency of PE or KE is double than that of SHM.

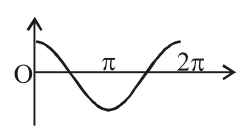
8. **(b)** When some mercury is drained off, the centre of gravity of the bob moves down and so length of the pendulum increases, which result increase in time period.

Assertion/ Reason

1. **(a)** A periodic function is one whose value repeats after a definite interval of time sin θ and cos θ are periodic functions because they repeat itself after 2π interval of time



sin curve



cos curve

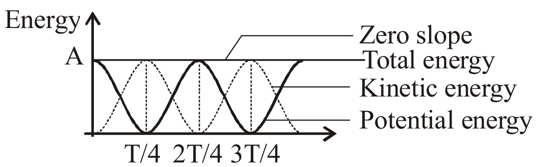
2. **(c)** S.H.M. is to and fro motion of an object and it is periodic.

$$v = \omega\sqrt{k^2 - x^2}$$

If x = 0, v has maximum value. At x = k, v has minimum velocity. Similarly, when x = – k, v has zero value, all these indicate to and from movement.

3. **(a)** The total energy of S.H.M = Kinetic energy of particle + potential energy of particle

The variation of total energy of the particle in SHM with time is shown in a graph



4. **(b)** In SHM. K.E.= $\frac{1}{2}m\omega^2(a^2-y^2)$ and P.E. = $\frac{1}{2}m\omega^2y^2$.

For K.E. = P.E. $\Rightarrow 2y^2 = a^2 \Rightarrow y = a/\sqrt{2}$.

Since total energy remains constant through out the motion, which is E = K.E. + P.E. So, when P.E. is maximum then K.E. is zero and viceversa.

5. **(a)** The time period of a oscillating spring is given by $T = 2\pi\sqrt{\frac{m}{k}} \Rightarrow T \propto \frac{1}{\sqrt{k}}$, Since the spring constant is large for hard spring, therefore hard spring has a less periodic time as compared to soft spring.

6. **(b)** Energy of damped oscillator at an any instant t is given by

$$E = E_0 e^{-bt/m}$$

[where $E_0 = \frac{1}{2}kx^2$ = maximum energy]

Due to damping forces the amplitude of oscillator will go on decreasing with time whose energy is expressed by above equation.

7. **(c)** Amplitude of oscillation for a forced damped oscillatory is

$$A = \frac{F_0/m}{\sqrt{(\omega^2-\omega_0{}^2)+(b\omega/m)^2}}$$, where b is constant related to the strength of the resistive force, $\omega_0 = \sqrt{k/m}$ is natural frequency of undamped oscillator (b = 0)

When the frequency of driving force $(\omega) \approx \omega_0$, then amplitude A is very larger.

For $\omega < \omega_0$ or $\omega > \omega_0$, the amplitude decreases.

8. **(d)** Both assertion and reason are wrong. At the mountain top g will decrease and $T \propto \frac{1}{\sqrt{g}}$.

It will increase. Thus the pendulum clock will become slow. So, pendulum clock loses time.

Matching Based Questions

1. **(c)** 2. **(a)** 3. **(b)** 4. **(c)** 5. **(d)**

Critical Thinking Type Questions

1. **(a)** Here,

$x = x_0 \cos(\omega t - \pi/4)$

$\therefore$ Velocity,

$$v = \frac{dx}{dt} = -x_0\omega\sin\left(\omega t - \frac{\pi}{4}\right)$$

Acceleration,

$$a = \frac{dv}{dt} = -x_0\omega^2\cos\left(\omega t - \frac{\pi}{4}\right)$$

$$= x_0\omega^2\cos\left[\pi + \left(\omega t - \frac{\pi}{4}\right)\right]$$

$= x_0\,\omega^2$

$$\cos\left(\omega t + \frac{3\pi}{4}\right) \quad ...(1)$$

Acceleration, $a = A\cos(\omega t + \delta)$ ...(2)

Comparing the two equations, we get

$A = x_0\omega^2$ and $\delta = \frac{3\pi}{4}$

2. **(b)** $t_1 = 2\pi\sqrt{\frac{m}{k_1}}, t_2 = 2\pi\sqrt{\frac{m}{k_2}}$

when springs are in series then,

$$k_{eff} = \frac{k_1k_2}{k_1+k_2}$$

$$\therefore T = 2\pi\sqrt{\frac{m(k_1+k_2)}{k_1k_2}}$$

$$\therefore T = 2\pi\sqrt{\frac{m}{k_2}+\frac{m}{k_1}}$$

$$= 2\pi\sqrt{\frac{t_2^2}{(2\pi)^2}+\frac{t_1^2}{(2\pi)^2}} \Rightarrow T^2 = t_1^2 + t_2^2$$

3. **(d)** $T = 2\pi\sqrt{\frac{\ell}{g}}$

$$\log T = \log(2\pi) + \frac{1}{2}\log\left(\frac{\ell}{g}\right)$$

$$\Rightarrow \log T = \log(2\pi) + \frac{1}{2}\log(\ell) - \frac{1}{2}\log(g)$$

Differentiating, $\dfrac{\Delta T}{T} = 0 + \dfrac{1}{2} \times \dfrac{\Delta \ell}{\ell} - 0$

$\Rightarrow \dfrac{\Delta T}{T} \times 100 = \dfrac{1}{2} \times \dfrac{\Delta \ell}{\ell} \times 100$

$= \dfrac{1}{2} \times 21 = 10.5 \approx 10\%$

Note: In this method, the % error obtained is an approximate value on the higher side. Exact value is less than the obtained one.

4. (b) Amplitude of a damped oscillator at any instant t is given by

$A = A_0 e^{-bt/2m}$

where A_0 is the original amplitude

From question,

When t = 2 s, $A = \dfrac{A_0}{3}$

$\therefore \dfrac{A_0}{3} = A_0 e^{-2b/2m}$

or, $\dfrac{1}{3} = e^{-b/m}$ … (i)

When t = 6 s, $A = \dfrac{A_0}{n}$

$\therefore \dfrac{A_0}{n} = A_0 e^{-6b/2m}$

or, $\dfrac{1}{n} = e^{-3b/m} = (e^{-b/m})^3$

or, $\dfrac{1}{n} = \left(\dfrac{1}{3}\right)^3$ (Using eq. (i))

5. (b) The time period of pendulam is given by

$T = 2\pi \dfrac{l}{g}$

Acceleration due to gravity of earth is

$g_e = \dfrac{GM}{R_e^2}$

Value of 'g' on planet is

$g_p = \dfrac{GM_p}{R_p^2} = \dfrac{G.2M}{4R^2} = \dfrac{g_e}{2}$

$\therefore T_p = 2\pi \sqrt{\dfrac{l.2}{g_e}} = \sqrt{2}T$

i.e. $T_p = 2\sqrt{2}$

6. (d) As we know, $E = E_0 e^{-\frac{bt}{m}}$

$15 = 45 e^{-\frac{b15}{m}}$

[As no. of oscillations = 15 so t = 15sec]

$\dfrac{1}{3} = e^{-\frac{b15}{m}}$

Taking log on both sides

$\dfrac{b}{m} = \dfrac{1}{15} \ell n\, 3$

14 Waves

Fill in the Blanks

1. Matter waves
2. Mach number,

$$\frac{\text{speed of body}}{\text{speed of sound}} = \text{mach number}$$

3. Interference, When two waves, one incident and other reflected wave, interfere with each other in the string than a new type of wave is produced, which appears stationary in the medium. This wave is called stationary or standing wave. Therefore, standing wave in a string are produced due to interference of waves.
4. Same, frequencies, phases and amplitudes at a given time or place.
5. Harmonics
6. In relative motion, These apparent change in frequency due to motion of source and observer relative to the medium along the line of sight is called Doppler's effect.
7. Interference
8. odd harmonics. The harmonics of frequencies 2n, 4n ____ are missing.

True/ False

1. True,
The particles of the medium only oscillate but do not travel from one place to another.
2. False, Waves transport energy and the pattern of disturbance has information that propagate from one point to another.
3. False, Mechanical waves only transfer energy from one point to another.
4. True,
5. True, In a closed organ pipe, two waves travelling in opposite direction (one incident and other reflected wave from boundary) superimpose with each other to develop a wave pattern which is standing or stationary.
6. False, In an open organ pipe,
Natural frequencies = $v = \dfrac{nv}{2L}$; n = 1, 2, 3, ...
Thus, even and odd i.e., all the harmonics are present.
7. False, Change in frequency has nothing to do with distance between source and listener.

Conceptual MCQs

1. **(d)** An open organ pipe produces both even and odd harmonics.
2. **(a)** Fundamental frequency of an organ pipe,
$$\nu \propto \frac{1}{L}$$
3. **(d)** Phase difference = 60° = $\dfrac{\pi}{3}$
Path difference = $\dfrac{\lambda}{2\pi}$ (phase diff.)
$$= \frac{\lambda}{2\pi} \times \frac{\pi}{3} = \frac{\lambda}{6}$$
4. **(a)** The direction of motion is always perpendicular to the line joining the source and the listener, hence apparent frequency is equal to the actual frequency.
5. **(c)** As the star is moving towards the earth, the apparent frequency of light must be greater than its actual frequency.
6. **(d)** For propagation of a wave, a medium must possess elasticity, inertia and low resistance.
7. **(c)** $f_{\text{apparent}} = \left(\dfrac{u + u/5}{u}\right) f = \dfrac{6}{5} f = 1.2 f$
Wavelength remains constant (unchanged) in this case.
8. **(c)** Speed of a wave represented by the equation
$y(x, t) = \text{A} \sin (kx - \omega t + \phi)$ is $v = \dfrac{\omega}{k}$
By comparison, $\omega = 4\pi$; $k = 0.5\pi$
$$v = \frac{\omega}{k} = \frac{4\pi}{0.5\pi} = 8 \text{ m/sec}$$
9. **(c)** $\text{A} = 2\text{cm}, \dfrac{\omega}{\text{k}} = 128 \text{ ms}^{-1}, 5\lambda = 4, \lambda = \dfrac{4}{5}\text{m}$
$y = \text{A} \sin (\text{kx} - \omega\text{t})$,
$$\text{k} = \frac{2\pi}{\lambda} = \frac{2\pi \times 5}{4} = \frac{31.4}{4} = 7.85$$
$y = 0.02 \text{ m} \sin (7.857 - 1005 \text{ t})$
$\omega = 128 \times 7.85 = 1005$
10. **(b)** $\dfrac{\Delta f}{f} = \dfrac{\nu}{C}$
$$\Rightarrow \frac{(\text{Beats})/2}{f} = \frac{\nu}{C}$$
$$\Rightarrow \text{Beats} = \frac{2 f\nu}{C} = 4.$$
11. **(d)** $2\pi f_1 = 600\ \pi$
$f_1 = 300$ ... (1)
$2\pi f_2 = 608\ \pi$
$f_2 = 304$ ...(2)
$|f_1 - f_2| = 4$ beats
$$\frac{I_{\max}}{I_{\min}} = \frac{(A_1 + A_2)^2}{(A_1 + A_2)^2} = \frac{(5+4)^2}{(5-4)^2} = \frac{81}{1},$$
where A_1, A_2 are amplitudes of given two sound wave.
12. **(c)** Free surface of liquids tends to regain its shape due to its surface tension and causes a transverse wave to propagate on the surface.
13. **(c)** Shock waves do not show Doppler's effect.
14. **(b)** For producing standing waves, the superposing waves must have same amplitude & speed, a phase difference of π and must be travelling in opposite direction.
15. **(d)** $I_{\max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = \left(2\sqrt{I}\right)^2 = 4I$
16. **(b)** Let the oscillations of particle of the wave at $x = 0$ are represented by
$x = a \sin \omega t$
then at crest,
$a = a \sin \omega t$ or $\omega t = \dfrac{\pi}{2}$ ...(1)
and at trough,
$-A = A \sin \omega t_2$ or $\omega t_2 = \dfrac{3\pi}{2}$ ...(2)
Subtracting (1) from (2) we get
$\omega (t_2 - t_1) = \pi$
or $t_2 - t_1 = \dfrac{\pi}{\omega} = \dfrac{T}{2}$
17. **(d)**

18. **(c)** $y = 0.5 \sin \frac{2\pi}{3.2}(64t - x)$. Standard equation of the wave is : $y = a \sin \frac{2\pi}{\lambda}(vt - x)$.

Comparing the given equation with the standard equation, we get $v = 64$ and $\lambda = 3.2$. Therefore, frequency $= \frac{64}{3.2} = 20\text{Hz}$.

19. **(b)** When the waves overlap, the P.E will become zero, hence energy of pulse will be purely kinetic.

20. **(c)** We know that the length of pipe closed at one end for first overtone $(l_1) = \frac{3\lambda}{4}$ and length of the open pipe for third overtone $(l_2) = \frac{4\lambda}{2} = 2\lambda$.

Therefore, the ratio of lengths $\frac{l_1}{l_2} = \frac{3\lambda/4}{2\lambda} = \frac{3}{8}$

or $l_1 : l_2 = 3 : 8$.

21. **(a)** Let ℓ be length of string

$$\ell = \left(\frac{\lambda}{2}\right)2 \Rightarrow \lambda = \ell$$

Hence, the wavelength of standing wave $= \lambda = \ell = 1.21\text{Å}$

22. **(c)** Pressure change will be minimum at both ends. In fact, pressure variation is maximum at $\ell/2$ because the displacement node is pressure antinode.

23. **(c)** Frequencies of sound waves are $\frac{330}{5} \& \frac{330}{5.5}$

i.e., 66 Hz and 60 Hz

Frequencies of beat = 66 – 60 = 6 per second

24. **(b)** According to Doppler's effect

$$n' = \left(\frac{v - v_0}{v - v_s}\right)n = \left(\frac{340 - 10}{340 + 10}\right)n = \frac{330}{350} \times 1950$$

= 2068 Hz

Diagram Based Questions

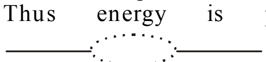
1. **(b)** For a moving source, $\lambda' < \lambda$ (normal wavelength).

2. **(c)** As two waves meet a point with opposite phase hence desctructive interference i.e., minimum sound at that point.

3. **(b)** After 2 s, the each wave travels a distance = $2 \times 2 = 4$ m.

The wave shape is shown in figure.

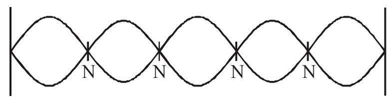
Thus energy is purely kinetic.



4. **(c)** When the waves meet a point with opposite phase, destructive interference is obtained at that point. In this case phase difference,

$$\phi = 180° \text{ or } (2n - 1)\pi \quad n = 1, 2, 3, ...$$

5. **(a)**



Total no. of nodes = 4

6. **(d)** Figure**(a)** represents a harmonic wave of frequency 7.0 Hz, figure **(b)** represents a harmonic wave of frequency 5.0 Hz. Therefore beat frequency

$v_s = 7 - 5 = 2.0$ Hz.

Assertion/ Reason

1. **(c)** In longitudinal waves, the constituents of the medium oscillate parallel to the direction of wave propagation. So sound wave is an example of longitudinal wave.

2. **(d)** Two waves moving in uniform string with uniform tension shall have same speed and may be moving in opposite directions. Hence both waves may have velocities in opposite direction.

3. **(c)** There is no material medium over a long distance between earth and other planets. So explosions on other planets are not heard on Earth.

4. **(a)** Two astronauts cannot talk to each other on moon because moon has no atmosphere and hence there is no medium for propagation of sound.

5. **(c)** Laplace assumed adiabatic process during sound propagation.

6. **(a)** Reflection from a rigid boundary is a case of reflection from a denser medium. In that case the particle velocity and wave velocity are reversed in sign.

7. **(c)** At nodes pressure is maximum. Particles within a loop vibrate in phase.

8. **(d)** Relative to an observer at rest in a medium the speed of a mechanical wave in that medium depends only on elastic and other properties of the medium. It does not depend on the velocity of the source.

9. **(d)** In doppler effect for sound wave effect due to observer and source motion are different.

Matching Based Questions

1. **(c)** **2.** **(c)** **3.** **(d)** **4.** **(d)** **5.** **(b)**
6. **(c)** **7.** **(d)**

Critical Thinking Type Questions

1. **(c)** $y = A \sin(\omega t - kx)$

Particle velocity,

$$v_p = \frac{dy}{dt} = A\omega \cos(\omega t - kx)$$

$\therefore \quad v_{p\,max} = A\omega$

wave velocity $= \frac{\omega}{k}$

$\therefore \quad A\omega = \frac{\omega}{k}$

i. e., $A = \frac{1}{k}$ But $k = \frac{2\pi}{\lambda}$

$\therefore \quad \lambda = 2\pi A$

2. **(b)** From equation, $\omega = 100$

$\therefore \frac{2\pi}{T} = 100 \Rightarrow \nu = \frac{100}{2\pi}$

$\frac{2\pi}{\lambda} = 20 \Rightarrow \lambda = \frac{2\pi}{20}$

$v = \lambda\nu = \frac{2\pi}{20} \times \frac{100}{2\pi} = 5 \text{m/s}$

3. **(d)** Load supported by sonometer wire = 4 kg
Tension in sonometer wire = 4 g
If μ = mass per unit length

then frequency $\upsilon = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

$\Rightarrow \quad 416 = \frac{1}{2l}\sqrt{\frac{4g}{\mu}}$

When length is doubled, i.e., $l' = 2l$
Let new load = L
As, $\upsilon' = \upsilon$

$\therefore \quad \frac{1}{2l'}\sqrt{\frac{Lg}{\mu}} = \frac{1}{2l}\sqrt{\frac{4g}{\mu}}$

$\Rightarrow \quad \frac{1}{4l}\sqrt{\frac{Lg}{\mu}} = \frac{1}{2l}\sqrt{\frac{4g}{\mu}}$

$\Rightarrow \sqrt{L} = 2 \times 2 \quad \Rightarrow L = 16$ kg

4. **(b)** Fundamental frequency,

$$f = \frac{v}{2\ell} = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}} = \frac{1}{2\ell}\sqrt{\frac{T}{A\rho}}$$

$$\left[\because v = \sqrt{\frac{T}{\mu}} \text{ and } \mu = \frac{m}{\ell}\right]$$

Also, $Y = \frac{T\ell}{A\Delta\ell} \Rightarrow \frac{T}{A} = \frac{Y\Delta\ell}{\ell}$

$\Rightarrow f = \frac{1}{2\ell}\sqrt{\frac{\gamma\Delta\ell}{\ell\rho}}$ ....(i)

$\ell = 1.5$ m, $\frac{\Delta\ell}{\ell} = 0.01$, $\rho = 7.7 \times 10^3$ kg/m^3 (given)

$\gamma = 2.2 \times 10^{11}$ N/m^2 (given)

Putting the value of ℓ, $\frac{\Delta\ell}{\ell}$, ρ and γ in eq^n.

(i) we get,

$f = \sqrt{\frac{2}{7} \times \frac{10^3}{3}}$

or, $f \approx 178.2$ Hz

5. **(b)** Fundamental frequency of closed organ pipe

$V_c = \frac{V}{4l_c}$

Fundamental frequency of open organ pipe

$V_0 = \frac{V}{2l_0}$

Second overtone frequency of open organ pipe

$= \frac{3V}{2l_0}$

From question,

$\frac{V}{4l_c} = \frac{3V}{2l_0}$

$\Rightarrow \quad l_0 = 6l_c = 6 \times 20 = 120$ cm

6. **(c)** Let f' be the frequency of sound heard by cliff.

$\therefore f' = \frac{vf}{v - v_c}$ ......(1)

Now for the reflected wave cliff. acts as a source

$\therefore 2f' = \frac{f'(v + v_c)}{v}$ ......(2)

$2f = \frac{(v + v_c)f}{v - v_c} \Rightarrow 2v - 2v_c = v + v_c$

or $\frac{v}{3} = v_c$

7. **(c)** Frequency of the echo detected by the driver of the train is
(According to Doppler effect in sound)

$f' = \left(\frac{v + u}{v - u}\right) f$

where f = original frequency of source of sound
f' = Apparent frequency of source because of the relative motion between source and observer.

$f' = \left(\frac{330 + 220}{330 - 220}\right) 1000 = 5000$ Hz

15 Electric Charges and Fields

Fill in the Blanks

1. Increases; Every system tends to decrease its potential energy to attain more stability, when we increase charge on soap bubble its radius increases,

$$u \propto \frac{1}{r}$$

2. $\frac{1}{r^2}$ Electric field, $E = \frac{1}{4\pi \epsilon_0} \frac{q}{r^2}$
3. Millikan's oil drop experiment
4. $\vec{\tau} = \vec{p} \times \vec{E}$, Torque (t) = Either force × perpendicular distance between the two forces = qaEsinθ or

$$\tau = pE \sin\theta \text{ or } \vec{\tau} = \vec{p} \times \vec{E} \text{ (vector form)}$$

5. $\phi_E = \frac{2e}{\varepsilon_0}$,

Electric flux, $\phi_E = \frac{q}{\varepsilon_0}$

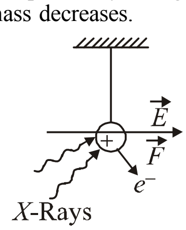
Charge on α-particle = 2e

$$\phi_E = \frac{2e}{\varepsilon_0}$$

6. Zero, Electric charge resides only on the surface of a shell.
7. 90°, $\tau = p\ E\ \sin\ \theta$
8. Coulomb's law

True/ False

1. False,
Electrostatic force is conservative in nature, therefore work done is path independent.
2. True, The metallic sphere which gets negatively charged gains electrons and hence its mass increases. The metallic sphere which gets positively charged loses electrons and hence its mass decreases.
3. True, When high energy *X*-ray beam falls, it will knock out electrons from the small metal ball making it positively charged. Therefore the ball will be deflected in the direction of electric field.



4. True
5. False, Electric field lines start from positive charge and end at negative charged
6. False, they do not form closed loops.
7. False, $E \neq 0$ but potential V = 0

Conceptual MCQs

1. **(b)** Charge(+ Q) gets distributed uniformly over the surface of the sphere. We know that electrostatic potential inside a solid, conducting sphere is constant.
2. **(d)** Charges (–e) on electron and (e) on proton exert a force of attraction given by

$$\text{Force} = (K)\frac{(-e)(e)}{r^2}\hat{r} = \frac{-Ke^2}{r^3}\vec{r}$$

$$\left(\because \hat{r} = \frac{\vec{r}}{|r|}\right)$$

Note : Magnitude of Coulomb force is given by $\frac{1}{4\pi\varepsilon_0}\frac{q_2 q_2}{r^2}$,

but in vector form $\vec{F} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^3}\vec{r}$

3. **(d)**
4. **(a)** Given : Length of the dipole (2*l*) =10cm = 0.1m or *l* = 0.05 m
Charge on the dipole (q) = 500 μC = 500 × 10^{-6} C and distance of the point on the axis from the mid-point of the dipole (*r*) = 20 + 5 = 25 cm = 0.25 m. We know that the electric field intensity due to dipole on the given point (E) =

$$\frac{1}{4\pi\varepsilon_0} \times \frac{2(q.2l)r}{(r^2 - l^2)^2}$$

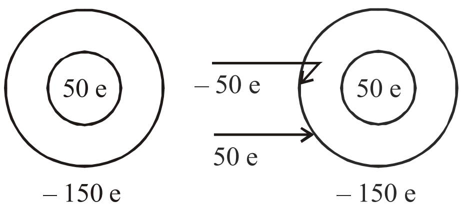
$$= 9 \times 10^9 \times \frac{2(500 \times 10^{-6} \times 0.1) \times 0.25}{[(0.25)^2 - (0.05)^2]^2}$$

$$= \frac{225 \times 10^3}{3.6 \times 10^{-3}} = 6.25 \times 10^7 \ N/C$$

5. **(b)** There exists a point P on the x-axis (other than the origin), where net electric field is zero. Once the charge Q reaches point P, attractive forces of the two -ve charge will dominate and automatically cause the charge Q to cross the origin.
Now if Q is projected with just enough velocity to reach P, its K.E. at P is zero, but while being

attracted towards origin it acquires KE and hence its net energy at the origin is positive. (P.E. at origin = zero)

6. (b)



The charge on inner and outer surfaces = – 50 e, – 100 e

7. (a) The number of molecules in 18 g of water = 6.02×10^{23}

$\therefore$ Number of molecules in 180 g of water

$= 6.02 \times 10^{23} \times \frac{180}{18} = 6.02 \times 10^{24}$

The number of protons in a molecule of water = 10

So, total number of protons, $n = 6.02 \times 10^{24} \times 10 = 6.02 \times 10^{25}$

The total charge, q = ne

$= 6.02 \times 10^{25} \times 1.6 \times 10^{-19} = 0.96 \times 10^{7}$

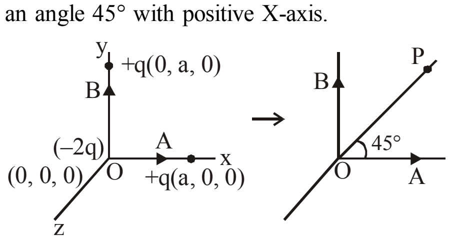
$\approx 1.0 \times 10^{7}$ C.

8. (b) Electric field at a point inside a charged conducting spherical shell is zero.

9. (a) Three point charges +q, –2q and +q are placed at points B (x = 0, y = a, z = 0), O (x = 0, y = 0, z = 0) and A(x = a, y = 0, z = 0)

The system consists of two dipole moment vectors due to (+q and –q) and again due to (+q and –q) charges having equal magnitudes qa units – one along $\overrightarrow{OA}$ and other along $\overrightarrow{OB}$. Hence, net dipole moment,

$p_{net} = \sqrt{(qa)^2 + (qa)^2} = \sqrt{2}qa$ along $\overrightarrow{OP}$ at an angle 45° with positive X-axis.



10. (d) Since $\phi_{total} = \phi_A + \phi_B + \phi_C = \frac{q}{\varepsilon_0}$

Where q is the total charge.

As shown in the figure, flux associated with the curved surface B is $\phi = \phi_B$

Let us assume flux linked with the plane surfaces A and C be

$\phi_A = \phi_C = \phi'$

Therefore,

$$\frac{q}{\varepsilon_0} = 2\phi' + \phi_B = 2\phi' + \phi$$

$$\Rightarrow \phi' = \frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$$

11. (c) Work done in rotating a dipole, = pE (1 – cos θ)

If θ = 90°, work done = pE (1 – 0) = pE

12. (c) Cube has 6 faces. Flux through any face is given by

$$\phi = \frac{q}{6\varepsilon_0} = \frac{q4\pi}{6(4\pi\varepsilon_0)}$$

13. (c) $E = \frac{V}{d} = \frac{2}{4 \times 10^{-8}}$

$= 0.5 \times 10^{8} = 5 \times 10^{7}\ Vm^{-1}$

14. (c) K.E. = Force × distance = qE.y

15. (a) By Gauss theorem

Total electric flux = $\frac{\text{Total charge inside cube}}{\varepsilon_0}$

$$\Rightarrow \phi = \frac{q}{\varepsilon_0}$$

16. (c) Charges (q) = 2×10^{-6} C, Distance **(d)** = 3 cm = 3×10^{-2} m and electric field (E) = 2×10^{5} N/C. Torque (τ) = q.d.

E =$(2 \times 10^{-6}) \times (3 \times 10^{-2}) \times (2 \times 10^{5})$

= 12×10^{-3} N–m .

17. (d) Electric field at location of Q is due to –2Q.

$$E_Q = \frac{-K.2Q}{r^2} = E$$

Electric field at location of – 2Q is due to Q.

$$\therefore E_{-2Q} = \frac{KQ}{r^2}$$

$$\Rightarrow \frac{E_{-2Q}}{E_Q} = \frac{\frac{KQ}{r^2}}{-K\frac{2Q}{r^2}}$$

$$\Rightarrow E_{-2Q} = -\frac{E_Q}{2} = \frac{-E}{2}$$

18. (d) The force between the charges

$$F = k\frac{q(Q-q)}{d^2} = \frac{k(Qq - q^2)}{d^2}$$

For maximum F, $\frac{dF}{dq} = 0$

or $\frac{d}{dq}(Qq - q^2) = 0$

or $Q - 2q = 0$

$\Rightarrow Q = 2q$

$\Rightarrow q = Q/2$

19. **(b)** As new distance = 2 r and electric field due to single charge, $E \propto \frac{1}{r^2}$, therefore, new intensity = E/4.

20. **(d)** According to Gauss's theorem,

$$E\oint ds = \frac{q}{\epsilon_0}\left[\text{Here} \oint ds = 4\pi R^2\right]$$

$$\therefore E = \frac{q/4\pi R^2}{\epsilon_0} \quad [\because q/4\pi R^2 = \sigma]$$

or $E = \sigma/\varepsilon_0$

Diagram Based Questions

1. **(c)** The weight mg of the charge hold in air is in equillibrium with net electrostatic force exerted by the four charges situated at the corners. The net electrostatic force is given by the vector sum of the individual forces exerted by the charges at the corners. This is principle of superposition.

2. **(c)** When charged rod is brought near uncharged conductor near end of conductor has opposite charge.When for end of this conductor is connected is ground (i.e., earthed), charge of far end flows down to ground when for end connection and rod are removed charge on conductor spreads uniformly on surface.

3. **(b)** The electric field around a charge propagates with the speed of light away from the charge. Therefore the required time $= \frac{\text{distance}}{\text{speed}} = \frac{OP}{c}$.

4. **(c)**

5. **(d)** Since electric field $\vec{E}$ decreases inside water, therefore flux $\phi = \vec{E}.\vec{A}$ also decreases.

6. **(a)** The flux is zero according to Gauss' Law because it is a open surface which enclosed a charge q.

Assertion/ Reason

1. **(a)** Conservation of electric charge states that the total charge of an isolated system remains unchanged with time

2. **(c)** Coulomb force and gravitational force follow the same inverse-square law. But gravitational force has only one sign which is always attractive, while coulomb force can be of both signs which are attractive and repulasive.

3. **(d)** Gravitational force is the dominating force in nature and not coulomb's force. Gravitational force is the weakest force. Also, Coulomb's force > > gravitational force.

4. **(b)** Coulomb attraction exists even when one body is charged, and the other is uncharged.

5. **(c)** $q_d = e$, $m_d = 2m_p = 2m$

$q_\alpha = 2e$, $m_\alpha = 4m_p = 4m$

$F_1 = F_\alpha = eE$, $F_2 = F_\alpha = 2eE \neq F_1$

Further, $a_1 = \frac{F_1}{2m} = \frac{eE}{2m}$

and $a_2 = \frac{F_2}{2m} = \frac{2eE}{4m} = \frac{eE}{2m} = a_1$ s

6. **(b)** Force on any charge due to a number of other charges is the vector sum of all the forces on that charge due to the other charges, taken one at a time. The individual force are unaffected due to the presence of other charges. This is the principle of superposition of charges.

7. **(b)** Though the net charge on the conductor is still zero but due to induction negatively charged region is nearer to the rod as compared to the positively charged region. That is why the conductor gets attracted towards the rod.

8. **(d)** The rate of decrease of electric field is different in the two cases. In case of a point charge, it decreases as $1/r^2$ but in the case of electric dipole it decreases more rapidly, as $E \propto 1/r^3$.

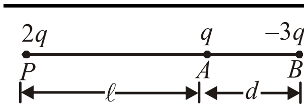
9. **(a)** Since for an infinitely long straight uniformly charged wire, $E = \frac{\lambda}{2\pi\varepsilon_0 r}$ on moving a distance two times the initial distance away from wire, the distance from wire becomes 3r. Therefore final value of electric field $E' = \frac{\lambda}{2\pi\varepsilon_0(3r)} = \frac{E}{3}$.

Matching Based Questions

1. **(c)** **2.** **(a)** **3.** **(a)** **4.** **(b)** **5.** **(c)**

Critical Thinking Type Questions

1. **(b)**



Let a charge $2q$ be placed at P, at a distance I from A where charge q is placed, as shown in figure.

The charge $2q$ will not experience any force, when force, when force of repulsion on it due to q is balanced by force of attraction on it due to $-3q$ at B where AB = d

or $\frac{(2q)(q)}{4\pi\varepsilon_0 \ell^2} = \frac{(2q)(-3q)}{4\pi\varepsilon_0(\ell+d)^2}$

$(\ell + d)^2 = 3\ell^2$

or $2\ell^2 - 2\ell d - d^2 = 0$

$\therefore \quad \ell = \frac{2d \pm \sqrt{4d^2 + 2d^2}}{4} = \frac{d}{2} \pm \frac{\sqrt{3}d}{2}$

$\ell = \frac{d + \sqrt{3}d}{2}$

2. **(c)** In vacuum, $F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}$ ...(i)

Suppose, force between the chrages is same when charges are r' distance apart in dielectric.

$\therefore \quad F' = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{kr'^2}$ ...(ii)

From (i) and (ii), $kr'^2 = r^2$ or, $r = \sqrt{kr'}$

In the given situation, force between the charges would be

$$F' = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{\left(\frac{r}{2} + \sqrt{4}\frac{r}{2}\right)^2} = \frac{4}{9}\frac{q^2}{4\pi\varepsilon_0 r^2} = \frac{4F}{9}$$

3. **(d)** They will not experience any force if $|\vec{F}_G| = |\vec{F}_e|$

$\Rightarrow \quad G\frac{m^2}{(16\times10^{-2})^2} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q^2}{(16\times10^{-2})^2}$

$\Rightarrow \frac{q}{m} = \sqrt{4\pi\varepsilon_0 G}$

4. **(a)** Here, $q = 1$ C, $\varepsilon_0 = 8.85 \times 10^{-12}$ $C^2N^{-1}m^{-2}$

Number of lines of force = Electric force

$= \frac{q}{\varepsilon_0} = \frac{1}{8.85\times10^{-12}} = 1.13 \times 10^{11}$

5. **(a)** **Given :** Length of the dipole ($2l$) = 10cm = 0.1m or l = 0.05 m

Charge on the dipole (q) = 500 μC = 500×10^{-6} C and distance of the point on the axis from the mid-point of the dipole (r) = 20 + 5 = 25 cm = 0.25 m.

We know that the electric field intensity due to dipole on the given point (E)

$= \frac{1}{4\pi\varepsilon_0} \times \frac{2(q.2l)r}{(r^2 - l^2)^2}$

$= 9\times10^9 \times \frac{2(500\times10^{-6}\times0.1)\times0.25}{[(0.25)^2 - (0.05)^2]^2}$

$= \frac{225\times10^3}{3.6\times10^{-3}} = 6.25\times10^7$ N/C

(k = 1 for air)

6. **(d)** Torque, $\vec{\tau} = \vec{p}\times\vec{E} = pE\sin\theta$

$4 = p \times 2 \times 10^5 \times \sin 30°$

or, $p = \frac{4}{2\times10^5\times\sin30°} = 4\times10^{-5}$ Cm

Dipole moment, $p = q \times l$

$q = \frac{p}{l} = \frac{4\times10^{-5}}{0.02} = 2\times10^{-3}$ C = 2mC

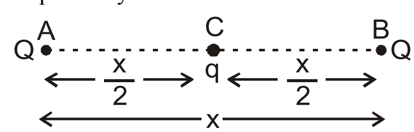
7. **(d)** According to Gauss's theorem,

$E\oint ds = \frac{q}{\varepsilon_0}\left[\text{Here} \oint ds = 4\pi R^2\right]$

$\therefore E = \frac{q/4\pi R^2}{\varepsilon_0}$ $[\because q/4\pi R^2 = \sigma]$

or $E = \sigma/\varepsilon_o$

8. **(d)** Let q charge is situated at the mid position of the line AB. The distance between AB is x. A and B be the positions of charges Q and Q respectively.



Let $AC = \frac{x}{2}$, $BC = \frac{x}{2}$

The force on A due to charge q at C,

$\vec{F}_{CA} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{Q.q}{(x/2)^2}$ along $\overrightarrow{AC}$

The force on A due to charge Q at B

$\vec{F}_{AB} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{Q^2}{x^2}$ along $\overrightarrow{BA}$

The system is in equilibrium, then two oppositely directed force must be equal, i.e., total force on A is equal to zero.

$\vec{F}_{CA} + \vec{F}_{AB} = 0 \Rightarrow \vec{F}_{CA} = -\vec{F}_{AB}$

$\frac{1}{4\pi\varepsilon_0}\cdot\frac{4Q.q}{x^2} = \frac{-1}{4\pi\varepsilon_0}\cdot\frac{Q^2}{x^2}$

$\Rightarrow q = -\frac{Q}{4}$

16 Electrostatic Potential and Capacitance

Fill in the Blanks

1. Zero, W = PE(cos 90° – cos 270°) = 0.
2. Increases, Since capacitance $C = \frac{\varepsilon_0 A}{d}$, as d decreases capacitance increases.
3. Electric energy
4. remains unchanged As $C = \frac{\varepsilon_0 A}{(d-t)}$
5. dielectric strength
6. $U = \int_0^v CV\, dV = \frac{1}{2}CV^2$
7. Capacitor
8. Van De graff generator, It is a machine that can built up high voltages of the order of a few million volts. The resulting large electric fields are used to accelerate charged particles (electrons, protons, ions) to high energies needed for experiments to probe the small scale structure of matter.

True/ False

1. True, ; Because of internal fields in the molecule.
2. True, Electric field lines are always perpendicular to equipotential surface
3. False, they cannot be in a direction of tangent to an equipotential surface.
4. True,
5. True, for any two points on equipotential surface the potential difference is zero.
6. True
7. True; This is in case of series grouping of capacitors.

Conceptual MCQs

1. **(d)** All **(a)**, **(b)**, **(c)** are not true. When dielectric is removed C decreases by a factor k. Hence **(a)** is not true.
   q = CV = constant. ∴ V increases by a factor k. **(c)** is not true.
   E = V/d. ∴ E increases by a factor k. Hence **(b)** is not true.
2. **(d)** $\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$

   $= -[(6-8y)\hat{i} + (-8x-8+6z)\hat{j} + (6y)\hat{k}]$

   At (1, 1, 1), $\vec{E} = 2\hat{i} + 10\hat{j} - 6\hat{k}$

   $\Rightarrow \quad (\vec{E}) = \sqrt{2^2 + 10^2 + 6^2} = \sqrt{140} = 2\sqrt{35}$

   $\therefore \quad F = q\vec{E} = 2 \times 2\sqrt{35} = 4\sqrt{35}$
3. **(b)** $V = \frac{q}{4\pi\varepsilon_0 a}$
4. **(a)** Due to the change inside a sphere of radius r only.
5. **(b)**
6. **(c)** Capacitance of the capacitor, $C = \frac{Q}{V}$

   After inserting the dielectric, new capacitance C^1 = K.C

   New potential difference

   $V^1 = \frac{V}{K}$

   $u_i = \frac{1}{2}cv^2 = \frac{Q^2}{2C} \qquad (\because Q = cv)$

   $u_f = \frac{Q^2}{2f} = \frac{Q^2}{2kc} = \frac{C^2V^2}{2KC} = \left(\frac{u_i}{k}\right)$

   $\Delta u = u_f - u_i = \frac{1}{2}cv^2\left\{\frac{1}{k} - 1\right\}$

   As the capacitor is isolated, so change will remain conserved p.d. between two plates of the capacitor

   $L = \frac{Q}{KC} = \frac{V}{K}$
7. **(b)** Potential at the centre of the sphere = potential on the surface = 80 V.
8. **(c)** The electric field inside the inner shell is zero. So, the potential on inner shell and all the points inside it will be constant.
9. **(a)** Work = Increase in potential energy

   $= Kq_1q_2\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$

   $= 9 \times 10^9 \times 8 \times 10^{-6} \times 12 \times 10^{-6}$

   $\left(\frac{1}{6 \times 10^{-2}} - \frac{1}{10 \times 10^{-2}}\right)$

$= 9 \times 8 \times 12 \left(\frac{1}{6} - \frac{1}{10}\right) \times 10^{-1} = 5.8$ J

10. (c) On an isolated capacitor charge remains constant .

11. (c) If q_1 and q_2 are the final charges, then $q_1 + q_2 = 15 + 15 = 30$ ...(1)

and $\frac{1}{4\pi\varepsilon_0}\frac{q_1}{r_1} = \frac{1}{4\pi\varepsilon_0}\frac{q_2}{r_2}$

or $\frac{q_1}{q_2} = \frac{r_1}{r_2} = \frac{5}{10} = \frac{1}{2}$ ...(2)

Solving (i) & (ii), $q_1 = 10\mu C$

12. (b) The potential of A, $V_a = +$ ve

$V_b = 0$

$V_d = 0$

$V_c = -$ ve

Thus $V_a > V_b = V_d > V_c$

13. (b) By conservation of charge, the charge on bigger drop Q = Nq

If R is the radius of the bigger drop, then

$\frac{4}{3}\pi R^3 = N \times \frac{4}{3}\pi r^3 \Rightarrow R = N^{1/3} r$

For small drop $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$

The potential of bigger drop,

$V_0 = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$

$= \frac{1}{4\pi\varepsilon_0}\frac{Nq}{N^{1/3} r} = N^{2/3}\frac{1}{4\pi\varepsilon_0}\frac{q}{r}$

$= N^{2/3}$ V

14. (c) $U = \frac{1}{2}C_1V^2 = \frac{1}{2} 1 \times 10^{-6} \times 4^2$

$= 8 \times 10^{-6}$ J

15. (c)
$$\begin{matrix} V_1 & V_2 & V_3 & V_4 \\ -7 & -5 & -9 & -8 \end{matrix}$$

16. (a) Work done = potential difference × charge

For BC,

$W = (V_C - V_B) \times Q = (-3 - 1) \times -2 = 8J$

(Workdone depends only on initial and final position)

For BAD,

$W = (V_D - V_B) \times Q = (2 - 1) \times -2 = -2J$

For AD,

$W = (V_D - V_A) \times Q = (2 + 1) \times -2 = -6J$

For ABC,

$W = (V_C - V_A) \times Q = (-3)-(-1) \times -2 = +4$ J

Thus work is maximum for path BC

17. (c) $\frac{\varepsilon_0 A}{d}$, charge on plate is $Q = CV = \frac{\varepsilon_0 A V_0}{d}$

Energy stored is $W = Q^2/2C$

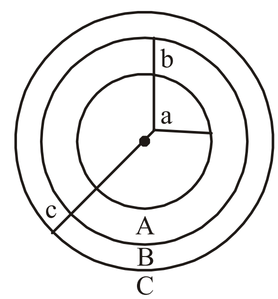
As d is increased 3 times, C decreases 3 times. Battery is disconnected, so Q remains same. The difference in the energy is the work done.

18. (d) c = a + b.

$$V_A = \frac{\sigma a}{\varepsilon_0} - \frac{\sigma b}{\varepsilon_0} + \frac{\sigma c}{\varepsilon_0} = \frac{\sigma}{\varepsilon_0}[c - (b - a)]$$

$$V_B = \frac{-\sigma b}{\varepsilon_0} + \frac{1}{4\pi\varepsilon_0} \cdot \frac{\sigma \times 4\pi a^2}{b} + \frac{\sigma c}{\varepsilon_0}$$

$$= \frac{\sigma}{\varepsilon_0}\left[c - \frac{(b^2 - a^2)}{b}\right]$$



$$V_C = \frac{\sigma c}{\varepsilon_0} - \frac{1}{4\pi\varepsilon_0} \cdot \frac{\sigma \times 4\pi b^2}{c} + \frac{1}{4\pi\varepsilon_0} \cdot \frac{\sigma \times 4\pi a^2}{c}$$

$$= \frac{\sigma}{\varepsilon_0}\left[c - \frac{(b^2 - a^2)}{c}\right]$$

$$= \frac{\sigma}{\varepsilon_0}[c - (b - a)]$$

$V_A = V_C \neq V_B$

19. (a) Given that, $V = Q \times 10^{11}$ volts

Electric potential at point is given by

$$V = \frac{1}{4\pi\epsilon_0}.\frac{Q}{r} \text{ or, } Q \times 10^{11} = \frac{1}{4\pi\epsilon_0}.\frac{Q}{r}$$

$$\Rightarrow r = \frac{1}{4\pi\epsilon_0}.10^{-11} m.$$

$$\text{As } |E| = \frac{|V|}{r} = \frac{Q \times 10^{11}}{\frac{1}{4\pi\epsilon_0}.10^{-11}}$$

$$= 4\pi\epsilon_0 Q \times 10^{22} \text{ volt m}^{-1}.$$

20. (d) At two different points, outside the sphere if $|E_1| = |E_2|$, then their potential must be equal.

21. (c) The energy stored by a capacitor

$$U = \frac{1}{2}CV^2 \qquad ...(i)$$

V is the p.d. between two plates of the capacitor. The capacitance of the parallel plate capacitor

$V = E.d.$

$$C = \frac{A\varepsilon_0}{d}$$

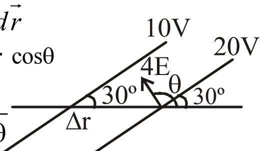
Substituting the value of C in equation (i)

$$U = \frac{1}{2}\frac{A\varepsilon_0}{d}(Ed)^2 = \frac{1}{2}A\varepsilon_0 E^2 d$$

Diagram Based Questions

1. (b) Electric field is always zero inside a conductor. If there is any excess of charge on a hollow conductor it always resides on the outer surface of conductor. Therefore inside a hollow conductor there is no charge and hence charge density is zero.

2. (c) Using $dV = -\vec{E}.d\vec{r}$



$\Rightarrow \Delta V = -E\,\Delta r\cos\theta$

$\Rightarrow E = \dfrac{-\Delta V}{\Delta r\cos\theta}$

$\Rightarrow E = \dfrac{-(20-10)}{10\times10^{-2}\cos120°}$

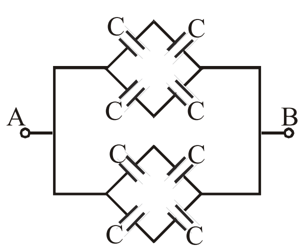
$= \dfrac{-10}{10\times10^{-2}(-\sin 30°)}$

$= \dfrac{-10^2}{-1/2} = 200\ V/m$

Direction of E be perpendicular to the equipotential surface *i.e.* at 120° with X-axis.

3. (a)

4. (b)



The figure shows two independent balanced wheatstone Brides connected in parallel each having a capacitance C. So,

$C_{net} = C_{AB} = 2C$

5. (b) Potential difference across the branch de is 6 V. Net capacitance of de branch is 2.1 μF

So, q = CV

$\Rightarrow$ q = 2.1 × 6 μC

$\Rightarrow$ q = 12.6 μ C

Potential across 3 μF capacitance is

$V = \dfrac{12.6}{3} = 4.2$ volt

Potential across 2 and 5 combination in parallel is 6 – 4.2 = 1.8 V

So, q' = (1.8) (5) = 9 μC

Assertion/ Reason

1. (c) Potential and potential energy are different quantities and cannot be equated.

2. (d) For a non-uniformly charged thin circular ring with net zero charge, electric potential at each point on its axis is zero. Hence electric field at each point on its axis must be perpendicular to the axis. Therefore Assertion is false and Reason is true.

3. (a) As these is no electric field inside the conductor, and so no energy inside it.

4. (c) Reason is false because the work done in bringing a unit positive charge from infinity to a point in equatorial plane is equal and opposite for the two charges of the dipole.

5. (c) $C' = kC$, and so, $U' = \frac{1}{2}(kC)V^2 = kU$. Also $q' = C'V = kCV = kq$, and so charge density increases.

6. (c) $C' = kC$, and $U' = \dfrac{q^2}{2C'} = \dfrac{q^2}{2kC}$. With the introduction of dielectric, energy of the system decreases. As charge on the capacitor remains same, and so force between them remains same.

7. (a) $U = \frac{1}{2}CV^2$. In the battery connected capacitor V remains constant while C increases with the introduction of dielectric and so U will increase.

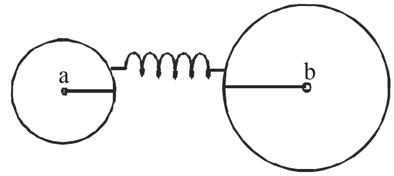
8. (d) Two equipotential surfaces never intersect each other so they cannot be orthogonal.

Matching Based Questions

1 (a) **2. (b)** **3. (b)** **4. (d)**

Critical Thinking Type Questions

1. (c)



Let charge on each sphere $= q$

when they are connected together their potential will be equal .

Now let charge on $a = q_1$ and on $b = 2q - q_1$

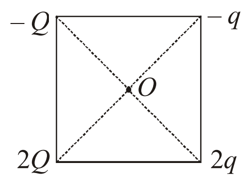
$$\Rightarrow V_a = V_b \text{ or } \frac{1}{4\pi\varepsilon_o}\frac{q_1}{a} = \frac{1}{4\pi\varepsilon_o}\frac{2q - q_1}{b}$$

$$\Rightarrow \frac{q_1}{2q - q_1} = \frac{a}{b}$$

$$\frac{E_a}{E_b} = \frac{\frac{1}{4\pi\varepsilon_o}\cdot\frac{q_1}{a^2}}{\frac{1}{4\pi\varepsilon_o}\frac{q_2}{b^2}} = \left(\frac{q_1}{2q - q_1}\right)\frac{b^2}{a^2}$$

$$= \frac{a}{b}\cdot\frac{b^2}{a^2} = \frac{b}{a} \quad = b : a$$

2. (a) Let the side length of square be 'a' then potential at centre O is



$$V = \frac{k(-Q)}{\left(\frac{a}{\sqrt{2}}\right)} + \frac{k(-q)}{\frac{a}{\sqrt{2}}} + \frac{k(2q)}{\frac{a}{\sqrt{2}}} + \frac{k(2Q)}{\frac{a}{\sqrt{2}}} = 0$$

(Given)

$= -Q - q + 2q + 2Q = 0 = Q + q = 0$

$Q = -q$

3. **(d)** $\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$

$= -[(6 - 8y)\hat{i} + (-8x - 8 + 6z)\hat{j} + (6y)\hat{k}]$

At (1, 1, 1), $\vec{E} = 2\hat{i} + 10\hat{j} - 6\hat{k}$

$\Rightarrow (\vec{E}) = \sqrt{2^2 + 10^2 + 6^2} = \sqrt{140} = 2\sqrt{35}$

$\therefore \quad F = q\vec{E} = 2 \times 2\sqrt{35} = 4\sqrt{35}$

4. **(c)** Capacitance of the capacitor, $C = \frac{Q}{V}$

After inserting the dielectric, new capacitance

$C^1 = K.C$

New potential difference

$V^1 = \frac{V}{K}$

$U_i = \frac{1}{2}CV^2 = \frac{Q^2}{2C} \qquad (\because Q = cv)$

$U_f = \frac{Q^2}{2F} = \frac{Q^2}{2KC} = \frac{C^2V^2}{2KC} = \left(\frac{u_i}{k}\right)$

$\Delta U = U_f - U_i = \frac{1}{2}CV^2\left\{\frac{1}{K} - 1\right\}$

As the capacitor is isolated, so change will remain conserved p.d. between two plates of the capacitor

$L = \frac{Q}{KC} = \frac{V}{K}$

5. **(d)** : Here, $V = 15 \times 10^6\ V$ dielectric strength $= 5 \times 10^7\ V\ m^{-1}$

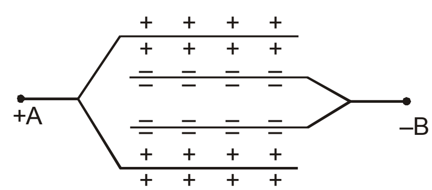
Maximum electric field, E = 10% of dielectirc stength

$\therefore \quad E = \frac{10}{100} \times 5 \times 10^7 = 5 \times 10^6\ V\ m^{-1}$

As $E = \frac{V}{r}$

$\therefore \quad r = \frac{V}{E} = \frac{15 \times 10^6}{5 \times 10^6} = 3\ m$

6. **(b)** It consists of two capacitors in parallel, therefore, the total capacitance is $= \frac{2\in_0 A}{d}$



(The plates of B, having negative charge do not constitute a capacitor).

17 Current Electricity

Fill in the Blanks

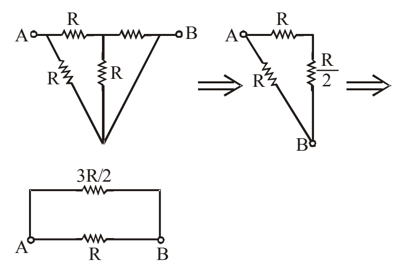
1. Potential ,V ; $V_d = \dfrac{V}{\rho\ell ne}$
2. $R = \dfrac{V}{I}$
3. Negligible temperature co-efficient of resistance
4. high
5. $\dfrac{n}{n+1}$, Internal resistance = r, External resistance = nr.
   Let terminal voltage = V
   then $V = E - Ir \Rightarrow V = E - \dfrac{Er}{(n+1)r}$
   $V = \dfrac{nE}{n+1} \Rightarrow \dfrac{V}{E} = \dfrac{n}{n+1}$
6. Charge
7. remain unchanged
8. Conductance; $\sigma = \dfrac{1}{R}$
9. Increasing .

True/ False

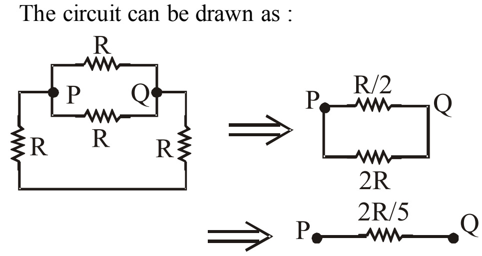
1. True **2.** False
3. False; microscopic form of ohm's law is $J = \sigma\vec{E}$
4. True, When resistances are connected in series the same current flows through each resistance.
5. False ; Same current through all resistors in series.
6. True,
7. False, The order of magnitude of current in lightening is very high approx 10,000 of amperes.

Conceptual MCQs

1. **(b)** Given : Length of wire (l) = 15m
   Area (A) = 6×10^{-7} m^2
   Resistance (R) = 5Ω.
   We know that resistance of the wire material
   $$R = \rho\frac{l}{A}$$
   $$\Rightarrow 5 = \rho \times \frac{15}{6\times10^{-7}} = 2.5\times10^{7}\rho$$
   $$\Rightarrow \rho = \frac{5}{2.5\times10^{7}} = 2\times10^{-7}\ \Omega - \text{m}$$
   [where ρ = coefficient of resistivity]
2. **(c)**
3. **(d)** Arrange the resistors in all possible combinations and get the number of combinations as ten with nine different values. The combinations can be all 4 in series, all 4 in parallel, 3 in series with 1 in parallel, 3 in parallel with 1 in series etc.
4. **(d)** The circuit can be redrawn as and finally $R_{AB} = \dfrac{3}{5}R$



5. **(a)** As we know that resistance varies with temperature as
   $R = R_0\,[1 + \alpha t]$
   Ist Case : $5 = R_0\,[1 + \alpha(50)]$ ....(I)
   IInd Case : $7 = R_0\,[1 + \alpha(100)]$ .....(II)
   Divide (I) by (II), $\dfrac{5}{7} = \dfrac{1+50\alpha}{1+100\alpha}$
   $5 + 500\alpha = 7 + 350\alpha$
   $150\,\alpha = 2 \Rightarrow \alpha = \dfrac{2}{150} = 0.001\,/°C$
6. **(b)** The circuit can be drawn as :



   $\therefore\ R_{PQ} = \dfrac{2R}{5}$.
7. **(a)** Here $E > \dfrac{ER}{R+r}$, hence the lengths 110 cm and 100 cm are interchanged.
   Without being short-circuited through R, only the battery E is balanced.

$$E = \frac{V}{L} \times l_1 = \frac{V}{L} \times 110 \ldots\ldots(i)$$

When R is connected across E, $Ri = \frac{V}{L} \times l_2$

or, $R\left(\frac{E}{R+r}\right) = \frac{V}{L} \times 100 \ldots\ldots(ii)$

Dividing (i) by (ii), we get

$$\frac{R+r}{R} = \frac{110}{100}$$

or, 100 R + 100 r = 110 R

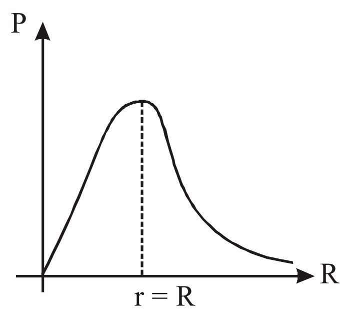
or, 10 R = 100 r

$$\therefore\ r = \frac{10R}{100} = \frac{10 \times 10}{100} (\because R = 10\Omega)$$

$\Rightarrow r = 1\Omega.$

8. **(a)** Power maximum when $r = R$.

So, power consumed by it will decrease for $R > r$.



9. **(a)** In a Wheatstone bridge, the deflection in the galvanometer does not change if the battery and galvanometer are interchanged.

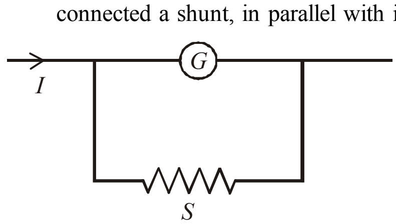
10. **(d)** In parallel combination, potential drop across each resistance is same.

Heat developed $= \frac{V^2}{R}$

$$H_1 = \frac{V^2}{R}, \qquad H_2 = \frac{V^2}{2R}, \quad H_3 = \frac{V^2}{3R}$$

$\therefore$ Heat developed in resistance R is maximum.

11. (a) Galvanometer is converted into ammeter, by connected a shunt, in parallel with it.



$$\frac{GS}{G+S} = \frac{V_G}{I} = \frac{25 \times 10^{-3}}{25}$$

$$\frac{GS}{G+S} = 0.001\Omega$$

Here $S << G$ so

$S = 0.001\ \Omega$

12. **(d)** Copper is a metal whereas Germanium is semi-conductor.

13. **(d)** **14.** **(a)** **15.** **(c)** **16.** **(b)**

17. **(a)** $H = \frac{i^2 R}{2\pi r \ell} = \frac{i^2 \frac{\rho \ell}{\pi r^2}}{2\pi r \ell}$

or $H \propto \frac{1}{r^3}$

18. **(a)** Kirchhoff ' s first law deals with conservation of electrical charge & the second law deals with conservation of electrical energy.

19. **(a)** In conductors, the charge carriers are free electrons.

20. **(c)** $H = \frac{V^2}{R} t = \frac{(V/2)^2}{\rho} t'$

$\therefore$ $t' = 4t$

21. **(c)** $P = \frac{V^2}{R} = \frac{V'^2}{R'}$

22. **(c)** Power $= V . I = I^2 R$

$$i_2 = \sqrt{\frac{\text{Power}}{R}} = \sqrt{\frac{2}{8}} = \sqrt{\frac{1}{4}} = \frac{1}{2}\ A$$

Potential over 8Ω = $Ri_2 = 8 \times \frac{1}{2} = 4V$

This is the potential over parallel branch. So,

$$i_1 = \frac{4}{4} = 1\ A$$

Power of $3\Omega = i_1{}^2 R = 1 \times 1 \times 3 = 3W$

23. **(a)** Current $I = 2E/(R + r_1 + r_2)$.

Diagram Based Questions

1. **(d)** As we know, resistance $R = \rho \frac{l}{A}$. The resistance of conductor l is given by

$$R_I = \rho \frac{l}{3A} = \frac{R}{3} \qquad \left(\text{where} \quad R = \rho \frac{l}{A}\right)$$

Similarly, $R_{II} = \rho \frac{2l}{A} = 2R$

and $R_{III} = \rho \frac{3l}{2A} = \frac{3}{2} R$

From this we conclude that $R_{II} > R_{III} > R_I$. Since in parallel combination of resistances current distributes in inverse ratio of resistances, therefore $i_2 < i_3 < i_1$

2. **(c)** The resistivity of semiconductor decreases with increase in temperature.

3. **(c)** $I = \frac{E}{R+r} = \frac{E}{(\sqrt{R} - \sqrt{r})^2 + 2\sqrt{R}\sqrt{r}}$

I is maximum when R = r

$P = I^2R$, when I is max, P is also max.

$P_{max} = I^2_{max}R$.

4. **(b)** If we apply Kirchhoff's loop rule to the loop BCDEB in clockwise direction the changes in potential across R_3 and R_4 are negative. Therefore $i_3\ R_3$ and $i_3\ R_4$ should have negative sign. But for this clockwise direction we are moving in a direction opposite to i_2 across R_2. Current flows from higher potential to lower potential but we are moving from lower potential to higher potential i.e., potential is increasing. So the change in potential is positive. Therefore $i_2\ R_2$ has positive sign.

5. **(b)** The working principle of meter bridge is

$$\frac{R}{S} = \frac{l}{100 - l} \quad \ldots \text{(i)}$$

When S' is connected in parallel with S we obtain equivalent resistance S_{eq} of S and S' which is less than S. Thus if the value of denominator of L.H.S. of eq. (i) decreases then value of denominator of R.H.S. of eq. (i) also decreases. For this to happen the null point shifts to the right of D.

6. **(d)** In balance condition, since no current flows through the galvanometer therefore *B* and D are at the same potential.

Assertion/ Reason

1. **(d)** We call those quantities as vector quantities which have magnitude and direction and obey laws of vector addition. Though current has magnitude as well as direction but it does not obey laws of vector addition. Hence it is not a vector quantity.

2. **(d)** A diode does not obey Ohm's law while a resistor obeys. But the equation $V = IR$ can be applied to both. In fact the equation $V = IR$ can be applied to all the conducting devices whether they obey Ohm's law or not. So $V = IR$ is not a statement of Ohm's law. Ohm's law states that V is directly proportional to I i.e.. $V \propto I$. The proportionality sign is changed to equality sign in the equation $V = IR$ with R as constant of proportionality know as resistance of conductor. Thus the equation $V = IR$ defines resistance.

3. **(c)** Before the presence of electric field, the free electrons move randomly in the conductor, so their drift velocity is zero and therefore there is no current in the conductor. In the presence of electric field, each electron in the conductor experience a force in a direction opposite to the electric field. Now the free electrons are accelerated from negative and to the positive end of the conductor and hence a current starts to flow from the conductor.

4. **(a)** We know that $V = IR$

Since $R = \rho\frac{l}{A}$

Therefore $V = I\rho\frac{l}{A}$ $\quad \ldots$ (i)

Now $\frac{I}{A} = j$ is the current density.

Therefore eq. (i) becomes

$V = j\rho l$ $\quad$ or $\quad \frac{V}{l} = j\rho$

Now $\frac{V}{l} = E,$ where E is magnitude of electric field.

Therefore $E = j\rho$ $\quad \ldots$ (ii)

Current density $\vec{j}$ is also a vector which is directed along $\vec{E}$. Therefore the relation (ii) can also be written in vector form $\vec{E} = \rho\,\vec{j}$.

5. **(a)** When temperature increases the random motion of electrons and vibration of ions increases which results in more frequent collisions of electrons with the ions. Due to this the average time between the successive collisions, denoted by τ, decreases which increases ρ.

6. **(b)** On increasing temperature of wire the kinetic energy of free electrons increase and so they collide more rapidly with each other and hence their drift velocity decreases. Also when temperature increases, resistivity increases and resistivity is inversely proportional to conductivity of material.

7. **(a)** Resistance wire $R = \rho\frac{I}{A}$, where ρ is resistivity of material which does not depend on the geometry of wire. Since when wire is bent resistivity, length and area of cross-section do not change, therefore resistance of wire also remain same.

8. **(a)** If either e.m.f. of the driver cell or potential difference across the whole potentiometer wire is lesser than the e.m.f. of then experimental cell, then balance point will not obtained.

9. **(c)** The resistance of the galvanometer is flexed. In meter bridge experiments, to protect the galvanometer from a high current, high resistance is conneted to the galvanometer in order to protect it from damage.

Matching Based Questions

1. (b) **2.** (d) **3.** (c) **4.** (c)
5. (d) **6.** (a) **7.** (b)

Critical Thinking Type Questions

1. **(a)** Current flowing through the conductor, I = n e v A. Hence

$$\frac{4}{1}=\frac{nev_{d_1}\pi(1)^2}{nev_{d_2}\pi(2)^2} \text{ or } \frac{v_{d_1}}{v_{d_2}}=\frac{4\times 1}{1}=\frac{16}{1}.$$

2. **(b)** $R_t = R_0(1+\alpha t)$
Initially, $R_0(1+30\alpha) = 10\ \Omega$
Finally, $R_0(1+\alpha t) = 11\ \Omega$

$$\therefore \frac{11}{10}=\frac{1+\alpha t}{1+30\alpha}$$

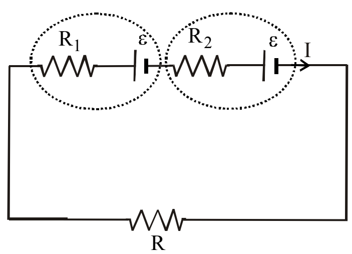
or, $10 + (10 \times 0.002 \times t) = 11 + 330 \times 0.002$
or, $0.02t = 1 + 0.66 = 1.066$ or

$$t=\frac{1.66}{0.02}=83°C.$$

3. **(c)** $R=\frac{\rho\ell}{(\pi D^2/4)}$ or $R\propto\frac{\ell}{D^2}.$

$$\frac{R_x}{R_y}=\frac{\ell_x}{D_x^2}\times\frac{D_y^2}{\ell_y}=\frac{\ell_y/2}{(D_y/2)^2}\times\frac{D_y^2}{\ell_y}=\frac{2}{1}$$

4. **(a)** $I=\frac{2\varepsilon}{R+R_1+R_2}$



Pot. difference across second cell

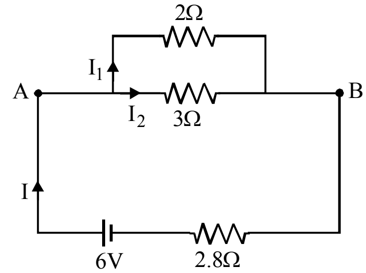
$= V=\varepsilon-IR_2=0$

$$\varepsilon=\frac{2\varepsilon}{R+R_1+R_2}.R_2=0$$

$$R+R_1+R_2-2R_2=0$$

$$R+R_1-R_2=0 \qquad \therefore R=R_2-R_1$$

5. **(c)** At steady state the capacitor will be fully charged and thus there will be no current in the 1Ω resistance. So the effective circuit becomes



Net current from the 6V battery,

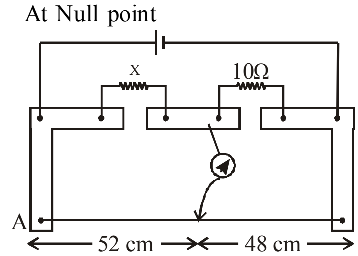
$$I=\frac{6}{\left(\frac{2\times 3}{2+3}\right)+\frac{2.8}{1}}=\frac{6}{1.2+2.8}=\frac{3}{2}=1.5A$$

Between A and B, voltage is same in both resistances, $2I_1=3I_2$

where $I_1+I_2=I=1.5$

$\Rightarrow \quad 2I_1=3(1.5-I_1)\Rightarrow I_1=0.9A$

6. **(b)** At Null point



$$\frac{X}{\ell_1}=\frac{10}{\ell_2}$$

Here ℓ_1 = 52 + End correction = 52 + 1 = 53 cm

ℓ_2 = 48 + End correction = 48 + 2 = 50 cm

$$\therefore \frac{X}{53}=\frac{10}{50} \qquad \therefore X=\frac{53}{5}=10.6\Omega$$

7. **(a)** Potential gradient

$$=\frac{V_A-V_B}{\ell}=\frac{i\times\rho}{A}=\frac{0.1\times 10^{-7}}{10^{-6}}$$

$$=10^{-2}V/m$$

18 Moving Charges and Magnetism

Fill in the Blanks

1. Biot-Savart's Law
2. Compress, due to the force of attraction between two adjacent coils carrying current in the same direction.
3. Magnetic Field
4. Momentum, $Bqv = \frac{mv^2}{r} \Rightarrow r = \frac{mv}{Bq}$

   $\Rightarrow \quad r \propto mv$
5. Zero, $F = q\, v\, B \sin 0° = 0$
6. $i = \frac{C\theta}{NAB} \Rightarrow i \propto \theta$
7. $\tau_{max} = NiAB,\ \tau = MB \sin\theta \Rightarrow [\ \theta = 90°]$
8. Helmholtz coils
9. $\vec{m} \times \vec{B}$

True/ False

1. True 2. True
3. False, It is based on the principle of electromagnetism.
4. True
5. False, If charge is not moving then the magnetic force is zero.

   Since $\vec{F}_m = q(\vec{v} \times \vec{B})$

   As $\vec{v} = 0$, for stationary charge

   $\therefore \quad \vec{F}_m = 0$
6. False 7. True

Conceptual MCQs

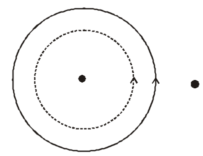
1. **(d)** Both $\vec{v}$ and $\vec{B}$ are perpendicular to plane of parallel wires. $\therefore \vec{F} = q(\vec{v} \times \vec{B})$ = zero.
2. **(a)** Both due to 20A (P) as well as 60 A (R), the force on Q is towards left.
3. **(c)** $\frac{\vec{p}_m}{\vec{L}} = \frac{q}{2m}$
4. **(a)** Since $\vec{B} = \frac{\mu_0}{4\pi} q \frac{\vec{v} \times \vec{r}}{r^3}$, $\vec{v} \times \vec{r}$ must be same

   where $\vec{v}$ = velocity of charge with respect to observer

   Let A and B are the observes

   then $(\vec{v}_C - \vec{v}_A) \times \vec{r} = (\vec{v}_C - \vec{v}_B) \times \vec{r}$

   or $(\vec{v}_A - \vec{v}_B) \times \vec{r} = 0$ or $(\vec{v}_A - \vec{v}_B) \parallel \vec{r}$
5. **(a)** Disc behaves like made up of coils arranged in a plane in which current is flowing in anticlockwise direction.

   Hence, the field at A is directed into the page.
6. **(d)** The magnetic force acting on the charged paraticle is given by

   $\vec{F} = q(\vec{v} \times \vec{B})$

   $= (-2\times 10^{-6})[\{2\hat{i} + 3\hat{j}) \times 10^6\} \times (2\hat{j})]$

   $= -4(2\hat{k})$

   $= -8\hat{k}$

   $\therefore$ Force is of 8N along – z-axis.
7. **(a)** The direction of $\vec{B}$ is along $(-\hat{k})$

   $\therefore$ The magnetic force

   $\vec{F} = Q(\vec{v} \times \vec{B}) = Q(v\hat{i}) \times B(-\hat{k}) = QvB\hat{j}$

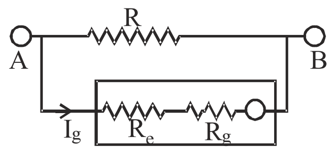
   $\Rightarrow \vec{F}$ is along OY.
8. **(d)** Magnetic moment, m = IA

   $= \frac{qv}{2\pi R}(\pi R^2) = \frac{qvR}{2} \left[\because I = \frac{q}{T} \text{ and } T = \frac{2\pi R}{v}\right]$
9. **(a)** If the electric field is switched off, and the same magnetic field is maintained, the electrons move in a circular orbit and electron will travel a magnetic field $\perp$ to its velocity.
10. **(a)** $R_g = 50\Omega,\ I_g = 25 \times 4 \times 10^{-4}\Omega = 10^{-2}$ A

    Range of V = 25 volts

    $V = I_g(R_e + R_g)$

    $\therefore R_e = \frac{V}{I_g} - R_g = 2450\Omega$

11. (b) The current is same in both the wire, hence magnetic field induced will be same.

12. (b) Force on a particle moving with velocity v in a magnetic field B is $F = q(\vec{v} \times \vec{B})$

If angle between $\vec{v}$ & $\vec{B}$ is either zero or 180º, then value of F will be zero as cross product of $\vec{v}$ and $\vec{B}$ will be zero.

13. (d) When the deflection produced by electric field is equal to the deflection produced by magnetic field, then the electron can go undeflected.

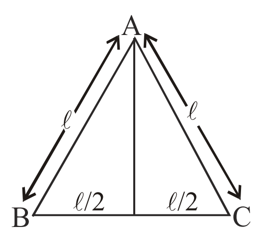
$B = \frac{\mu_0 i}{2\pi r}$ and so it is independent of thickness.

14. (a) Magnetic moment linked with one turn = iA

Magnetic moment linked with N turn = iNA amp-m^2. Here, A = Area of current loop.

15. (b) $\tau = mB \sin\theta$

$\tau = iAB \sin 90^\circ$



$\therefore \quad A = \frac{\tau}{iB}$; Also, A = 1/2 (BC) (AD)

But $\frac{1}{2}(BC)(AD) = \frac{1}{2}(l)\sqrt{l^2 - \left(\frac{l}{2}\right)^2} = \frac{\sqrt{3}}{4} l^2$

$\Rightarrow \frac{\sqrt{3}}{4}(l)^2 = \frac{\tau}{Bi} \quad \therefore l = 2\left(\frac{\tau}{\sqrt{3}\, B.i}\right)^{\frac{1}{2}}$

16. (a) $B = \frac{\mu_0 In}{2\pi a}$ Add vectorially

17. (b) Use the expression for magnetic field due to a current carrying straight conductor and

$\frac{B_1 - B_2}{B_1 + B_2} = \frac{I_1 - I_2}{I_1 + I_2}$

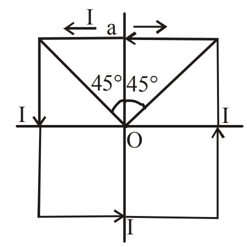
18. (c) Potential energy is given by $U = -\mu B$

19. (b) Using Ampere's law and noting that the steady current is uniformly distributed over the cross section of the conductor, the magnetic field is proportional to the distance r from the centre for r < R and outside the conductor proportional to 1/r.

20. (b) Field due to one side of loop at

$O = \frac{\mu_0 I}{4\pi\left(\frac{a}{2}\right)}(2\sin 45^\circ)$

Field at O due to all four sides is along unit vector $\hat{e}_z$



$\therefore$ Total field $= 4.\frac{\mu_0 I}{4\pi\left(\frac{a}{2}\right)}(2\sin 45^\circ) = \frac{2\sqrt{2}\mu_0 I}{\pi a}$

Diagram Based Questions

1. (a) $B = \frac{\mu_0 I}{2r} \times \frac{\theta}{2\pi} = \frac{\mu_0 I\theta}{4\pi r}$

2. (c) $dB = \frac{\mu_0}{4\pi}\frac{I dl \sin\theta}{r^2}$

Here, $dl = \Delta x = 0.05\ m$, $I = 10\ A$, $r = 1\ m$

$\sin\theta = \sin 90^\circ = 1$,

$\therefore dB = 10^{-7} \times \frac{10 \times 0.05 \times 1}{(1)^2}$

$= 0.50 \times 10^{-7} = 5.0 \times 10^{-8}$ T

3. (c) Since n is an even number, we can assume the wires in pairs such that the two wires forming a pair is placed diametrically opposite to each other on the surface of cylinder. The fields produced on the axis by them are equal and opposite and can get cancelled with each other.

4. (d) Since P.E. $= -\vec{m}\cdot\vec{B} = -mB\cos 0^\circ$

$\therefore$ P.E. $= -mB$

Since $\vec{m}$ increases in magnitude, therefore P.E. decreases.

5. (d) Obviously gravitational and electric force is there as both the particle have mass and charge. Since both charges are in motion so they constitute currents which generate magnetic fields around them and thus exert magnetic force on each other.

Assertion/ Reason

1. **(d)** Ampere's circuital law can be derived from Biot-Savart law and is not independent of Biot-Savart law.
2. **(a)** Magnetic field at the centre of circular loop is given by
$$B=\frac{\mu_0 i}{2R},\ \text{as}\ R\to\infty,\ \text{and so}\ B\to 0.$$
3. **(a)** Reversing the direction of the current reverses the direction of the magnetic field. However, it has no effect on the magnetic-field energy density, which is proportional to the square of the magnitude of the magnetic field.
4. **(c)** Due to electric field, the force is $\vec{F}=q\vec{E}$ in the direction of $\vec{E}$. Since $\vec{E}$ is parallel to $\vec{B}$, the particle velocity $\vec{v}$ (acquired due to force $\vec{F}$) is parallel to $\vec{B}$. Hence $\vec{B}$ will not exert any force since $\vec{v}\times\vec{B}=0$ and the motion of the particle is not affected by $\vec{B}$.
5. **(c)** We know that, $\oint\vec{B}.d\vec{\ell}=\mu_0 i_{in}$. Since $i_{in}=0$ and so $\oint\vec{B}.d\vec{\ell}=0$. The magnetic field on any point on the close loop is zero.
6. **(c)** In case of two electron streams the electric repulsion is greater than magnetic attraction.
7. **(d)** The value of torque depends on θ. For θ = 0, τ = *MBx* sin 0° = 0.
8. **(d)** The frequency of revolution is given by
$$\nu=\frac{qB}{2\pi m},$$ hence Statement I is false and II is true.

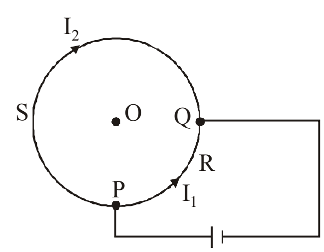
Matching Based Questions

1. (a) 2. (a) 3. (c) 4. (b) 5. (d)
6. (b)

Critical Thinking Type Questions

1. **(c)** From Ampere circuital law
$$\oint\vec{B}.\vec{dl}=\mu_0 I_{enc}$$
$$B\times 2\pi R=\mu_0 I_{enc}$$
$$B=\frac{\mu_0 I_{enc}}{2\pi R}=2\times10^{-7}\times\frac{75}{3}=5\times10^{-6}\ \text{T}$$
The direction of field at the given point will be vertical up determined by the screw rule or right hand rule.
2. **(b)** Let ℓ be length of wire

Ist case : $\ell=2\pi r\Rightarrow r=\dfrac{\ell}{2\pi}$
$$B=\frac{\mu_0 I}{2\pi r}=\frac{\mu_0 I}{\ell}$$
2nd Case : $\ell=2(2\pi r')\Rightarrow r'=\dfrac{\ell}{4\pi}$
$$B'=\frac{\mu_0 In}{2\pi\frac{\ell}{4\pi}}=\frac{2\mu_0 I}{\frac{\ell}{2}}\quad(\text{where } n=2)$$
on putting the value of B
$$\Rightarrow B'=4\left(\frac{\mu_0 I}{l}\right)=4B$$
3. **(b)** Here, $\vec{E}$ and $\vec{B}$ are perpendicular to each other and the velocity $\vec{v}$ does not change; therefore
$$qE=qvB\ \Rightarrow\ v=\frac{E}{B}$$
If velocity $\vec{v}$ is $\perp^r$ to both $\vec{E}$ and $\vec{B}$,
Also,
$$\left|\frac{\vec{E}\times\vec{B}}{B^2}\right|=\frac{E\,B\sin\theta}{B^2}=\frac{E\,B\sin 90^\circ}{B^2}=\frac{E}{B}=|\vec{v}|=v$$
4. **(a)** Let ℓ_1,ℓ_2 be the lengths of the two parts PRQ and PSQ of the conductor and ρ be the resistance per unit length of the conductor. The resistance of the portion PRQ will be $R_1=\ell_1\rho$



The resistance of the portion PSQ will be $R_2=\ell_2\rho$

Pot. diff. across P and Q = $I_1R_1=I_2R_2$

or $I_1\ell_1\rho=I_2\ell_2\rho$ or $I_1\ell_1=I_2\ell_2$ ...(1)

Magnetic field induction at the centre O due to currents through circular conductors PRQ and PSQ will be
$$=B_1-B_2$$
$$=\frac{\mu_0}{4\pi}\frac{I_1\ell_1\sin 90^\circ}{r^2}-\frac{\mu_0}{4\pi}\frac{I_2\ell_2\sin 90^\circ}{r^2}=0.$$
5. **(c)** $Bqv=\dfrac{mv^2}{r}$ or $B=\dfrac{mv}{rq}=\dfrac{(9\times10^{-31})\times10^6}{0.1\times(1.6\times10^{-19})}$
$$=5.5\times10^{-5}\ \text{T}$$

6. **(c)** $B = \frac{\mu_0}{4\pi}\frac{2\pi i}{r}$ where

$$i = \frac{2e}{t} = \frac{2\times1.6\times10^{-19}}{2} = 1.6\times10^{-19}\text{ A}$$

$$\therefore\ B = \frac{\mu_0 i}{2r} = \frac{\mu_0\times1.6\times10^{-19}}{2\times0.8} = \mu_0\times10^{-19}\text{ T}$$

7. **(b)** Here, $R_g = 100\ \Omega$; $I_g = 10^{-5}$ A; $I = 1$A; $S = ?$

$$S = \frac{I_gR_g}{I - I_g} = \frac{10^{-5}\times100}{1-10^{-5}} = 10^{-3}\ \Omega \text{ in parallel}$$

8. **(c)** Magnetic dipole moment

$$m = iA = \frac{e}{T}\times\pi r^2 = \frac{e}{(2\pi r/v)}\times\pi r^2 = \frac{erv}{2}.$$

$$= \frac{1.6\times10^{-19}\times50\times10^{-12}\times2.2\times10^6}{2}$$

$$= 8.8\times10^{-24}\text{ Am}^2.$$

19 Magnetism and Matter

Fill in the Blanks

1. Dipole
2. South pole to north pole
3. 90°
4. magnetic susceptibility
5. Ferromagnetic substance
6. Paramagnetic
7. Small and negative
8. ferromagnetic material become diamagnetic
9. Magnetic equator

True/ False

1. True
2. True
3. False, We cannot isolate the North or South-pole of a magnet. If a bar magnet is broken into two halves, we get two similar bar magnets with somewhat weaker strengths.
4. False, Domain theory is for ferromagnetic substance.
5. False, A paramagnetic material tends to move from a weak magnetic field to strong magnetic field.
6. True
7. True
8. False, Same angle of declination.

Conceptual MCQs

1. **(c)** We know that when a bar magnet is placed in the magnetic field at an angle θ, then torque acting on the bar magnet

$(\tau) = MB\sin\theta = \vec{M}\times\vec{B}$.

Note : This torque τ has a tendency to make the axis of the magnet parallel to the direction of the magnetic field.

2. **(c)** $T_1 = 2\pi\sqrt{\frac{I_1+I_2}{(M+2M)H}} = 2\pi\sqrt{\frac{I}{3MH}}$

$$T_2 = 2\pi\sqrt{\frac{I_1+I_2}{(2M-M)H}} = 2\pi\sqrt{\frac{I}{MH}}$$

Obviously, $T_2 > T_1$

3. **(d)** Torque, $\tau = MB\sin\theta$

$$\Rightarrow M = \frac{\tau}{B\sin\theta} = \frac{0.032}{0.16\times\sin30^\circ}$$

$$= \frac{0.032\times2}{0.16\times1} = 0.4\text{ J/T}$$

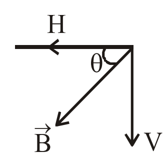
4. **(c)** $B_1 = \frac{2M}{d^3}$, $B_2 = \frac{M}{d^3}$; $\therefore \frac{B_1}{B_2} = 2:1$

5. **(a)**

6. **(a)**

7. **(a)** $\tan\theta = \frac{V}{H}, \tan\theta' = \frac{V}{H\cos x}$; $\frac{\tan\theta'}{\tan\theta} = \frac{1}{\cos x}$

8. **(c)**



Horizontal component of earth's field, $H = B\cos\theta$, since, $\theta = 60^\circ$

$$3.6\times10^{-5} = B\times\frac{1}{2} \Rightarrow B = 7.2\times10^{-5}\text{ Tesla}$$

9. **(a)** The torque acting on the magnet of magnetic moment M, when held at angle θ to magnetic field B, $\tau = MB\sin\theta$

$\tau = MB = 10^{-5}$ Nm.

$\tau = MB\sin30^\circ = 0.5\times10^{-5}$ Nm.

$= 5\times10^{-6}$ Nm

10. **(c)**

11. **(d)** Above Curie Temperature, a ferromagnetic substance becomes paramagnetic.

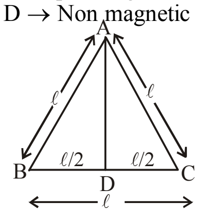
12. **(c)** The net energy dissipated per unit volume of the material during a complete cycle of magnetisation is equal to area of B.H curve.

13. **(b)** The iron can produces a magnetic screening for the equipment as lines of magnetic force can not enter iron enclosure.

14. **(a)**

15. **(a)** A → diamagnetic B → paramagnetic
C → Ferromagnetic D → Non magnetic

16. **(b)** $\tau = MB \sin\theta$
$\tau = iAB \sin 90°$



$\therefore\ A = \dfrac{\tau}{iB}$

Also, A = 1/2 (BC) (AD)

But $\dfrac{1}{2}(BC)(AD) = \dfrac{1}{2}(l)\sqrt{l^2 - \left(\dfrac{l}{2}\right)^2}$

$= \dfrac{\sqrt{3}}{4}l^2$

$\Rightarrow \quad \dfrac{\sqrt{3}}{4}(l)^2 = \dfrac{\tau}{Bi}$

$\therefore \quad l = 2\left(\dfrac{\tau}{\sqrt{3}\ B.i}\right)^{\frac{1}{2}}$

17. **(a)** The magnetic dipole moment of diamagnetic material is zero as each of its pair of electrons have opposite spins, i.e., $\mu_d = 0$.
Paramagnetic substances have dipole moment > 0, i.e. $\mu_p \neq 0$, because of excess of electrons in its molecules spinning in the same direction.
Ferro-magnetic substances are very strong magnets and they also have permanent magnetic moment, i.e. $\mu_f \neq 0$.

18. **(b)** $\tau = MH\sin\theta = MH\sin 30° = \dfrac{MH}{2}$

19. **(b)** $\tan\phi' = \dfrac{\tan\phi}{\cos\beta}$; where ϕ' = Apparent angle of dip,
ϕ = True angle of dip, β = Angle made by vertical plane with magnetic meridian.

$\Rightarrow \tan\phi' = \dfrac{\tan 60°}{\cos 30°} = 2 \Rightarrow \phi' = \tan^{-1}(2)$

20. **(b)** Electromagnet should be amenable to magnetisation & demagnetization.
∴ retentivity should be low & coercivity should be low

Diagram Based Questions

1. **(b)** Magnetic moment, $M = m\ell$

$\dfrac{M}{\ell} = m$, where m is the polestrength.

Therefore distance between poles

$= \sqrt{(\ell/2)^2 + (\ell/2)^2} = \dfrac{\ell}{\sqrt{2}}$

So, $M' = \dfrac{m\ell}{\sqrt{2}} = \dfrac{M}{\sqrt{2}}$

2. **(b)** The field is entering into the surface so flux is negative.

3. **(c)** **4.** **(d)** **5.** **(b)**

Assertion/ Reason

1. **(b)** When a magnet is cut into pieces, each piece becomes new magnet. $M' = \dfrac{m\ell}{2} = \dfrac{M}{2}$.

2. **(d)** Magnetic field of earth is due to moving charged particles in the atmosphere. With increase in temperature, the magnetic moment of magnet decreases.

3. **(a)** Because of high permeability of the iron, the entire magnetic field will pass through iron, and so rest space becomes free from magnetic field.

4. **(c)** Sensitivity of galvanometer,

$$s = \frac{\theta}{i} \simeq \frac{\tan\theta}{i}$$

$$= \frac{\mu_0 N}{2RB_H}.$$

If a magnetic material is placed inside coil of galvanometer, then

$$s' = \frac{\mu_r \mu_0 N}{2RB_H}.$$

5. **(b)** A magnetic field is produced by the motion of electric charge. Since motion is relative, the magnetic field is also relative.

6. **(c)** The susceptibility of ferromagnetic substance decreases with the rise of temperature in a complicated manner. After Curies point in the susceptibility of ferromagnetic substance varies inversely with its absolute tempearture. Ferromagnetic substance obey's Curie's law only above its Curie point.

7. **(d)** A paramagnetic sample display greater magnetisation when cooled, this is because at lower temperature, the tendency to disrupt the alignment of dipoles (due to magnetising field) decreases on account of reduced random thermal motion.

8. **(b)** Electromagnets are magnets, which can be turnd on and off by switching the current on and off. As the material in electromagnets is subjected to cyclic changes (magnification and demangetisation), the hysteresis loss of the material must be small. The material should attain high value of I and B with low value of magnetising field intensity H. As soft iron has small coercivity, so it is a best choice for this purpose.

Matching Based Questions

1. **(a)** **2.** **(b)** **3.** **(c)**

Critical Thinking Type Questions

1. **(c)** $\frac{M_1}{M_2} = \frac{T_2^2 + T_1^2}{T_2^2 - T_1^2} = \frac{6^2 + 4^2}{6^2 - 4^2} = \frac{52}{20} = (2.6):1$

2. **(a)** Here,

$2\ell = 8\,\text{cm},\ \ell = 4\,\text{cm},\ d = \frac{6}{2} = 3\,\text{cm}.$

At neutral point,

$H = B = \frac{\mu_0}{4\pi}\frac{M}{(d^2 + \ell^2)^{3/2}}$

$= 10^{-7}\frac{M}{(5 \times 10^{-2})^3} = \frac{M}{1250}$

$\therefore\ M = 1250\,H = 1250 \times 3.2 \times 10^{-5}\ \text{Am}^2$

$m = \frac{M}{2\ell} = \frac{1250 \times 3.2 \times 10^{-5}}{8 \times 10^{-2}}\ \text{A m}.$

$= 0.5\ \text{Am} = 0.5 \times \frac{1}{10}\text{ab amp} \times 100\ \text{cm}$

$= 5$ ab-amp cm.

3. **(d)** Here, $T_1 = \frac{60}{12} = 5\,\text{s},\ T_2 = \frac{60}{4} = 15\,\text{s}$

$\frac{M_1}{M_2} = \frac{T_2^2 + T_1^2}{T_2^2 - T_1^2} = \frac{15^2 + 5^2}{15^2 - 5^2} = \frac{250}{200} = \frac{5}{4}$

4. **(a)** We know that $T_1 = 2\pi\sqrt{\frac{T}{MB_{H_1}}}$ … (i)

Where $B_{H_1} = 24 \times 10^{-6}\,\text{T}$

The magnetic field produced by, wire

$B = \frac{\mu_0}{2\pi}.\frac{i}{r} = (2 \times 10^{-7}) \times \frac{(18)}{0.20} = 1.8 \times 10^{-6}\ \text{T}$

Now $B_{H_2} = B_{H_1} + B = 42 \times 10^{-6}$ T

$T_2 = 2\pi\sqrt{\frac{I}{MBH_2}}$ … (ii)

Using equations (i) and (ii) , and substituting the values, we get

$T_2 = 0.076$ s

5. **(c)** Here, $H = 2 \times 10^3\ \text{A}\ m^{-1}$, $B = 8\pi$ T, $\mu_0 = 4\pi \times 10^7$

Since $\mu_r = \frac{\mu}{\mu_0} = \frac{\mu H}{\mu_0 H} = \frac{B}{\mu_0 H}$

$= \frac{8\pi}{4\pi \times 10^{-7} \times 2 \times 10^3} = 10^4$

6. **(b)** According to Curie's law, $\chi_m = \frac{\mu_0 C}{T}$

where C is Curie constant, T = temperature

$\therefore \chi_m \alpha \frac{1}{T}$

$\frac{\chi_{m_1}}{\chi_{m_2}} = \frac{T_2}{T_1} = \frac{273 + 333}{273 + 30} = \frac{606}{303} = 2$

$\therefore \chi_{m_2} = \chi_{m_1}/2 = 0.5\chi_{m_1} = 0.5\chi.(\because \chi_{m_1} = \chi)$

7. **(d)** The bar magnet has coercivity $4 \times 10^3\ \text{Am}^{-1}$ i.e., it requires a magnetic intensity $H = 4 \times 10^3\ \text{Am}^{-1}$ to get demagnetised. Let i be the current carried by solenoid having n number of turns per metre length, then by definition H = ni. Here, $H = 4 \times 10^3\ \text{Am}^{-1}$

$n = \frac{N}{l} = \frac{60}{0.12} = 500$ turn metre^{-1}

$\Rightarrow\ i = \frac{H}{n} = \frac{4 \times 10^3}{500} = 8\text{A}$

8. **(a)** The torque acting on the magnet of magnetic moment M, when held at angle θ to magnetic field B, $\tau = MB\sin\theta$

$\tau = MB = 10^{-5}\,\text{Nm}.$

$\tau = MB\sin 30° = 0.5 \times 10^{-5}\,\text{Nm}.$

$= 5 \times 10^{-6}$ Nm

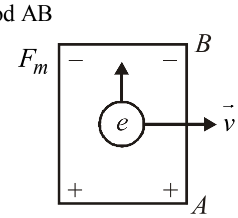
20 Electromagnetic Induction

Fill in the Blanks

1. Electromagnetic induction
2. Faradays' law **3.** Energy **4.** $\frac{1}{2}LI^2$
5. West to east
6. Mechanical energy into electrical energy
7. Self induction **8.** Eddy current

True/ False

1. True. A copper wire consists of billions and billions of free electrons. When the wire is at rest, the average velocity of each electron is zero. But when the wire is in motion, the electrons have a net velocity in the direction of motion.
A charged particle moving in a magnetic field experiences a force given by $\vec{F} = q(\vec{v} \times \vec{B})$.
Here also each electron experiences a force and therefore, electrons will move towards one end creating an emf between the two ends of a straight copper wire.
2. False : For induced emf to develop in a coil, the magnetic flux through it must change.
But in this case the number of magnetic lines of force through the coil is not changing. Therefore the statement is false.
3. True : When conduction rod AB moves parallel to x-axis in a uniform magnetic field pointing in the positive *z*-direction, then according to Fleming's left hand rule, the electrons will experience a force towards B. Hence, the end A will become positive.



4. False, When the current is decreasing at a steady rate then the change in the flux (decreasing inwards) on the right half of the wire is equal to the change in flux (decreasing outwards) on the left half of the wire such that $\Delta\phi$ through the circular loop is zero.
5. True
6. False, Relative motion between the magnet and the coil is responsible for current induction in the coil.
7. False
8. True, By inserting iron rod in the coil,
$L \uparrow z \uparrow I \downarrow$ so brightness $\downarrow$

Conceptual MCQs

1. **(c)** Given: current I = 2.5 A
Inductance, L = 5H
Magnatic flux, ϕ = ?
We know, $\phi = LI \Rightarrow 5 \times 2.5$ Wb = 12.5 Wb
2. **(b)** As number of turns are quadrupled, the induced emf will increase four times. Also, resistance of coil increases sixteen times. Hence power $\left(\frac{V^2}{R}\right)$ will not change.
3. **(d)** Induced emf, $E = NAB\omega \sin \omega t$
$\Rightarrow$ max emf ($\sin \omega t = 1$)
$E_{max} = NAB\omega$
If $\omega' = 2\omega$ then
$E' = 2E_{max}$
4. **(a)** When coil is rotated about the diament, the flux will change. In other cases no flux will change.
5. **(b)** Mutual Inductor of two coils
$$M = \sqrt{M_1 M_2} = \sqrt{2mh \times 8mh} = 4mH$$
6. **(c)** $L = 2mH,\ i = t^2e^{-t}$
$$E = -L\frac{di}{dt} = -L[-t^2e^{-t} + 2te^{-t}]$$
when E = 0,
$-e^{-t}t^2 + 2te^{-t} = 0$ or,
$2t\,e^{-t} = e^{-t}t^2$
$\Rightarrow$ t = 2 sec.
7. **(b)** $$e = -M\frac{di}{dt} = -0.005 \times \frac{d(i_0 \sin \omega t)}{dt}$$
$= -0.005 \times i_0 \times (\omega \cos \omega t)$
$e_{max.} = 0.005 \times i_0 \times \omega$ (when $\cos \omega t = -1$)
$= 0.005 \times 10 \times 100\pi = 5\pi$ V
8. **(c)** Initial current (I_1) = 10 A; Final current (I_2)= 0; Time (t) = 0.5 sec and induced e.m.f. (ε) = 220 V.
Induced e.m.f. (ε)
$$= -L\frac{dI}{dt} = -L\frac{(I_2 - I_1)}{t} = -L\frac{(0-10)}{0.5} = 20L$$
or, $L = \frac{220}{20} = 11H$
[where L = Self inductance of coil]

9. **(c)** $q = \int i dt = \frac{1}{R}\int e dt = \frac{1}{R}\int\left(\frac{-d\phi}{dt}\right)dt$

$= \frac{1}{R}\int d\phi$ (taking only magnitude of e)

Hence, total charge induced in the conducting loop depend upon the total change in magnetic flux.

10. **(c)** $\frac{\Delta\phi}{\Delta t} = \varepsilon = iR \Rightarrow \Delta\phi = (i\Delta t)R = QR$

$\Rightarrow Q = \frac{\Delta\phi}{R}$

11. **(a)** Induced e.m.f. $\varepsilon = \frac{d\phi}{dt} = \frac{dBA}{dt} = A_0\frac{dB}{dt}$

$= A_0\left(\frac{4B_0 - B_0}{t}\right) = 3A_0 B_0 / t$

12. **(d)** Since the magnetic field is uniform the flux f through the square loop at any time t is constant, because

f = B × A = B × L^2 = constant

$\therefore\ \varepsilon = -\frac{d\phi}{dt} = \text{zero}$

13. **(c)** $\varepsilon = (5\times10^{-3})(1/0.1) = 0.05\text{V}$.

14. **(d)** Total resistance of the circuit = 4000 + 400 = 4400 W

Current flowing $i = \frac{V}{R} = \frac{440}{4400} = 0.1$ amp.

Voltage across load = R i = 4000 × 0.1

= 400 volt.

15. **(b)** $\varepsilon = L\frac{di}{dt}$ or $2 = L\left[\frac{(3-2)}{10^{-3}}\right]$

$\therefore\ L = \frac{2\times10^{-3}}{1} = 2\,\text{mH}.$

16. **(a)** Change in flux = 2 B A N

∴ Induced e.m.f.

$= \frac{2\times0.3\times200\times70\times10^{-4}}{0.1} = 8.4\text{v}$

17. **(b)** The individual emf produced in the coil

$e = \frac{-d\phi}{dt}$

∴ The current induced will be

$i = \frac{|e|}{R} \Rightarrow i = \frac{1}{R}\frac{d\phi}{dt}$

But $i = \frac{dq}{dt}$

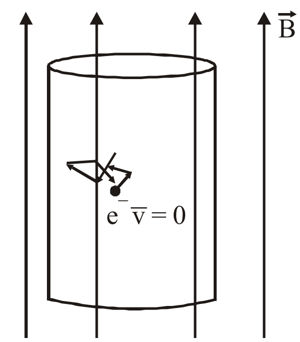
$\Rightarrow \frac{dq}{dt} = \frac{1}{R}\frac{d\varphi}{dt} \Rightarrow \int dq = \frac{1}{R}\int d\varphi \Rightarrow q = \frac{BA}{R}$

18. **(c)** $E = \frac{1}{2}Li^2 = \frac{1}{2}\times(100\times10^{-3})\times1^2 = 0.05\text{ J}$

19. **(d)**

20. **(a)** For a current to induce in the cylindrical conducting rod.

(i) The cylindrical rod should cut magnetic lines of force which will happen only when the cylindrical conducting rod is moving. Since conducting rod is at rest, no current will be induced.



(ii) The magnitude / direction of the magnetic field changes. A changing magnetic field will create an electric field which can apply force on the free electrons of the conducting rod and a current will get induced.

But since the magnetic field is constant, no current will be induced.

Diagram Based Questions

1. **(b)** The charge through the coil = area of current-time ($i - t$) graph

$q = \frac{1}{2}\times0.1\times4 = 0.2\text{ C}$

$q = \frac{\Delta\phi}{R}$ ∵ Change in flux $(\Delta\phi) = q \times R$

$q = 0.2 = \frac{\Delta\phi}{10}$

$\Delta\phi = 2$ weber

2. **(d)** $\phi = BA\cos\theta = 2.0\times0.5\times\cos60^\circ$

$= \frac{2.0\times0.5}{2} = 0.5$ weber.

3. **(c)** In this situation, the bar magent experiences a repulsive force due to the induced current. Therefore, a person has to do work in moving the magnet.

4. **(d)** When electron approaches nearby the loop flux inside loop will increase and when electron recedes from the loop the flux inside loop decreases and so current change in direction.

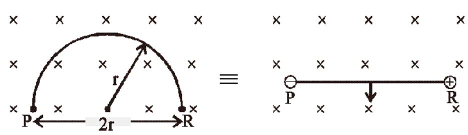
5. **(d)**

6. **(d)** Rate of decreasing of area of semicircular ring

$$= \frac{dA}{dt} = (2r)v$$

From Faraday's law of electromagnetic induction

$$e = -\frac{d\theta}{dt} = -B\frac{dA}{dt} = -B(2rv)$$



As induced current in ring produces magnetic field in upward direction hence R is at higher potential.

Assertion/ Reason

1. **(c)** Emf will always induces whenever, there is change in magnetic flux. The current will induced only in closed loop.

2. **(c)** In purely resistive circuit, the current and emf are in the same phase.

3. **(a)** Lenz's law (that the direction of induced emf is always such as to oppose the change that cause it) is direct consequence of the law of conservation of energy.

4. **(a)** When switch is closed , the magnetic flux through the ring will increase and so ring will move away form the solenoil so as to compensate this flux. This is according to Lenz's law.

5. **(b)** In both the cases, the magnetic flux will change, and so there is an induced current.

6. **(a)** In the given case, there is no component of velocity, perpendicular to the magnetic field and so e = $Bv\ell \sin 0°$.

7. **(b)** 8. **(b)**

Matching Based Questions

1. **(c)** 2. **(c)** 3. **(a)** 4. **(c)**

Critical Thinking Type Questions

1. **(b)** $\phi = 10t^2 - 50t + 250$

$$e = -\frac{d\phi}{dt} = -(20t - 50)$$

$$e_{t=3} = -10 \text{ V}$$

2. **(b)** $\varphi = \vec{B}.\vec{A}$ $\qquad \phi = BA\cos\omega t$

$$\varepsilon = -\frac{d\phi}{dt} = \omega BA \sin \omega t \; ; \; i = \frac{\omega BA}{R}\sin \omega t$$

$$P_{inst} = i^2 R = \left(\frac{\omega BA}{R}\right)^2 \times R\sin^2 \omega t$$

$$P_{avg} = \frac{\int_0^T P_{inst} \times dt}{\int_0^T dt}$$

$$= \frac{(\omega BA)^2}{R}\frac{\int_0^T \sin^2 \omega t dt}{\int_0^T dt}$$

$$= \frac{(\omega BA)^2}{R}\left(\frac{T}{2.T}\right).$$

$$\therefore P_{avg} = \frac{(\omega B\pi r^2)^2}{2R}$$

3. **(a)** Here, $r = 6$ cm $= 6 \times 10^{-2}$ m, $N = 20$, $\omega = 40$ rads^{-1}

$B = 2 \times 10^{-2}$ T, $R = 8\Omega$

Maximum emf induced, $\varepsilon = NAB\omega$

$= N(\pi r^2)B\omega$

$= 20 \times \pi \times (6 \times 10^{-2})\ 2 \times 10^{-2} \times 40 = 0.18$ V

Average value of emf induced over a full cycle

$\varepsilon_{av} = 0$

Maximum value of current in the coil.

$$I = \frac{\varepsilon I}{R} = \frac{0.18}{8} = 0.023 \text{ A}$$

Average power dissipated,

$$P = \frac{\varepsilon I}{2} = \frac{0.18 \times 0.023}{2} = 2.07 \times 10^{-3}\ W$$

4. **(b)**

$$B = \mu_0 n i = (4\pi \times 10^{-7})\,(200 \times 10^{-2}) \times 1.5$$

$= 3.8 \times 10^{-2}\ Wb / m^2$

Magnetic flux through each turn of the coil

$\phi = BA = (3.8 \times 10^{-2})\,(3.14 \times 10^{-4})$

$= 1.2 \times 10^{-5}$ weber

When the current in the solenoid is reversed, the change in magnetic flux

$$= 2 \times (1.2 \times 10^{-5}) = 2.4 \times 10^{-5} \text{ weber}$$

Induced e.m.f.

$$= N\frac{d\phi}{dt} = 100 \times \frac{2.4 \times 10^{-5}}{0.05} = 0.048\,V.$$

5. **(d)** $e = -\frac{d\phi}{dt} = -\frac{d(N\vec{B}.\vec{A})}{dt}$

$$= -N\frac{d}{dt}(BA\cos\omega t) = NBA\omega \sin\omega t$$

$\Rightarrow e_{max} = NBA\omega$

6. **(a)** $N\phi = LI$

$$\therefore \quad \phi = \frac{LI}{N} = \frac{8 \times 10^{-3} \times 5 \times 10^{-3}}{400}$$

$$= 10^{-7} = \frac{\mu_0}{4\pi} Wb$$

21 Alternating Current

Fill in the Blanks

1. 500 v , $E_{rms} = \frac{Eo}{\sqrt{2}}$ **2.** Heating
3. r.m.s current **4.** decreases finitely
5. eddy current. **6.** mutual induction
7. tank circuit **8.** AC circuits only.

True/ False

1. False, 50 Hz in India, 60 Hz in USA.
2. True
3. False, Natural frequency of a L-C circuit =

$$= \frac{1}{2\pi\sqrt{LC}}$$

4. True
5. False, The voltage leads the current because $\frac{1}{C\omega} > L\omega$ and if the voltage lags, the inductive reactance is greater than the capacitive reactance.
6. True **7.** True

Conceptual MCQs

1. **(d)** Power, $P = \mathbf{I}_{r.m.s} \times V_{r.m.s} \times \cos\phi$

In the given problem, the phase difference between voltage and current is p/2. Hence

$$P = \mathbf{I}_{r.m.s} \times V_{r.m.s} \times \cos(\pi/2) = 0.$$

2. **(c)** $\frac{\mathbf{I}_s}{\mathbf{I}_p} = \frac{n_p}{n_s}$; $\frac{80}{\mathbf{I}_p} = \frac{20}{1}$ or $\mathbf{I}_p = 4$ amp.

3. **(a)** **4.** **(b)**

5. **(a)** Impedance of circuit is

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

6. **(a)** **7.** **(b)** **8.** **(a)**

9. **(c)** In the case of maximum charge on capacitor, the whole energy is, stored in capacitor in the form of electric field which is

$$U = \frac{1}{2}\frac{Q^2}{C}$$

When energy in distributed equally between electric and magnetic field , then energy stored in electric field i.e. in capacitor is

$$U_1 = \frac{U}{2} = \left(\frac{1}{2}\frac{Q^2}{C}\right)\frac{1}{2}$$

At that time if charge on capacitor is Q_1, then

$$U_1 = \frac{1}{2}\frac{Q_1^2}{C} = \frac{U}{2} = \frac{1}{4}\frac{Q^2}{C} \Rightarrow Q_1 = Q/\sqrt{2}$$

10. **(d)** $V_{rms} = \frac{200\sqrt{2}}{\sqrt{2}} = 200V$

$I_{rms} = \frac{V_{rms}}{X_C} = \frac{200}{\frac{1}{100 \times 10^{-6}}}$

$= 2 \times 10^{-2} = 20mA$

11. **(d)**

$$Q = \frac{\text{Potential drop across capacitor or inductor}}{\text{Potential drop across R.}}$$

$$= \frac{\omega L}{R}$$

12. **(c)** The reactance of capacitor $X = \frac{1}{\omega C}$ where ω is frequency and C is the capacitance of capacitor.

13. **(c)**

14. **(d)** Draw phase diagram and verify.

15. **(b)** Time constant is L/R

Given, L = 40H & R = 8Ω

∴ τ = 40/8 = 5 sec.

16. **(a)** $f = \frac{1}{2\pi\sqrt{LC}}$

i.e. $f \propto \frac{1}{\sqrt{C}} \to \frac{1}{\sqrt{4}} = \frac{1}{2}$

17. **(d)** Average power delivered to an a.c. circuit is

$P = E_v I_v \cos\phi$

For resonance

$P = E_v I_v$ as $\cos\phi = 1$

Hence power is maximum when both inductive and capacitive reactances are equal, that is circuit behaves as pure resistor

18. **(d)** $\tan\theta = \frac{X_L}{R}$

19. **(d)** $i = \frac{V}{z} = \frac{V}{\sqrt{(\omega L)^2 + \left(\frac{1}{\omega C}\right)^2}}$

20. **(b)** Given $V = V_0 \sin\omega t$; $i = i_0 \sin(\omega t - \phi)$

Here current lays the potential. This can be possible when $X_L > X_C$ or $\omega L > \frac{1}{\omega C}$.

Diagram Based Questions

1. **(b)** $V_{rms} = \sqrt{\frac{(T/2)V_0^2 + 0}{T}} = \frac{V_0}{\sqrt{2}}$.

2. **(c)** The current drawn by inductor and capacitor will be in opposite phase. Hence net current drawn from generator

$= I_L - I_C = 0.9 - 0.4 = 0.5$ amp.

3. **(b)** As $V_L = V_C = 300\ V$, resonance will take place

$\therefore V_R = 220\ V$

Current, $I = \frac{220}{100} = 2.2A$

∴ reading of $V_3 = 220\ V$

and reading of $A = 2.2\ A$

4. **(d)** Current, $I = \frac{V}{Z}$

5. **(c)** At resonance $X_L = X_C \Rightarrow Z = R$ & current is maximum but finite, which is $I_{max} = \frac{E}{R}$, where E is applied voltage.

Assertion/ Reason

1. **(b)** The means or average value of alternating current or e.m.f during a half cycle is given by

$I_m = 0.636 I_0$ or $E_m = 0.636 E_0$

During the next half cycle, the mean value of ac will be equal in magnitude but opposite in direction. For this reason the average value of ac over a complete cycle is always zero. So the average value is always defined over a half cycle of ac.

2. **(c)** The inductive reactance limits the amplitude of current in a purely inductive circuit in the same way as the resistance limits the current in a purely resistive circuit.

i.e. $I_0 = \frac{\varepsilon_0}{X_L}$

3. **(a)** As $X_C = \frac{1}{\omega C}$, so for $\omega = 0$, $X_C \to \infty$.

4. **(a)** In a purely inductive or capacitive circuit, power factor, cos φ = 0 and no power is dissipated even though a current is flowing in the circuit. In such cases, current is referred to as wattless current.

5. **(d)** Power in a series ac circuit consisting of L, C and R is given by

$P = I_{rms} V_{rms} \cos\phi$ where

$\phi = \tan^{-1}\left(\frac{|X_L - X_C|}{R}\right)$

For a purely resistive circuit $X_L = 0$ and $X_C = 0$

Therefore, tan φ = 0 or φ = 0 and thereby cos φ = 1 and $P = IV$.

The power is maximum as cos φ is maximum. Power depends on the phase angle through the power factor cos φ.

6. **(d)** The currents in capacitor and in inductor are opposite and so net current is zero.

7. **(c)** In series resonance circuit, inductive reactance is equal to capacitive reactance.

i.e. $\omega L = \frac{1}{\omega C}$

$$\therefore \quad Z = \sqrt{R^2 + \left(\omega L = \frac{1}{\omega C}\right)^2} = R$$

8. **(a)** Transformer cannot produce power, but it transfer from primary to secondary.

9. **(d)** Large eddy currents are produced in non-laminated iron core of the transformer by the induced emf, as the resistance of bulk iron core is very small. By using thin iron sheets as core the resistance is increased. Laminating the core substantially reduces the eddy currents. Eddy current heats up the core of the transformer. More the eddy currents greater is the loss of energy and the efficiency goes down.

Matching Based Questions

1. **(d)** **2.** **(a)** **3.** **(b)** **4.** **(a)** **5.** **(c)**

Critical Thinking Type Questions

1. **(a)** The charging of inductance given by,

$$i = i_0\left(1 - e^{-\frac{Rt}{L}}\right)$$

$$\frac{i_0}{2} = i_0(1 - e^{-\frac{Rt}{L}}) \Rightarrow e^{-\frac{Rt}{L}} = \frac{1}{2}$$

Taking log on both the sides,

$$-\frac{Rt}{L} = \log 1 - \log 2$$

$$\Rightarrow t = \frac{L}{R}\log 2 = \frac{300 \times 10^{-3}}{2} \times 0.69$$

$\Rightarrow t = 0.1$ sec.

2. **(d)** For resonant frequency to remain same

$\sqrt{LC}$ = constant

LC = constant

As, $C \to 4C$

$$\therefore \quad L \to \frac{L}{4}$$

3. **(d)** The average power in the circuit where cos ϕ = power factory

$$< P > = V_{rms} \times I_{rms} \cos\phi$$

$$\phi = \pi/3 = \text{phase difference} = \frac{180}{3} = 60$$

$$V_{rms} = \frac{\frac{1}{\sqrt{2}}}{\sqrt{2}} = \frac{1}{2}\text{volt}$$

$$I_{rms} = \frac{\frac{1}{\sqrt{2}}}{\sqrt{2}} = \left(\frac{1}{2}\right)A$$

$$\cos\phi = \cos\frac{\pi}{3} = \frac{1}{2}$$

$$< P > = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8}W$$

4. **(b)** $\frac{n_p}{n_s} = \frac{E_p}{E_s} = \frac{1}{25}$

$\therefore E_s = 25E_p$

But $E_s I_s = E_p I_p$

$$\Rightarrow I_p = \frac{E_s \times I_s}{E_p} \Rightarrow I_p = 50A$$

5. **(a)** $\frac{E_s}{E_p} = \frac{n_s}{n_p}$ or $E_s = E_p \times \left(\frac{n_s}{n_p}\right)$

$$\therefore \quad E_s = 120 \times \left(\frac{200}{100}\right) = 240\,V$$

$\frac{\mathbf{I}_p}{\mathbf{I}_s} = \frac{n_s}{n_p}$ or $\mathbf{I}_s = \mathbf{I}_p\left(\frac{n_p}{n_s}\right)$

$$\therefore \quad \mathbf{I}_s = 10\left(\frac{100}{200}\right) = 5 \text{ amp}$$

6. **(a)** As = $\omega^2 \frac{1}{LC}$ = or $\omega = \frac{1}{\sqrt{LC}}$

Maximum energy stored in capacitor

$$= \frac{1}{2}\frac{Q_0^2}{C}$$

Let at any instant t, the energy be stored equally between electric and magnetic field. Then energy stored in electric field at instant t is

$$\frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}\left[\frac{1}{2}\frac{Q_0^2}{C}\right]$$

or $Q^2 = \frac{Q_0^2}{2}$ or $Q = \frac{Q_0}{\sqrt{2}}$

$$\Rightarrow Q_0 \cos\omega t = \frac{Q_0}{\sqrt{2}}$$

or $\omega t = \frac{\pi}{4}$

or $t = \frac{\pi}{4\omega} = \frac{\pi}{4\times(1/\sqrt{LC})}$

$= \frac{\pi\sqrt{LC}}{4}$

7. **(a)** $N_P = 400, N_S = 2000$ and $V_S = 1000$ V.

$\frac{V_P}{V_S} = \frac{N_P}{N_S}$ of,

$$V_P = \frac{V_S \times N_P}{N_S} = \frac{1000\times400}{2000} = 200\text{V}.$$

8. **(d)** Power in primary of transformer is

$P_P = V_p.I_P = 220 \times 0.5$
$= 110$ W

But power in secondary of transformer is

$Ps = 100$ W

$\therefore \eta = \frac{100}{110} = 0.9 = 90\%$

9. **(b)** Efficiency $\eta = \frac{V_s I_s}{V_p I_p} \Rightarrow 0.9 = \frac{V_s(6)}{3\times10^3}$

$\Rightarrow V_s = 450$ V

As $V_p I_p = 3000$ so

$$I_p = \frac{3000}{V_p} = \frac{3000}{200}\text{A} = 15\text{A}$$

22 Electromagnetic Waves

Fill in the Blanks

1. Polarization; Polarization is shown by only transverse waves.
2. Decrease, Current through capacitor,

$$I = \frac{E}{X_C} = \frac{E}{\frac{1}{\omega C}} = \omega CE = 2\pi\upsilon\, CE \text{ or } I \propto \upsilon.$$

$\therefore$ decrease in frequency υ of ac source decreases the conduction current. As displacement current is equal to conduction current, decrease in υ decreases displacement current in circuit.

3. Maxwell
4. $c = \frac{1}{\sqrt{\mu\varepsilon}}$ Velocity of light in a medium,

$$c = \frac{1}{\sqrt{\mu_0\,\varepsilon_0\,\mu_r\,\varepsilon_r}} = \frac{1}{\sqrt{\mu\,\varepsilon}}$$

5. ultraviolet rays
6. Infrared rays
7. Infrared rays

True/ False

1. True
2. False; B-rays are beam of fast moving electrons.
3. True, Momentum per unit time per unit area

$$= \frac{\text{intensity}}{\text{speed of wave}} = \frac{I}{c}$$

Change in momentum per unit time per unit area $= \Delta I/c$ = radiation pressure (P), *i.e.* $P = \Delta I/c$.
Momentum of incident wave per unit time per unit area $= I/c$

When wave is fully absorbed by the surface, the momentum

of the reflected wave per unit time per unit area $= 0$

Radiation pressure (P) = change in momentum per unit

time per unit area $= \frac{\Delta I}{c} = \frac{I}{c} - 0 = \frac{I}{c}$

4. False; Energy stored in form of electrical and magnetic.
5. False, Velocity of electromagnetic wave

$$c = \frac{1}{\sqrt{\mu_0\varepsilon_0}} = 3\times10^8\ m\ \text{s}^{-1}$$

It is independent of amplitude, frequency and wavelength of electromagnetic wave.

6. False; $f_{micro} < f_{uvrays}$
7. True, $\lambda_{micro} > \lambda_{infrared} > \lambda_{ultraviolet} > \lambda_{gamma}$

Conceptual MCQs

1. (b) Ultraviolet radiation is used in food processing as sterlizing agent.
2. (a) On comparing the given equation to

$\vec{E} = a_0\hat{i}\cos(\omega t - kz)$

$\omega = 6\times10^{8z}$,

$$k = \frac{2\pi}{r} = \frac{\omega}{c}$$

$$k = \frac{\omega}{c} = \frac{6\times10^8}{3\times10^8} = 2\,\text{m}^{-1}$$

3. (c) Accelerating charge produces electromagnetic radiation which is called Bremstrahlung radiation.
4. (b) 5. (c)
6. (a) The existence of electromagnetic wave was first predicted by Maxwell.
7. (d) Given $E_z = 60\sin(kx + \omega t)$ V/m. The magnetic field component must be perpendicular to E_z and x.

Also $B_0 = \frac{E_0}{c} = \frac{60}{c}$. Thus

$B_y = \frac{60}{c}\sin(kx + \omega t)$.

8. (a) Here, $\lambda = \frac{c}{\nu} = \frac{3\times10^8}{8.2\times10^6} = 36.6\,\text{m}$.
9. (b) Depends on the magnitude of frequency
10. (a) Size of particle = $2\times(3\times10^{-4}) = 6\times10^{-4}$ m. To observe a particle, the wavelength of electromagnetic waves must be of the size of particle.
11. (b) The average energy stored in the electric field

$U_E = \frac{1}{2}\varepsilon_0 E^2$

The average energy stored in the magnetic field

$= U_B = \frac{1}{2}\frac{B^2}{\mu_0}$,

According to conservation of energy $U_E = U_B$

$\varepsilon_0\mu_0 = \frac{B^2}{E^2}$

$\frac{B}{E} = \sqrt{\varepsilon_0\mu_0} = \frac{1}{C}$

12. (d) $B_0 = \frac{E_0}{c} = \frac{9\times10^3}{3\times10^8} = 3\times10^{-5}\,\text{T}$.
13. (a)
14. (c) β-rays are the beam of fast moving electrons.
15. (a) $\xrightarrow{\lambda \text{ decreasing}}$ RMIVUXGC

R $\rightarrow$ Radio waves

M $\rightarrow$ Micro waves

I $\rightarrow$ Infra red rays

V $\rightarrow$ Visible rays

U $\rightarrow$ Ultraviolet rays $X \rightarrow X$ *rays*

G $\rightarrow \gamma$ rays   C $\rightarrow$ Cosmic rays

$\Rightarrow$ γ rays has least wavelength

16. (b) Comparing with the equation of wave.
$E_y = E_0 \cos(\omega t - kx)$
$\omega = 2\pi f = 2\pi\times10^6$ $\therefore$ $f = 10^6$ Hz
$\frac{2\pi}{\lambda} = k = \pi\times10^{-2}\,\text{m}^{-1}$, $\lambda = 200$ m
17. (d) $\lambda = 10\text{Å} = 10\times10^{-10}\,\text{m} = 10^{-9}\,\text{m}$
X- ray wavelength is of the order of 1Å
18. (c) Microwave region wavelength $= 10^{-3}$ m to 1m
19. (c) Relation between E_0 and H_0

$\frac{E_o}{H_o} = \frac{1}{C} = \sqrt{\mu_0\varepsilon_0}$

i.e. $H_o = E_o\sqrt{\varepsilon_o\mu_o}$

20. (d)
21. (c)
22. (d) $\frac{1}{2}\varepsilon_0 E_0^2$ is electric energy density.

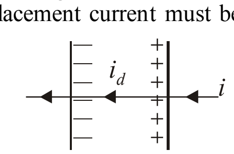
$\frac{B^2}{2\mu_0}$ is magnetic energy density.

So, total energy $= \frac{1}{2}\varepsilon_0 E_0^2 + \frac{B_0^2}{2\mu_0}$

Diagram Based Questions

1. (c) Light wave is an electromagnetic wave in which $\vec{E}$ and $\vec{B}$ are at right angles to each other as well as at right angles to the direction of wave propagation.
2. (a) Direction of energy progration of EM-waves is given by
$\vec{D} = K(\vec{E}\times\vec{B})$ or $-\hat{k} = K(E\hat{j}\times\vec{B})$
Clearly direction of magnetic field is along positive *x*-axis.
3. (c) $\oint \vec{B}.d\vec{\ell}\sqrt{b^2 - 4ac} = \mu_0 \in_0 \frac{d\phi}{dt}$

or $B\times2\pi r = \mu_0 \in_0 A\left(\frac{dE}{dt}\right)$ $\therefore$ $B \propto \left(\frac{dE}{dt}\right)$
4. (a) According to conservation of charge, the displacement current must be leftward.



Assertion/ Reason

1. **(d)** Displacement current arises when electric field in a region is changing with time, which is given by

$$I_D = \varepsilon_0 \frac{d\phi_E}{dt}$$

It will be so if the charge on a capacitor is not constant but changing with time.

2. **(a)** Transverse waves are those waves in which the particles of the medium oscillate perpendicular to the direction of wave propagation.

3. **(c)** Electrormagnetic waves interact with matter via their electric and magnetic field which in oscillation of charges present in all matter. The detailed interaction and so the mechanism of absorption, scattering, etc. depend of the wavelength of the electromagnetic wave, and the nature of the atoms and molecules in the medium.

4. **(b)** Consider a plane perpendicular to the direction of propagation of the electromagnetic wave. If electric charges are present in this plane, they will be set and sustained in motion by the electric and magnetic fields of the electromagnetic wave. The charge thus acquired energy and momentum from the wave. This illustrate the fact that an electromanetic wave like other waves carries energy and momentum.

5. **(a)** Electromagnetic waves have linear momentum as well as energy. This concludes that they can exert radiation pressure by falling beam of electromagnetic radiation on an object.

6. **(b)** $v = \frac{1}{\sqrt{\mu\varepsilon}} = \frac{c}{\sqrt{\mu_r \varepsilon_r}}$

7. **(a)** The basic difference between various types of electromagnetic waves lies in their wavelengths or frequencies since all of them travel through vacuum with the same speed. Consequently, the waves differ considerably in their mode of interaction with matter.

8. **(d)** The optical waves used in optical fibre communication are better carrier of signals than microwaves. The speed of microwave and optical wave is the same in vacuum.

9. **(b)** Infrared radiation help to maintain the earth warmth through the greenhouse effect. Incoming visible light which passes relatively easily through the atmosphere is absorbed by the earth's surface and re-radiated as infrared radiation. The radiation is trapped by greenhouse gases such as carbon dioxide and water vapour and they heat up and heat their surrondings.

Matching Based Questions

1. **(a)** 2. **(c)** 3. **(a)** 4. **(d)** 5. **(d)**

Critical Thinking Type Questions

1. **(d)** $I_d = 1\ mA = 10^{-3}$ A
$C = 2\mu F = 2 \times 10^{-6}$ F

$$I_D = I_C = \frac{d}{dt}(CV) = C\frac{dV}{dt}$$

Therefore, $\frac{dV}{dt} = \frac{I_D}{C} = \frac{10^{-3}}{2\times10^{-6}} = 500\ Vs^{-1}$

Therefore, applying a varying potential difference of 500 V s^{-1} would produce a displacement current of desired value.

2. **(d)** The frequency of electromagnetic wave remains unchanged but the wavelength of electromagnetic wave changes when it passes from one medium to another.

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

$$\therefore \quad c \propto \frac{1}{\sqrt{\varepsilon_0}} \text{ and } v \propto \frac{1}{\sqrt{\varepsilon}}$$

$$\therefore \quad \frac{c}{v} = \sqrt{\frac{\varepsilon}{\varepsilon_0}} = \sqrt{\frac{4}{1}} = 2$$

$$\frac{c}{v} = \frac{\upsilon\lambda}{\upsilon\lambda'} = \frac{\lambda}{\lambda'} = 2 \text{ or } \lambda' = \frac{\lambda}{2}$$

3. **(a)** On comparing the given equation to

$\vec{E} = a_0 \hat{i} \cos(\omega t - kz)$

$\omega = 6 \times 10^{8z}$,

$$k = \frac{2\pi}{r} = \frac{\omega}{c}$$

$$k = \frac{\omega}{c} = \frac{6\times10^8}{3\times10^8} = 2\,\text{m}^{-1}$$

4. **(b)** From question,
$B_0 = 20$ nT $= 20 \times 10^{-9}$T

$$\vec{E}_0 = \vec{B}_0 \times \vec{C}$$

$$|\vec{E}_0| = |\vec{B}_0|.|\vec{C}| = 20\times10^{-9} \times 3\times10^8 = 6 \text{ V/m.}$$

($\because$ velocity of light in vacuum $C = 3 \times 10^8$ ms^{-1})

5. **(a)** Here, amplitude of electric field, $E_0 = 100$ V/m; amplitude of magnetic field, $H_0 = 0.265$ A/m. We know that the maximum rate of energy flow, $S = E_0 \times H_0 = 100 \times 0.265 = 26.5$ W/m^2.

6. **(b)** $B_0 = \frac{E_0}{c}$

E_0 - Electric field, c - speed of light, B_0 - Magnetic Field.

$$B_0 = \frac{10^{-3}}{3\times10^8} = 3.33\times10^{-12}\ \text{T}$$

7. **(a)** Velocity of light

$$C = \frac{E}{B} \Rightarrow B = \frac{E}{C} = \frac{9.3}{3\times10^8} = 3.1\times10^{-8}\text{T}$$

8. **(a)** $E_{rms} = 720$
The average total energy density

$$= \frac{1}{2}\epsilon_0 E_0^2 = \frac{1}{2}\epsilon_0 [\sqrt{2}E_{rms}]^2 = \epsilon_0 E_{rms}^2$$

$$= 8.85\times10^{-12}\times(720)^2$$

$$= 4.58\times10^{-6}\ \text{J/m}^3$$

9. **(b)** Here, $k = \frac{2\pi}{\lambda}$, $\omega = 2\pi\upsilon$

$$\therefore \frac{k}{\omega} = \frac{2\pi/\lambda}{2\pi\upsilon} = \frac{1}{\pi\upsilon} = \frac{1}{c} \qquad (\because c = \upsilon\lambda)$$

where c is the speed of electromagnetic wave in vacuum. It is a constant whose value is 3×10^6 $m\ s^{-1}$

23 Ray Optics and Optical Instruments

Fill in the Blanks

1. 4f
2. Decreases
3. Curved spherical; Relation $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ true for any curved spherical surface.
4. Total internal reflection, As $i > i_c$
At $i = i_c$ angle of refraction 'r' = 90°

$$\therefore \frac{\sin i_c}{\sin 90°} = \mu = 1$$

5. Violet
6. i = r In the position of minimum deviation, i = r.
7. 2.5 cm.
8. Power of lens i.e., decrease the focal length of a lens.

True/ False

1. True
2. True; only intensity changes.
3. False, The image formed by a convex mirror is always virtual.
4. True, Normal is perpendicular to the tangent to surface at the point of incidence i.e., the normal is along the radius, the line joining the centre of curvature of the mirror to the point of incidence.
5. True, The variation of refractive index with wavelength may be more pronounced in some media than the other. In vacuum, of course, the speed of light is independent of wavelength. Thus, vacuum (or air approximately) is a non-dispersive medium in which all colours travel with the same speed.
6. True
7. False, According to Rayleigh, scattering $\propto (1/\lambda)^4$

Conceptual MCQs

1. **(b)** Magrification, m = v/u ; $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

2. **(c)** $v_g = \frac{c}{\mu} = \frac{3\times10^8}{\frac{3}{2}} = 2\times10^8$ m/s

$$t = \frac{x}{v_g} = \frac{4\times10^{-3}}{2\times10^8} = 2\times10^{-11}\ \text{s}$$

3. **(b)** A person suffering from hypermetropia can see objects beyond a particular point called the near point. If the object lies at a point nearer than this point, then image is not formed at the retina. This is also known as long-sight defect.

4. **(a)** Deviation produced by one is cancelled by the other. Use $\delta = A(\mu - 1)$.

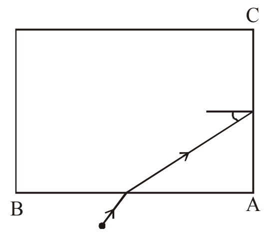
5. **(a)** $\lambda_g = \frac{\lambda_a}{\mu} = \frac{5460}{1.5} = 3640\text{Å}$

6. **(c)** For object not to be visible from vertical face (AC) any ray starting from object should not come out of vertical face. i.e., suffer TIR at vertical face.
Assume BAC to be prism of angle A = 90°.
The condition for no ray to emerge from second refracting surface of prism is $A \geq 2C$

$\Rightarrow$ $90 \geq 2C$

or $C \leq 45°$

$\Rightarrow$ $\sin C \leq 1/\sqrt{2}$



or $n \geq \sqrt{2}$

7. **(b)** In normal adjustment of telescope, the final image is formed at infinity. The incident rays from the object at infinity forms first image at the focus of eye piece.

8. **(d)** f = 24 cm
u = 60 cm

Mirror formula, $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$ .....(1)

$$\therefore \frac{1}{60}+\frac{1}{v}=\frac{1}{24}$$

$$\frac{1}{v}=\frac{1}{24}-\frac{1}{60}=\frac{5-2}{120}=\frac{3}{120}$$

v = 40 cm.

The image is formed at a distance of 40 cm in mirror, Differentiating (1) with respect to t

$$\frac{1}{u^2}.\frac{du}{dt}+\frac{1}{v^2}.\frac{dv}{dt}=0 \quad .....(2)$$

Here, $\frac{du}{dt}=9\,\text{cm/sec}$

Sub: the values in (2), we get

$$\frac{1}{(60)^2}\times 9+\frac{1}{(40)^2}\times\frac{dv}{dt}=0$$

$$\frac{dv}{dt}=\frac{-9\times 1600}{3600}=-4 \text{ cm/sec.}$$

i.e., the speed of the image is 4cm/sec away from the mirror.

9. **(b)** We know that

$$\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\frac{1}{6}=(1.5-1)\left(\frac{1}{\infty}-\frac{1}{-R}\right) \Rightarrow R = 3 \text{ cm.}$$

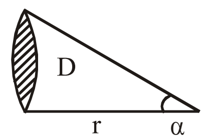
10. **(d)** We know that $\frac{1}{f}=\sum_{i=1}^{n}\frac{1}{f_i}$

$$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2} \quad ; f_1 = 80 \text{ cm}, f_2 = -50 \text{ cm}$$

$$\frac{1}{f}=\frac{1}{\frac{80}{100}}-\frac{1}{\frac{50}{100}}$$

$$\Rightarrow P=\frac{1}{f} = 1.25 - 2 = -0.75\text{D}$$

11. **(c)** Given, D = 3.5×10^3 km and r = 3.8×10^5 km



$$\alpha = \frac{3.5\times 10^3}{3.8\times 10^5}=9.2\times 10^{-3}\text{rad.}$$

Magnification of telescope

$$M = \frac{f_o}{f_e}=\frac{400}{10}=40$$

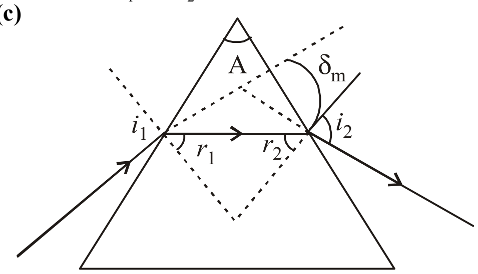
By the definition

$$M = \frac{\beta}{\alpha} \text{ or } 40 = \frac{\beta}{\alpha}$$

$\therefore$ $\beta = 40\,\alpha = 40 \times 9.2 \times 10^{-3} = 21°$

12. **(a)** Note that a ray of light passes twice through the lens and gets reflected once from the curved surface. If f, f_1 and f_2 denote the focal length of combination, lens and mirror respectively, use $1/f = 2/f_1 + 1/f_2$.

13. **(c)**



$i_1 + i_2 = A + \delta_m, r_1 + r_2 = A$

Given, $\delta_m = A$

But in case of minimum deviation

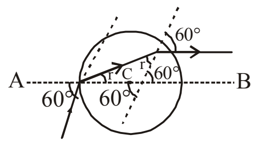
$i_1 = i_2 = i, r_1 = r_2 = r \;\therefore\; r = A/2$

$$\therefore \mu = \frac{\sin\frac{A+\delta_m}{2}}{\sin r}=\frac{\sin\frac{A+A}{2}}{\sin\frac{A}{2}} \mu = \frac{\sin A}{\sin\frac{A}{2}}$$

$$\mu = 2\cos\frac{A}{2}, \sqrt{3} = 2\cos\frac{A}{2}, \frac{\sqrt{3}}{2}=\cos\frac{A}{2}$$

$$\cos 30° = \cos\frac{A}{2} \;\therefore A = 60°$$

14. **(b)**



$60° = r + r, r = 30°.$

$$\therefore \mu = \frac{\sin 60°}{\sin 30°} = \frac{\sqrt{\frac{3}{2}}}{\frac{1}{2}} \quad \therefore \mu = \sqrt{3}$$

15. **(d)** Because, the focal length of eye lens can not decrease beyond a certain limit.

16. **(c)** For reading purposes :
$u = -25$ cm, $v = -50$ cm, $f = ?$

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = -\frac{1}{50} + \frac{1}{25} = \frac{1}{50};$$

$$P = \frac{100}{f} = +2\,D$$

For distant vision, f' = distance of far point = – 3 m

$$P = \frac{1}{f'} = -\frac{1}{3}D = -0.33\ D$$

17. **(a)** Number of images $(n_1) = \frac{360°}{\theta} - 1$
where θ = angle between mirrors
Here, $\theta = 60°$

So, number of images $n_1 = \frac{360°}{60°} - 1 = 5$

18. **(c)** $\mu = \frac{\text{velocity of light in vacuum}}{\text{velocity of light in glass plate}}$

or $\mu = \frac{c}{c'}$ or $c' = \frac{c}{\mu}$
Time taken = distance/velocity

$$= t/(c/\mu) = \frac{\mu t}{c}$$

19. **(b)** $\frac{v_2}{v_1} = \frac{\mu_1}{\mu_2} = \frac{1}{1.33}$

or $v_2 = \frac{v_1}{1.33} = 2.25 \times 10^8 \text{ m/s}$

20. **(d)** Let d be the depth of two liquids.
Then apparent depth

$$\frac{(d/2)}{\mu} + \frac{(d/2)}{1.5\mu} = \frac{d}{2} \text{ or } \frac{1}{\mu} + \frac{2}{3\mu} = 1$$

Solving we get $\mu = 1.671$

21. **(a)** $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{f_2 + f_1}{f_1 f_2}$; $P = \frac{1}{F} = \frac{f_1 + f_2}{f_1 f_2}$

Diagram Based Questions

1. **(a)**

2. **(b)** ${}^a\mu_g = \frac{\sin 60°}{\sin 35°}$ ... (i)

${}^a\mu_w = \frac{\sin 60°}{\sin 41°}$ ... (ii)

${}^w\mu_g = \frac{\sin 41°}{\sin\theta}$ ... (iii)

${}^a\mu_w \times {}^w\mu_g = {}^a\mu_g$

$\frac{\sin 60°}{\sin 41°} \times \frac{\sin 41°}{\sin\theta} = \frac{\sin 60°}{\sin 35°}$ (Using (i), (ii) and (iii)) $= \sin\theta = \sin 35°$ $\theta = 35°$

3. **(d)** As $r_1 < i_1$ i.e., the incident ray bends towards the normal $\Rightarrow$ medium 2 is denser than medium 1.
Or $r_2 < i_1 \Rightarrow$ medium 3 is denser than medium 1.
Also, $r_2 > r_1 \Rightarrow$ medium 2 is denser than medium 3.

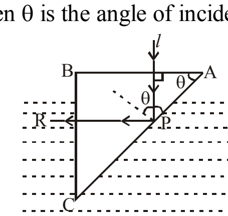
4. **(c)** For the prism as the angle of incidence (i) increases, the angle of deviation (δ) first decreases goes to minimum value and then increases.

5. **(b)** For minimum deviation, incident angle is equal to emerging angle.
$\therefore$ QR is horizontal.

6. **(a)** The phenomenon of total internal reflection takes place during reflection at P.

$$\sin\theta = \frac{1}{{}^{\omega}_{g}\mu} \quad \text{... (i)}$$

When θ is the angle of incidence at P



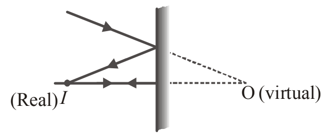
Now, ${}^{\omega}_{g}\mu = \frac{{}^{a}_{g}h}{{}^{\omega}_{g}\mu} = \frac{1.5}{4/3} = 1.125$

Putting in (i), $\sin\theta = \frac{1}{1.125} = \frac{8}{9}$

$\therefore$ sin θ should be greater than or equal to $\frac{8}{9}$.

Assertion/ Reason

1. **(b)** Plane mirror may form real image, if object is virtual.



2. **(d)** Focal length of the spherical mirror does not depend on the medium in which it placed.
3. **(c)** The image of real object may be real in case of concave mirror.
4. **(d)** The distance of image in convex mirror is always $v \le f$.
5. **(c)** The rays from centre of hemisphere cut at the centre after refraction - Snell's law is valid in each case of refraction.
6. **(d)** $f_w = f\dfrac{{}_a\mu_g - 1}{\left(\dfrac{{}_a\mu_g}{{}_a\mu_w} - 1\right)} = f\dfrac{\left(\dfrac{3}{2} - 1\right)}{\left(\dfrac{3/2}{4/3} - 1\right)} = 4f$
7. **(c)** $\dfrac{1}{f} = (\mu - 1)\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right) = (1.5 - 1)\left(\dfrac{1}{R} - \dfrac{1}{-R}\right)$

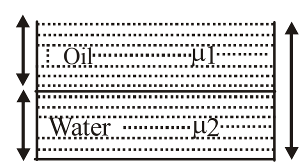
   or $f = R$.
8. **(d)** If the rays cross focal point of convex lens, they become diverging.
9. **(a)** RP $\propto$ diameter of objective.

Matching Based Questions

1. (c) 2. (d) 3. (b) 4. (a) 5. (d)
6. (c)

Critical Thinking Type Questions

1. **(a)**



As refractive index, $\mu = \dfrac{\text{Real depth}}{\text{Apparent depth}}$

$\therefore$ Apparent depth of the vessel when viewed from above is

$$d_{\text{apparent}} = \frac{x}{2\mu_1} + \frac{x}{2\mu_2} = \frac{x}{2}\left(\frac{1}{\mu_1} + \frac{1}{\mu_2}\right)$$

$$= \frac{x}{2}\left(\frac{\mu_2 + \mu_1}{\mu_1\mu_2}\right) = \frac{x(\mu_1 + \mu_2)}{2\mu_1\mu_2}$$

2. **(d)** Here, $v_A = 1.8 \times 10^8$ m s^{-1}
   $v_B = 2.4 \times 10^8$ m s^{-1}

Light travels slower in denser medium. Hence medium A is a denser medium and medium B is a rarer medium. Here, Light travels from medium A to medium B. Let C be the critical angle between them.

$$\therefore \quad \sin C = {}^A\mu_B = \frac{1}{{}^B\mu_A}$$

Refractive index of medium B w.r.t. to medium A is

$${}^A\mu_B = \frac{\text{Velocity of light in medium } A}{\text{Velocity of light in medium } B} = \frac{v_A}{v_B}$$

$$\therefore \quad \sin C = \frac{v_A}{v_B} = \frac{1.8 \times 10^8}{2.4 \times 10^8} = \frac{3}{4}$$

or $C = \sin^{-1}\left(\dfrac{3}{4}\right)$

3. **(b)** $\dfrac{1}{f_a} = \left(\dfrac{1.5}{1} - 1\right)\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$ ... (i)

$$\frac{1}{f_m} = \left(\frac{\mu_g}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f_m} = \left(\frac{1.5}{1.6} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{... (ii)}$$

Dividing (i) by (ii), $\dfrac{f_m}{f_a} = \left(\dfrac{1.5 - 1}{\dfrac{1.5}{1.6} - 1}\right) = -8$

$$P_a = -5 = \frac{1}{f_a} \Rightarrow f_a = -\frac{1}{5}$$

$$\Rightarrow f_m = -8 \times f_a = -8 \times -\frac{1}{5} = \frac{8}{5}$$

$$P_m = \frac{\mu}{f_m} = \frac{1.6}{8} \times 5 = 1\text{D}$$

4. **(b)** Using lens maker's formula,

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f_1} = \left(\frac{1.5}{1} - 1\right)\left(\frac{1}{\infty} - \frac{1}{-20}\right)$$

$\Rightarrow f_1 = 40$cm

$$\frac{1}{f_2}=\left(\frac{1.7}{1}-1\right)\left(\frac{1}{-20}-\frac{1}{+20}\right)$$

$$\Rightarrow\ f_2=-\frac{100}{7}\text{ cm}$$

and $\dfrac{1}{f_3}=\left(\dfrac{1.5}{1}-1\right)\left(\dfrac{1}{\infty}-\dfrac{1}{-20}\right)$

$\Rightarrow f_3 = 40$ cm

$$\frac{1}{f_{eq}}=\frac{1}{f_1}+\frac{1}{f_2}+\frac{1}{f_3}$$

$$\Rightarrow \frac{1}{f_{eq}}=\frac{1}{40}+\frac{1}{-100/7}+\frac{1}{40}$$

$\therefore\ \ f_{eq} = -50$ cm

Therefore, the focal length of the combination is – 50 cm.

5. **(a)** As we know, the refractive index of the material of the prism

$$\mu=\frac{\sin\left(\dfrac{\delta_m+A}{2}\right)}{\sin(A/2)}$$

$$\cot A/2=\frac{\sin\left(\dfrac{A+\delta_m}{2}\right)}{\sin A/2}=\frac{\cos(A/2)}{\sin(A/2)}$$

[$\because\ \mu = \cot(A/2)$]

$$\Rightarrow\ \text{Sin}\left(\frac{\delta_m+A}{2}\right)=\sin(90^\circ + A/2)$$

$$\Rightarrow\ \delta_{min} = 180^\circ - 2A$$

6. **(a)** (i) $M=-\dfrac{f_0}{f_e}\left(1+\dfrac{f_e}{d}\right)$

$$=-\frac{200}{5}\left(1+\frac{5}{25}\right)=-48$$

(since least distance d = 25cm)

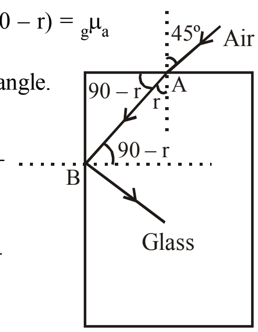
(ii) $M=-\dfrac{f_0}{f_e}=-\dfrac{200}{5}=-40$

7. **(a)** For point A, ${}_a\mu_g=\dfrac{\sin 45^\circ}{\sin r}$

$$\Rightarrow\ \sin r=\frac{1}{\sqrt{2}\,{}_a\mu_g}$$

for point B, $\sin(90 - r) = {}_g\mu_a$

(90 – r) is critical angle.



$$\therefore\ \cos r={}_g\mu_a=\frac{1}{{}_a\mu_g}$$

$$\Rightarrow\ {}_a\mu_g=\frac{1}{\cos r}$$

$$=\frac{1}{\sqrt{1-\sin^2 r}}=\frac{1}{\sqrt{1-\dfrac{1}{2\,{}_a\mu_g^{\,2}}}}$$

$$\Rightarrow\ {}_a\mu_g^{\,2}=\frac{1}{1-\dfrac{1}{2\,{}_a\mu_g^2}}=\frac{2\,{}_a\mu_g^2}{2\,{}_a\mu_g^2-1}$$

$$\Rightarrow\ 2\,{}_a\mu_g^2-1=2\ \Rightarrow\ {}_a\mu_g=\sqrt{\frac{3}{2}}$$

24 Wave Optics

Fill in the Blanks

1. Wavefront
2. Converging spherical
3. Destructive interference; When path difference = $n\lambda$ (n = 0, 1, 2...).
4. Bright
5. Decrease, The wavelength of light in water $\left(\lambda_w = \frac{\lambda_a}{\mu}\right)$ is less than that in air. When the set-up is immersed in water, fringe width $\beta(\propto \lambda)$ will decrease.
6. Elliptically polarised
7. Decreases; As, B = $\frac{D}{d}\lambda$ d = diameter of wire.
8. Reduces; Polaroid glass polarises light reducing the light intensity to half its original value.
9. M = tan i_p

True/ False

1. True, A light ray emerging out of convex lens when a point source is placed at its focus.
2. True
3. False, At a large distance from the source, the small portion of the sphere can be considered as plane wave.
4. True, MD As it is clear from the relation.

   Fringe with $\beta = \frac{\lambda D}{d}$

   D = distance between the slit and screen
   d = distance between the slits.
   Smaller the 'd' higher will be the value of fringe width.
5. True, Since, $\Delta\theta \approx \frac{0.61\lambda}{a}$

   where $\Delta\theta$ = angle subtended by the image of the object on focus of the length.
   λ = wavelength of light used
   a = aperture of the objective lens
   For '$\Delta\theta$' to be small, 'a' must be large
6. False, The magnification produced by a microscope

   $$m = \frac{v}{f} = \frac{D}{f} = 2 \tan \beta$$
7. False; As, $\beta = \frac{D}{d}\lambda$ and $\lambda_{red} > \lambda_{blue}$

Conceptual MCQs

1. **(d)** For the first minima,

   $$\theta = \frac{\eta\lambda}{a} \Rightarrow \sin 30° = \frac{\lambda}{a} = \frac{1}{2}$$

   First secondary maxima will be at

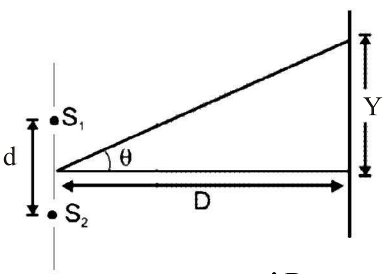
   $$\sin\theta = \frac{3\lambda}{2a} = \frac{3}{2}\left(\frac{1}{2}\right) \Rightarrow \theta = \sin^{-1}\left(\frac{3}{4}\right)$$
2. **(c)**
3. **(b)** $n_1 \lambda_1 = n_2 \lambda_2$
   $10 \times 7000 = n_2 \times 5000 \Rightarrow n_2 = 14$
4. **(c)** 5. **(c)** 6. **(c)**
7. **(a)** The related light becomes plane polarised.
8. **(a)** $K = I + I + \sqrt{II}\cos 2\pi = 4I$,

   $K' = I + I + 2\sqrt{II}\cos 2\pi = I$,

   $= \frac{K}{4}$
9. **(c)** for min^m $\sin\theta = \lambda, 2\lambda, 3\lambda, \ldots\ldots, \lambda_a = 2\lambda_b$
10. **(b)** The distance of n^{th} fringe is given by $y_n = \frac{nD\lambda}{d}$

    As $\lambda_{violet} < \lambda_{red}$,
    $\therefore$ fringes will come closer.

11. **(b)**



Angular width, $\theta = \frac{Y}{D} = \frac{n\lambda D}{dD}$

$$\left[\because Y = \frac{D\lambda}{d}\right]$$

so, $\theta = \frac{\lambda}{d}$, v $\uparrow \lambda \downarrow \theta \downarrow$

[For central maxima n = 1]

Hence, with increase in speed of electrons angular width of central maximum decreases.

12. (a) Fringe width, $\beta = \frac{\lambda D}{d}$,
where D = distance of screen,
d = distance between slits, λ = wavelength
Now, d' = d/2, D' = 2D

$\Rightarrow \beta' = \frac{\lambda 2D}{d/2} = \frac{4\lambda D}{d}$

13. (c) Distance of nth maxima, $x = n\lambda \frac{D}{d} \propto \lambda$

As $\lambda_b < \lambda_g$

$\therefore x_{blue} < x_{green}$

14. (a) $\beta' = \frac{\beta}{\mu} = \frac{0.4}{\frac{4}{3}} = 0.3$ mm

15. (d) For dark fringe

$$x = (2n-1)\frac{\lambda D}{2d}$$

$$\therefore \lambda = \frac{2xd}{(2n-1)D} = \frac{2\times 10^{-3} \times 0.9 \times 10^{-3}}{(2\times 2-1)\times 1}$$

$\lambda = 0.6\times 10^{-6}$ m $= 6 \times 10^{-5}$ cm

16. (b) $x = (n)\lambda \frac{D}{d} = 3 \times 5000 \times 10^{-10} \times \frac{2}{0.2\times 10^{-3}}$

$= 1.5 \times 10^{-2}$ m = 1.5 cm

17. (a) As $\beta = \frac{\lambda D}{d}$ and $\lambda_b < \lambda_y$,

$\therefore$ fringe width β will decrease

18. (d) In vaccum, λ increases very slightly compared to that in air. As $\beta \propto \lambda$, therefore, width of interference fringe increases slightly.

19. (b) If I_0 is the intensity of light incident on the first polarizer, then the intensity which comes out of it is $I_1 = I_0/2$. This is the intensity incident on the second polarizer which is crossed at an angle of 60°. Therefore, the intensity that comes out of this second polarizer is $I_2 = I_1 \cos^2 60° = I_0/8$.

20. (b) $\theta = \sin^{-1}\left(\frac{\lambda}{a}\right)$ .... (1)

According to question
$\lambda = 2 \times 10^{-3}$ m
$a = 4 \times 10^{-3}$ m .... (2)
From equation (1) and (2)
$\theta = \sin^{-1}(1/2) \Rightarrow \theta = 30°$.

21. (c) $n_1 \lambda_1 = n_2 \lambda_2$ for bright fringe
$n (7.5 \times 10^{-5}) = (n + 1) (5 \times 10^{-5})$

$$n = \frac{5.0\times 10^{-5}}{2.5\times 10^{-5}} = 2.$$

22. (a) $a_1 = 6$ units, $a_2 = 8$ units

$$\frac{I_{max}}{I_{min}} = \frac{\left[\frac{a_1}{a_2}+1\right]^2}{\left[\frac{a_1}{a_2}-1\right]^2} = \frac{\left[\frac{6}{8}+1\right]^2}{\left[\frac{6}{8}-1\right]^2}$$

$$\Rightarrow \frac{I_{max}}{I_{min}} = \frac{49}{1}$$

Diagram Based Questions

1. (d) It will be concentric circles.

2. (c) Angular width $= \frac{\lambda}{d} = 10^{-3}$ (given)

$\therefore$ No. of fringes within 0.12° will be

$$n = \frac{0.12\times 2\pi}{360\times 10^{-3}} \cong [2.09]$$

$\therefore$ The number of bright spots will be three.

3. (c) Wavelength for which maximum obtained at the hole has the maximum intensity on passing. So,

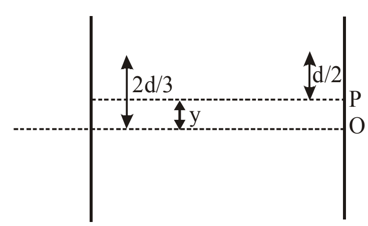
$$x = \frac{n\lambda D}{d}$$

$$\lambda = \frac{xd}{nD} = \frac{1\times 10^{-3} \times 0.5\times 10^{-3}}{n\times 50\times 10^{-2}} = \frac{1\times 10^{-6}}{n} = \frac{1000\text{nm}}{n}$$

$n = 1$, $\lambda = 1000$ nm $\rightarrow$ Not in the given range
$n = 2$, $\lambda = 500$nm

4. (c) The nearest white spot will be at P, the central maxima.

$$\therefore y = \frac{2d}{3} - \frac{d}{2} = \frac{d}{6}$$



5. (d) Light waves coming out of two independent sources do not have any fixed phase difference as they undergo phase changes in time of the order of 10^{-10}s.
Hence, the sources are incoherent and the intensities on the screen just add up. Hence no interference fringer will be observed on the screen.

6. (c) The position of all the bands depends on the wavelength, higher the wavelength, wider is the band.
7. (c) In Fraunhoffer diffraction, for minimum intensity,

$$\Delta x = m\frac{\lambda}{2}$$

For first minimum, m = 1

$$\therefore \quad \Delta x = \frac{\lambda}{2}$$

Assertion/ Reason

1. (a) $\beta = \frac{D\lambda}{d}$. When $d \to 0$, $\beta \to \infty$, and so fringes will not be seen over the screen.
2. (d) For interference, the waves may be of unequal intensities.
3. (c) Interference will take place in green light only.
4. (d) 5. (b) 6. (b)
7. (a) As $\beta = \frac{D\lambda}{d}$ and wavelength of yellow light is shorter than red, so fringe width is narrower for yellow light.
8. (a)

Matching Based Questions

1. (d) 2. (a) 3. (a) 4. (b)

Critical Thinking Type Questions

1. (d) : Resultant amplitude,

$$A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

Here, $A_1 = A_2$ 1 cm, $\phi = 3\pi$ rad

$$\therefore A = \sqrt{1^2 + 1^2 + 2\times1\times1\times\cos 3\pi}$$

$$= \sqrt{2 + 2\times(-1)} = 0$$

2. (c) $\Delta = x\frac{d}{D}$, where Δ is path difference between two waves.

$$\therefore \text{ phase difference } = \phi = \frac{2\pi}{\lambda}\Delta.$$

Let a = amplitude at the screen due to each slit.
$\therefore$ $I_0 = k(2a)^2 = 4ka^2$, where k is a constant.
For phase difference ϕ,
amplitude = A = $2a\cos(\phi/2)$.

[Since, $a^2 = a_1^2 + a_2^2 + 2a_1a_2\cos\phi$, here $a_1 = a_2$]
Intensity I,

$$I = kA^2 = k(4a^2)\cos^2(\phi/2) = I_0\cos^2\left(\frac{\pi x}{\beta}\Delta\right)$$

$$= I_0\cos^2\left(\frac{\pi}{\lambda}.\frac{xd}{D}\right) = I_0\cos^2\left(\frac{\pi x}{\beta}\right)$$

3. (c) For path difference λ,
phase difference = 2π rad.
For path difference $\frac{\lambda}{4}$,
phase difference = $\frac{\pi}{2}$ rad.
As $K = 4I_0$ so intensity at given point where path difference is $\frac{\lambda}{4}$

$$K' = 4I_0\cos^2\left(\frac{\pi}{4}\right)\left(\cos\frac{\pi}{4} = \cos 45^\circ\right)$$

$$= 2I_0 = \frac{K}{2}$$

4. (c) Suppose intensity of unpolarised light = 100.
$\therefore$ Intensity of polarised light from first nicol prism

$$= \frac{I_0}{2} = \frac{1}{2}\times100 = 50$$

According to law of Malus,

$$I = I_0\cos^2\theta = 50\,(\cos 60^\circ)^2$$

$$= 50\times\left(\frac{1}{2}\right)^2 = 12.5$$

5. (d) By principle of polarization, $\mu = \tan\theta_p$
or $\mu = \tan 54.74°$ or $\mu = 1.414$
For an equilateral prism, $\angle A = 60°$

$$\therefore \quad \mu = \frac{\sin\left(\frac{A+\delta}{2}\right)}{\sin(A/2)} = \frac{\sin\left(\frac{60°+\delta}{2}\right)}{\sin(60°/2)}$$

$$\text{or, } \frac{1.141\times1}{2} = \sin\left(\frac{60°+\delta}{2}\right)\left[\because 1.414 = \sqrt{2}\right]$$

$$\text{or, } \frac{\sqrt{2}}{2} = \sin\left(\frac{60°+\delta}{2}\right) \text{ or } \frac{1}{\sqrt{2}} = \sin\left(\frac{60°+\delta}{2}\right)$$

or, sin 45°

$$= \sin\left(\frac{60°+\delta}{2}\right) \text{ or } 45° = \left(\frac{60°+\delta}{2}\right)$$

6. (d) According to malus law, intensity of emerging beam is given by,
$I = I_0\cos^2\theta$
Now, $I_{A'} = I_A\cos^2 30°$

$$I_{B'} = I_B\cos^2 60°$$

As $I_{A'} = I_{B'}$

$$\Rightarrow \quad I_A\times\frac{3}{4} = I_B\times\frac{1}{4}$$

$$\frac{I_A}{I_B} = \frac{1}{3}$$

25 Dual Nature of Radiation and Matter

Fill in the Blanks

1. Decreases; As velocity v increase m increases according to Einstein's equation. Hence specific charge $\frac{e}{m}$ decreases.

2. Greater than, For occurence of photoelectric effect, the incident light should have frequency more than a certain minimum which is called the threshold frequency (v_0).

We have, $\frac{1}{2}mv^2 = h\nu - h\nu_0$

For photoelectric effect emission $\nu > \nu_0$ where ν is the frequency of the incident light.

3. electrons

4. Photons. The photon may be absorbed or a new photon may be created.

5. Intensity of incident light.

6. Alpha (α) particle

7. 1 electron volt (ev) = 1.6×10^{-19} joule

8. Ultraviolet The ultraviolet light provided sufficient energy for the electrons to escape from the surface of detector (metal) loop and hence the current increased.

True/ False

1. True; Particle nature – photoelectric effect.
Wave nature – Diffraction.

2. False, As Cathode rays are positively charged, hence, get deflected in the electric field.

3. False, According to Einstein's photoelectric equation $k_{max} = h\nu - h\nu_0$ if $\nu_0 > \nu$ k_{max} $^{-(ve)}$

4. False, The stopping potential is independent of intensity of incident radiation.

5. True

6. False, Neither wave nor particle nature of light.

Conceptual MCQs

1. **(a)** Photoelectric effect can be explained only by quantum nature of light.

2. **(b)** $W = \frac{hc}{\lambda_0}$

$= \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{600 \times 10^{-9}}$ J

$= 3.31 \times 10^{-19}$ J

3. **(a)** $\because \lambda_0 = \frac{hc}{\phi}$

$\therefore (\lambda_0)_{sodium} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{2 \times 1.6 \times 10^{-19}} = 6188$ Å

$\because \lambda_0 \propto \frac{1}{\phi} \Rightarrow \frac{(\lambda_0)_{sodium}}{(\lambda_0)_{copper}} = \frac{(\phi)_{copper}}{(\phi)_{sodium}}$

$\Rightarrow (\lambda_0)_{copper} = \frac{2}{4} \times 6188 = 3094$ Å

To eject photo-electrons from sodium the longest wavelength is 6188 Å and that for copper is 3094 Å.

Hence for light of wavelength 4000 Å, sodium is suitable.

4. **(d)** $K_{max} = \frac{hc}{\lambda} - W = \frac{hc}{\lambda} - 5.01$

$= \frac{12375}{\lambda(\text{in Å})} - 5.01$

$= \frac{12375}{2000} - 5.01 = 6.1875 - 5.01 = 1.17775$

$\simeq 1.2$ V

5. **(a)** In the Davisson and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by increasing the potential difference between the anode and filament.

6. (a) Give that, only 25% of 200W converter electrical energy into light of yellow colour

$\left(\frac{hc}{\lambda}\right) \times N = 200 \times \frac{25}{100}$

Where N is the No. of photons emitted per second, h = plank's constant, c, speed of light.

$N = \frac{200 \times 25}{100} \times \frac{\lambda}{hc}$

$= \frac{200 \times 25 \times 0.6 \times 10^{-6}}{100 \times 6.2 \times 10^{-34} \times 3 \times 10^8} = 1.5 \times 10^{20}$

7. **(d)** From Equation $K.E = h\nu - \phi$

slope of graph of K.E & ν is h (Plank's constant)

which is same for all metals

8. **(a)** For first photocathode

$hf_1 - W = \frac{1}{2}mv_1^2$ ....(i)

For second photocathode

$$hf_2 - W = \frac{1}{2}mv_2^2$$

....(ii)

Subtracting (ii) from (i) we get

$$(hf_1 - W) - (hf_2 - W)$$

$$= \frac{1}{2}mv_1^2 - \frac{1}{2}mv_2^2$$

$$\therefore\ h(f_1 - f_2) = \frac{m}{2}(v_1^2 - v_2^2)$$

$$\therefore\ v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$$

9. (d)

$$\frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{m_\alpha q_\alpha V_\alpha}{m_p q_p V_p}} = \sqrt{\frac{(4m_p)(2e)\times(800)}{(m_p)\times(e)\times(100)}} = 8$$

$$\Rightarrow \lambda_\alpha = \frac{\lambda_p}{8} = \frac{\lambda_0}{8}$$

10. (a) $\lambda_{photon} = \frac{hc}{E}$, $\lambda_e = \frac{h}{\sqrt{2mE}}$

$$\frac{\lambda_{photon}}{\lambda_e} = \frac{hc}{E} \times \frac{\sqrt{2mE}}{h} = c\sqrt{\frac{2m}{E}}$$

11. (b) For electron and positron pair production, minimum energy is 1.02 MeV.
Energy of photon is given $1.7\times10^{-3}\text{J} = \frac{1.7\times10^{-13}}{1.6\times10^{-19}}$
= 1.06 MeV.
Since energy of photon is greater than 1.02 MeV. so electron positron pair will be created.

12. (b) By using $h\nu - h\nu_0 = K_{max}$
$\Rightarrow h(\nu_1 - \nu_0) = K_1$ ..... (i)
And $h(\nu_2 - \nu_0) = K_2$ ..... (ii)

$$\Rightarrow \frac{\nu_1 - \nu_0}{\nu_2 - \nu_0} = \frac{K_1}{K_2} = \frac{1}{K},\ \text{Hence}\ \nu_0 = \frac{k\nu_1 - \nu_2}{K - 1}.$$

13. (a) $\lambda = 400$ nm, $hc = 1240$ eV.nm, K.E. =1.68 eV
We know that

$$\frac{hc}{\lambda} - W = K.E \Rightarrow W = \frac{hc}{\lambda} - K.E$$

$$\Rightarrow W = \frac{1240}{400} - 1.68 = 3.1 - 1.68 = 1.42\ \text{eV}$$

14. (b) $eV_1 = h\nu_1 - h\nu_0$

$eV_2 = h\nu_2 - h\nu_0$

$$V_2 - V_1 = \frac{hc}{e}\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right)$$

$$= 12400\left(\frac{1}{3000} - \frac{1}{4000}\right) = 1.03\ \text{eV}$$

15. (b) $E = W_0 + eV_0$
For hydrogen atom, E = +13.6 eV
$\therefore\ +13.6 = 4.2 + eV_0$

$$\Rightarrow V_0 = \frac{(13.6 - 4.2)\text{eV}}{e} = 9.4\text{V}$$

Potential at anode = – 9.4 V

16. (c)

17. (b) For emission of electrons incident energy of each photon must be greater than work function (threshold energy).

18. (c) K.E. = $2E_0 - E_0 = E_0$ (for $0 \le x \le 1$) $\Rightarrow \lambda_1 = \frac{h}{\sqrt{2mE_0}}$

K.E. = $2E_0$ (for $x > 1$) $\Rightarrow \lambda_2 = \frac{h}{\sqrt{4mE_0}}$

$$\Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{2}.$$

19. (b) Stopping potential = $\frac{1}{e}\left[\frac{hc}{\lambda} - \phi\right]$ where

hc = 1240eV –nm

$$= \frac{1}{e}\left[\frac{1240}{200} - 4.7\right] = \frac{1}{e}[6.2 - 4.7]$$

$$= \frac{1}{e}\times1.5eV = 1.5\text{V}$$

But $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r} = \frac{1}{4\pi\varepsilon_0}\frac{ne}{r}$

$$\therefore\ n = \frac{Vr(4\pi\varepsilon_0)}{e} = \frac{1.5\times10^{-2}}{9\times10^9\times1.6\times10^{-19}}$$

$\therefore\ n = 1.04 \times 10^7$
Comparing it with $A \times 10^z$ we get, z = 7

20. (a) By using $\frac{hc}{\lambda} = W_0 + \frac{1}{2}m\upsilon^2$

$$\Rightarrow \frac{hc}{400\times10^{-9}} = W_0 + \frac{1}{2}m\upsilon^2 \quad ...(i)$$

and $$\frac{hc}{250\times10^{-9}} = W_0 + \frac{1}{2}m(2\upsilon)^2 \quad ...(ii)$$

On solving (i) and (ii)

$$\frac{1}{2}m\upsilon^2 = \frac{hc}{3}\left[\frac{1}{250\times10^{-9}} - \frac{1}{400\times10^{-9}}\right]$$ ...(iii)

From equation (i) and (iii) $W_0 = 2hc \times 10^6 J$.

Diagram Based Questions

1. **(c)** Changing the material of plate A will not affect the no. of photoelectrons emitted for the given material of plate C and intensity & frequency of light used.
2. **(c)** 3. **(b)**
4. **(a)** From the graph it is clear that A and B have the same stopping potential and therefore the same frequency. Also B and C have the same intensity.
5. **(d)** Intensity $\propto 1/(\text{distance})^2$; No. of photoelectrons emitted is proportional to intensity of incident light.
6. **(d)** As λ is increased, there will be a value of λ above which photoelectrons will be cease to come out so photocurrent will become zero. Hence **(d)** is correct answer.

Assertion/ Reason

1. **(b)** If radiation of single wavelength is incident on photosensitive surface, electrons of different KE will be emitted.
2. **(a)** When a light of single frequency falls on the electrons of inner layer of metal, then this electron comes out of the metal surface after a large number of collisions with atom of it's upper layer.
3. **(b)** The kinetic energy of emitted photoelectrons varies from zero to a maximum value. Work function depends on metal used.
4. **(d)** Photoelectric saturation current is independent of frequency. It only depends on intensity of light.
5. **(b)** Less work function means less energy is required for ejecting out the electrons.
6. **(d)** Total number of emitted photons depends on energy of each photon. The energy of photons of two sources may be different.
7. **(d)** To photons of equal wavelength will have equal momentum (magnitude), but direction of momentum may be different.
8. **(b)**

Matching Based Questions

1. **(a)** 2. **(a)** 3. **(c)** 4. **(b)**

Critical Thinking Type Questions

1. **(a)** Einstein equation $E = h\upsilon_o + K.E$
where E = energy of incident photon.
$h\upsilon_o$ = work function of metal
K.E = max. kinetic energy of e^-
$\therefore 4\text{ eV} = 2\text{ eV} + K.E$ or $K.E = 2\text{ eV}$
Stopping potential is the potential difference which may stop this e^-.
Let it be V, then $eV = 2e \Rightarrow V = 2$ volt.
2. **(b)** Since work function for a metal surface is
$$W = \frac{hc}{\lambda_0}$$
where λ_0 is threshold wavelength or cut-off wavelength for a metal surface.
here $W = 4.125\text{ eV} = 4.125 \times 1.6 \times 10^{-19}$ Joule
$$\text{so } \lambda_0 = \frac{6.6\times10^{-34}\times3\times10^8}{4.125\times1.6\times10^{-19}} = 3000Å$$
3. **(a)** K.E. = $h\nu - h\nu_{th} = eV_0$ (V_0 = cut off voltage)
$$\Rightarrow V_0 = \frac{h}{e}(8.2\times10^{14} - 3.3\times10^{14})$$
$$= \frac{6.6\times10^{-34}\times4.9\times10^{14}}{1.6\times10^{-19}} \approx 2V.$$
4. **(b)** From photoelectric equation,
$h\nu' = h\nu + K_{max}$ ...(i)
$$h.2\nu = h\nu + \frac{1}{2}mV^2_{max} \quad [\because \nu' = 2\nu]$$
$$\Rightarrow h\nu = \frac{1}{2}mV^2_{max} \Rightarrow V_{max} = \sqrt{\frac{2h\nu}{m}}$$
5. **(a)** $$E_k = \frac{hc}{c}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)(\text{in eV})$$
$$= \frac{6.6\times10^{-34}\times3\times10^8}{1.6\times10^{-19}}\left(\frac{10^{10}}{1800} - \frac{10^{10}}{2300}\right) = 0.15eV$$
6. **(a)** The de-Broglie's wavelength associated with the moving electron $\lambda = \frac{h}{P}$
Now, according to problem
$$\frac{d\lambda}{\lambda} = -\frac{dp}{P}$$
$$\frac{0.5}{100} = \frac{P}{P'} \quad \text{or } P' = 200P$$
7. **(d)** As $P = \frac{E}{C}$
$$\lambda_p = \frac{\hbar C}{E} \quad ...(i)$$
$$\lambda_e^2 = \frac{\hbar h}{\sqrt{2mE}} \quad ...(ii)$$
From equations (i) and (ii)
$\lambda_p \propto \lambda_e^2$

8. **(c)** $\lambda = \frac{h}{mv}$, $v = \frac{m_0}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$,

$v \to c, m \to \infty$

hence, $\lambda \to 0$.

9. **(d)** For photon E = hν

$E = \frac{hc}{\lambda} \Rightarrow \lambda_2 = \frac{hc}{E}$ ...(i)

for proton $E = \frac{1}{2} m_p v_p^2$

$E = \frac{1}{2}\frac{m_p^2 v_p^2}{m} \Rightarrow p = \sqrt{2mE}$

From De Broglie Eqn.

$p = \frac{h}{\lambda_1} \Rightarrow \lambda_1 = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$ ...(ii)

$\frac{\lambda_2}{\lambda_1} = \frac{hc}{E \times \frac{h}{\sqrt{2mE}}} \infty E^{-1/2}$

26 Atoms

Fill in the Blanks

1. Coulomb's forces
2. 931 Mev
3. J.J. Thomson
4. Positively
5. In ground state, angular momentum = $\frac{h}{2\pi}$.

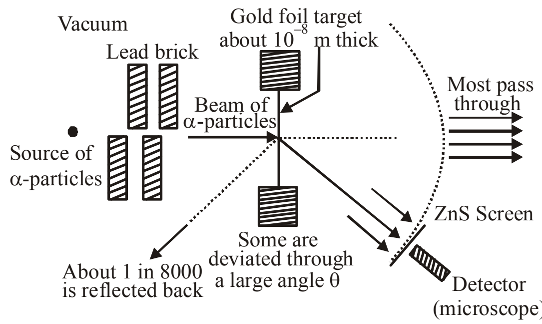
   According to Bohr's theory,

   Angular momentum, $mvr = \frac{nh}{2\pi}$
6. Balmer, In 1885, the first spectral series were observed by a Swedish school teacher Johann Jakob Balmer.
7. Visible region; Transition from higher states to n = 2 lead to emission of radiation with wavelengths 656.3 nm and 365.0 nm. These wavelengths fall in the visible region.

8 $\frac{\in_0 n^2 h^2}{\pi m Z e^2}$

True/ False

1. **False,** K.E. = –(T.E.)
2. **True**
3. **True,** Heavy mass at the centre of atom is responsible for large angle scattering of alpha particles
4. **True,** Many of the α-particles pass through the foil. It means that they do not suffer any collisions.



Schematic arrangement of the Geiger-Marsden experiment

Only about 0.14% of the incident α-particles scatter by more than 1° and about 1 in 8000 deflected by more than 90°.32.

5. **True,** Orbital speed varies inversely as the radius of the orbit.

   $v \propto \frac{1}{n}$
6. True
7. False
8. False; As according to coulomb's force

   $F = K\frac{q_1 q_2}{r^2}$

Conceptual MCQs

1. **(b)** Some of α-particles was found to be scattered at very large angles inspite of having very high kinetic energy. This shows that these are the α-particles which will be passing very close to Nucleus. Rutherford confirmed that the repulsive force on α-particle due to nucleus varies with distance according to inverse square law.
2. **(d)**

3. **(d)** Ultraviolet light is emitted when electron makes transition from any higher energy level to n = 1 level. Similarly, visible light is emitted when electron jumps from any higher level to n = 2 level. X-rays are also emitted when one of the electrons from some inner shell of atom is knocked out and the vacancy so created is filled up by jumping of electron from higher energy shell. On the other hand, γ-rays are emitted from the nucleus of an atom.

4. **(d)** $\omega = \frac{v}{r}$ As $v \propto \frac{1}{n}$ and $r \propto n^2$ hence $\omega \propto \frac{1}{n^3}$

5. **(d)** $E = E_4 - E_3$

$$= -\frac{13.6}{4^2} - \left(-\frac{13.6}{3^2}\right) = -0.85 + 1.51$$

= 0.66 eV

6. **(b)**

7. **(d)** According to Bohr's second postulate:

$$mvr = \frac{nh}{2\pi},\ n = 1, 2, ...$$

8. **(d)** $\frac{1}{\lambda_z} = Z_2 R\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$; λ_z is minimum.

when Z is maximum. Z is maximum (= 3) for doubly ionised lithium.

9. **(a)** The range of wavelengths of the lines of Lyman series varies from 912 A° to 1216 A°.

10. **(c)**

11. **(a)** As $\Delta E = h\nu$, hence ν is highest when ΔE is maximum. ΔE is maximum for n = 1 to n = 2 transition. For absorption, it should be a transition from lower energy level to higher energy level.

12. **(a)** 13. **(d)**

14. **(a)** Line spectrum is related with atomic state of matter because every atom is found to emit a radiations of certain fixed discrete wavelengths only.

15. **(d)** Energy in the first excited state

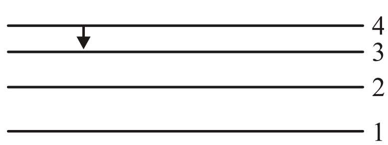
$$= \frac{-13.6}{n^2} = \frac{-13.6}{2^2} = -3.4\,\text{eV}$$

But K.E. = –(Total energy) = +3.4 eV.

16. **(d)** $L = mvr = \frac{nh}{2\pi}$, As $r \propto n^2$, hence $L \propto \sqrt{r}$.

17. **(d)**

18. **(c)** $\frac{n(n-1)}{2} = 6$



$n^2 - n - 12 = 0$

$(n - 4)(n + 3) = 0$ or $n = 4$

19. **(c)** When white light from the photosphere (central portion of the sun) passes through vapours of various elements present in the outer chromosphere, then these elements absorb those wavelengths which they themselves emit on being incandescent. Hence dark lines (absence of light) appear at those places in the continuous solar spectrum,

20. **(a)** The wavelengths of different lines in Lyman series varies from 912 A° to 1216 A°.

21. **(d)** Speed of electron, $v = \frac{C}{137}\frac{z}{n}$,

Energy $= \frac{-13.6}{n^2}$ and radius = 0.53 n^2Å

22. **(d)** $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right)$

$\therefore\ \lambda = \frac{4}{R} = 4 \times 912 = 365\text{nm}$.

23. **(a)** Linear momentum $\Rightarrow mv \propto 1/n$

angular momentum $\Rightarrow mv \propto n$

$\therefore$ product of linear momentum and angular momentum $\propto n^0$.

24. **(d)** For 2^{nd} line of Balmer series in hydrogen spectrum

$$\frac{1}{\lambda} = R\,(1)\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = \frac{3}{16}R$$

For Li^{2+} which is satisfied by n = 12 → n = 6

Diagram Based Questions

1. **(d)** α-particle cannot be attracted by the nucleus.

2. **(c)** Transition A (n = ∞ to 1) : Series line of Lyman series

Transition B (n = 5 to n = 2) : Third spectral line of Balmer series

Transition C (n = 5 to n = 3) : Second spectral line of Paschen series

3. **(d)** Radius of n^{th} orbit $r_n \propto n^2$, graph between r_n and n is a parabola. Also,

$$\frac{r_n}{r_1} = \left(\frac{n}{1}\right)^2 \Rightarrow \log_e\left(\frac{r_n}{r_1}\right) = 2\log_e(n)$$

Comparing this equation with y = mx + c,

Graph between $\log_e\left(\frac{r_n}{r_1}\right)$ and $\log_e$ (n) will be a straight line, passing from origin.

Similarly it can be proved that graph between $\log_e\left(\frac{f_n}{f_1}\right)$ and $\log_e n$ is a straight line. But with negative slops.

4. **(b)**

5. **(d)** Number of possible emission lines

$$= \frac{n(n-1)}{2}$$

Assertion/ Reason

1. **(b)** Rutherford confirmed that the repulsive force of α–particle due to nucleus varies with distance according to inverse square law and that the positive charges are concentrated at the centre and not distributed throughout the atom.
2. **(d)** According to classical electromagnetic theory, an accelerated charged particle continuously emits radiation. As electrons revolving in circular paths are constantly experiencing centripetal acceleration, hence they will be losing their energy continuously and the orbital radius will go on decreasing, form spiral and finally the electron will fall in the nucleus.
3. **(b)** Bohr postulated that electrons in stationary orbits around the nucleus do not radiate.
This is the one of Bohr's postulate, According to this the moving electrons radiates only when they go from one orbit to the next lower orbit.
4. **(c)** According to postulates of Bohr's atom model the electron revolves around the nucleus in fixed orbit of definite radii. As long as the electron is in a certain orbit it does not radiate any energy.
5. **(b)** When the atom gets appropriate energy from outside, then this electron rises to some higher energy level. Now it can return either directly to the lower energy level or come to the lowest energy level after passing through other lower energy levels hence all possible transitions take place in the source and many lines are seen in the spectrum.
6. **(a)** The wavelength in Balmer series is given by

$$\frac{1}{\lambda}=R\left[\frac{1}{2^2}-\frac{1}{n^2}\right],\quad n=3,4,5,.....$$

$$\frac{1}{\lambda_{max}}=R\left[\frac{1}{2^2}-\frac{1}{3^2}\right]$$

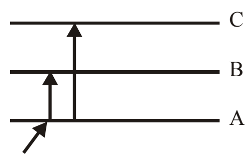
$$\lambda_{max}=\frac{36}{5R}=\frac{36}{5\times1.097\times10^7}=6563\ \text{Å}$$

and $$\frac{1}{\lambda_{min}}=R\left[\frac{1}{2^2}-\frac{1}{\infty^2}\right]$$

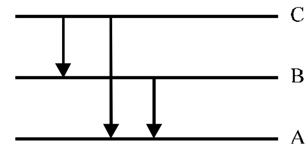
$$\lambda_{min}=\frac{4}{R}=\frac{36}{1.097\times10^7}=3646\ \text{Å}$$

The wavelength 6563 Å and 3646 Å lie in visible region. Therefore, Balmer series lies in visible region.

7. **(a)** Absorption transition



Two possibilities in absorption transition.



Three possibilities in emission transition.
Therefore, absorption transition < emission.

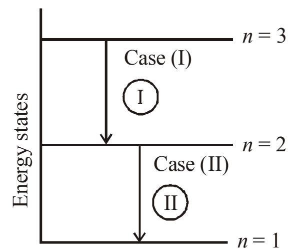
8. **(b)**

Matching Based Questions

1. **(c)** 2. **(a)** 3. **(b)** 4. **(a)**

Critical Thinking Type Questions

1. **(c)**



The wave number $(\bar{\nu})$ of the radiation $=\frac{1}{\lambda}$

$$=R_\infty\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$$

Now for case (I) $n_1=3,\ n_2=2$

$$\frac{1}{\lambda_1}=R_\infty\left[\frac{1}{9}\frac{-1}{4}\right],\ R_\infty=\text{ Rydberg constant}$$

$$\frac{1}{\lambda_1}=R_\infty\left[\frac{4-9}{36}\right]=\frac{-5R_\infty}{36}\Rightarrow\lambda_1=\frac{-36}{5R_\infty}$$

$$\frac{1}{\lambda_2}=R_\infty\left[\frac{1}{4}-\frac{1}{1}\right]=\frac{-3R_\infty}{4}$$

$$\lambda_2=\frac{-4}{3R_\infty}\Rightarrow\frac{\lambda_1}{\lambda_2}=\frac{-36}{5R_\infty}\times\frac{3R_\infty}{-4}$$

$$\frac{\lambda_1}{\lambda_2}=\frac{27}{5}$$

2. **(a)** From Mosley's law, we have,

$$(Z-1)^2\propto\nu\ \therefore\ (Z-1)^2=A\frac{c}{\lambda_{k_\alpha}}$$

where A is some constant,

$$\therefore\ \frac{(Z_{MO}-1)^2}{(Z_{Cu}-1)^2}=\frac{\lambda_{Cu}}{\lambda_{MO}}\ \text{or}\ \left(\frac{41}{28}\right)^2=\frac{\lambda_{Cu}}{0.71}$$

$\therefore\ \lambda_{Cu} = 0.71 \times \left(\frac{41}{28}\right)^2 = 1.52Å$

3. (d) For an atom following Bohr's model, the radius is given by $r_m = \frac{r_0 m^2}{Z}$ where r_0 = Bohr's radius and m = orbit number.
For Fm, $m = 5$ (Fifth orbit in which the outermost electron is present)

$\therefore\ r_m = \frac{r_0 5^2}{100} = nr_0$ (given) $\Rightarrow n = \frac{1}{4}$

4. (d) For Lyman series $(2 \to 1)$

$$\frac{1}{\lambda_L} = R\left[1 - \frac{1}{2^2}\right] = \frac{3R}{4}$$

For Balmer series $(3 \to 2)$

$$\frac{1}{\lambda_B} = R\left[\frac{1}{4} - \frac{1}{9}\right] = \frac{5R}{36}$$

$$\Rightarrow \frac{\lambda_L}{\lambda_B} = \frac{\frac{4}{3R}}{\frac{36}{5R}} = \frac{4}{36}\left(\frac{5}{3}\right) = \frac{5}{27}$$

5. (a) For Lyman series

$$\upsilon = R_C\left[\frac{1}{1^2} - \frac{1}{n^2}\right]$$

where n = 2, 3, 4, ...
For the series limit of Lyman series, $n = \infty$

$$\therefore\ \upsilon_1 = R_C\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right] = R_C \quad ...(i)$$

For the first line of Lyman series, $n = 2$

$$\therefore\ \upsilon_2 = R_C\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = \frac{3}{4}R_C \quad ...(ii)$$

For Balmer series

$$\upsilon = R_C\left[\frac{1}{2^2} - \frac{1}{n^2}\right]$$

where n = 3, 4, 5 .....
For the series limit of Balmer series, $n = \infty$

$$\therefore\ \upsilon_3 = R_C\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right] = \frac{R_C}{4} \quad ...(iii)$$

From equation (i), (ii) and (iii), we get
$\upsilon_1 = \upsilon_2 + \upsilon_3$ or $\upsilon_1 - \upsilon_2 = \upsilon_3$

6. (b) Radius of circular path followed by electron is given by,

$$r = \frac{m\upsilon}{qB} = \frac{\sqrt{2meV}}{eB} = \frac{1}{B}\sqrt{\frac{2m}{e}V}$$

$$\Rightarrow\ V = \frac{B^2 r^2 e}{2m} = 0.8V$$

For transition between 3 to 2.

$$E = 13.6\left(\frac{1}{4} - \frac{1}{9}\right) = \frac{13.6 \times 5}{36} = 1.88eV$$

Work function = 1.88 eV – 0.8 eV = 1.08 eV ≈ 1.1eV

7. (a) : For a Balmer series

$$\frac{1}{\lambda_B} = R\left[\frac{1}{2^2} - \frac{1}{n^2}\right] \quad ...(i)$$

where n = 3, 4, ...
By putting $n = \infty$ in eauaton (i), we obtain the series limit of the Balmer series. This is the shortest wavelength of the Balmer series.

$$\text{or} \quad \lambda_B = \frac{4}{R} \quad ...(ii)$$

For a Lyman series

$$\frac{1}{\lambda_L} = R\left[\frac{1}{1^2} - \frac{1}{n^2}\right] \quad ...(iii)$$

where n = 2, 3, 4, ...
By putting $n = \infty$ in equation (iii), we obtain the series limit of the Balmer series. This is the shortest wavelength of the Lyman series.

$$\text{or} \quad \lambda_L = \frac{1}{R} \quad ...(iv)$$

Dividing (ii) by (iv), we get

$$\frac{\lambda_B}{\lambda_L} = \frac{4}{1}$$

8. (d) The wavelength of the first line of lyman series for hydrogen atom is

$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$$

The wevelength of the second line of Balmer series for like ion is

$$\frac{1}{\lambda'} = Z^2 R\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

According to question = $\lambda = \lambda'$

$$\Rightarrow\ R\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = Z^2 R\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

or $\frac{3}{4} = \frac{3Z^2}{16}$ or $Z^2 = 4$ or $Z = 2$

27 Nuclei

Fill in the Blanks

1. Electron; Positron is the antiparticle of electron.
2. neutrons 3. isotones
4. less than 5. Irene Curie and Joliot
6. 10^7 K 7. cadmium.
8. Directly proportional

True/ False

1. False; ${}_8O^{18} + {}_1H^1 \rightarrow {}_9F^{18} + {}_0n^1$.
2. True
3. True
4. True, The common time measure of how long any given type of radionuclide lasts is the half-life $T_{1/2}$ of a radionuclide, Which is the time at which both N and R have been reduced to one-half their initial values.
5. False, Neutrons can't be deflected by a magnetic field.
6. True, This density is very large compared to ordinary matter, say water which is 10^{23} kg m^{-3}. This is understandable, as we have already seen that most of the atom is empty.
7. True, Ordinary matter consisting of atoms has a large amount of empty space.
8. False, Nuclear Magnetic Resonance.

Conceptual MCQs

1. (a) ${}^X_Y A \rightarrow {}^Y_X A \rightarrow {}^{Y-4}_{X-2} B + {}_2He^4$,

   ${}^{Y-4}_{X-2}B \rightarrow {}^{Y-2}_X C + 2e^-$ ${}^Y_X A$ and ${}_X C^{Y-2}$

   Hence, A and C are isotopes.
2. (d) Moderator slows down the neutrons to thermal energies.
3. (b) 4. (b)
5. (c) We know, $r = r_0 A^{1/3}$

   $\therefore \quad \frac{r_1}{r_2} = \left(\frac{A_1}{A_2}\right)^{1/3}$

   $= \left[\frac{216}{64}\right]^{1/3} = \frac{6}{4} = 1.5$
6. (c) The rate of fission = P/E

   $= \frac{3}{200 \times 1.6 \times 10^{-13}} = 10^{11}$
7. (b) The mass defect,

   $\Delta m = 31.97391 - 31.97207 = 0.00184u$

   The energy released E = Δmc^2

   = 1.7 MeV.
8. (c) ${}_6C^{12} + {}_1H^1 = {}_7N^{13} + {}_0n^1$
9. (c) Let n-alpha and m-beta particles be emitted, then

   $238 = 206 + n \times 4 \quad \Rightarrow n = 8$

   and $92 - 8 \times 2 + m \times 1 = 82 \Rightarrow m = 6$.
10. (a) $\frac{A}{A_0} = e^{-\lambda t}$

    $A = A_0 e^{-\lambda t} = 128\ e^{-6.95 \times 1/2}$

    $128\ e^{-3.475} = 4$m Cu

    OR

    $T = \frac{0.693}{6.93} = \frac{1}{10}$

    $n = \frac{t}{T} = \frac{y_2}{y_{10}} = 5,$

    $A = 128\left(\frac{1}{2}\right)^5 = 4$
11. (d) Five alpha and three beta particles results

    ${}^{231}AC_{89} \longrightarrow \underset{(89-5\times2+3\times1)=82}{\overset{231-5\times4=211}{Pb}}$
12. (c) 1 a.m.u = 931 MeV
13. (d) ${}^A_Z X \longrightarrow {}_{Z+1}Y^A$ (since Z $\rightarrow$ Z + 1)

    $\therefore$ β emission

    ${}^A_{Z+1}Y \longrightarrow {}_{Z-1}Y^{A-4}$

    (decrease in A = 4, decrease in Z = 2)

    $\therefore$ α particle emission

    ${}_{Z-1}K^{A-4} \longrightarrow {}_{Z-1}K^{A-4}$

    (decrease in A = 0, decrease in Z = 0)

    $\therefore$ γ emission.
14. (b) Thorium has atomic mass 234 and atomic number 90 hence

    ${}^{235}_{92}U \longrightarrow {}^{234}_{90}Th + X$

    For X, A = 4, Z = 2

    which means Z = alpha particle.
15. (b) If N_0 is the initial number of nuclei present, then the activities at the time instants t_1 and t_2 can be written as $R_1 = N_0 \exp(-\lambda t_1)$ and $R_2 = N_0 \exp(-\lambda t_2)$ respectively. Equate for N_0 to get the result.
16. (b) ${}_Z X^A \longrightarrow {}_{Z-1}Y^A + e^+ + v$

    $\downarrow$

    $2\alpha + {}_{Z-5}X'^{A-B}$

Given $A - 8 = 224$

& $Z - 5 = 89 \quad \Rightarrow \quad A = 237, Z = 94$

17. (c) Energy released = (80 × 7 + 120 × 8 – 200 × 6.5) = 220 MeV.

18. (b) $^{140}_{54}Xe \xrightarrow{-4\beta} {}_{58}Y^{140}$

$^{94}_{38}Sr \xrightarrow{-2\beta} {}^{94}_{40}Sr$

19. (a) The radioactive substances complete 4 and 3 of their respective half lives in 2 days.

20. (d) mass defect $\Delta m = 2 \times 2.01471 - 4.00388 = 0.02554$ amu

energy liberated = 0.02554 × 931.5 MeV = 23.79 MeV

21. (a) Activity $A = \dfrac{-dN}{dt} = \lambda N$

$$A = \frac{0.693}{T} \times N = \frac{0.693}{34.65 \times 60} \times 10^{22}$$

$= 3.34 \times 10^{18}$ disintegration /sec

Diagram Based Questions

1. (c)

2. (c) Energy is released in a process when total binding energy (BE) of products is more than the reactants. By calculations we can see that this happens in option **(c)**.

Given $W = 2Y$

BE of reactants = 120 × 7.5 = 900 MeV

BE of products = 2 × (60 × 8.5) = 1020 MeV.

3. (c) The range of energy of β-particles is from zero to some maximum value.

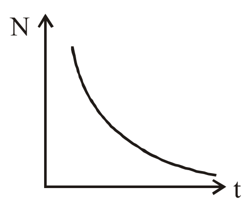
4. (c) No. of nuclide at time t is given by

$N = N_o e^{-\lambda t}$

Where N_o = initial nuclide

thus this equation is equivalent to $y = ae^{-kx}$

thus correct graph is



Assertion/ Reason

1. (a) $\rho = \dfrac{M}{V} = \dfrac{A}{\frac{4}{3}\pi r^3}$

$$= \frac{A}{\frac{4}{3}\pi (r_0 A^{1/3})^3} = \frac{1}{\left(\frac{4}{3}\pi r_0^3\right)} = \text{constant}$$

2. (b) Both statements are separately correct.

3. (d) In case of hydrogen atom mass number and atomic number are equal.

4. (c) Nuclear force is nearly same for all nucleus.

5. (c) Radioactivity $= -\dfrac{dN}{dt} = \lambda N = \dfrac{0.693N}{T_{1/2}}$

$$= \frac{0.693 \times 10^8}{50} = \frac{0.693 \times 1.2 \times 10^8}{60}.$$

$$= 0.693 \times 2 \times 10^6$$

Radioactivity is proportional to $1/T_{1/2}$, and not to $T_{1/2}$.

6. (b) β-particles, being emitted with very high speed compared to α-particles, pass for very little time near the atoms of the medium. So the probability of the atoms being ionised is comparatively less. But due to this reason, their loss of energy is very slow and they can penetrate the medium through a sufficient depth.

7. (c) Electrons are not inside nucleus.

8. (d) **9. (c)**

10. (d) We know that energy is released when heavy nuclei undergo fission or light nuclei undergo fusion.

The second statement is false because for heavy nuclei the binding energy per nucleon decreases with increasing Z and for light nuclei, B.E/nucleon increases with increasing Z.

Matching Based Questions

1. (b) **2. (c)** **3. (a)** **4. (b)**

Critical Thinking Type Questions

1. (a) Iodine and Yttrium are medium sized nuclei and therefore have more binding energy per nucleon as compared to Uranium which has a big nucleus and less B.E. / nucleon. In other words, Iodine and Yttrium are more stable and therefore, possess less energy and less rest mass. Also, when Uranium nuclei explodes, it will convert into I and Y nuclei having kinetic energies.

2. (a) $B.E_H = \dfrac{2.22}{2} = 1.11$

$B.E_{He} = \dfrac{28.3}{4} = 7.08$

$B.E_{Fe} = \dfrac{492}{56} = 8.78 =$ maximum

$B.E_U = \dfrac{1786}{235} = 7.6$

$^{56}_{26}Fe$ is most stable as it has maximum binding energy per nucleon.

3. (b) $Q = 4(x_2 - x_1)$

4. **(b)** Initially $P \to 4N_0$

$Q \to N_0$

Half life $T_P = 1$ min.

$T_Q = 2$ min.

Let after time t number of nuclei of P and Q are equal, that is

$$\frac{4N_0}{2^{t/1}} = \frac{N_0}{2^{t/2}} \Rightarrow \frac{4N}{2^{t/1}} = \frac{1}{2^{t/2}}$$

$\Rightarrow 2^{t/1} = 4.2^{t/2}$

$2^2.2^{t/2} = 2^{(2 + t/2)}$

$$\Rightarrow \frac{t}{1} = 2 + \frac{t}{2} \Rightarrow \frac{t}{2} = 2 \Rightarrow t = 4 \text{ min}$$

$$N_P = \frac{(4N_0)}{2^{4/1}} = \frac{N_0}{4}$$

at t = 4 min.

$$N_0 = \frac{N_0}{4} = \frac{N_0}{4}$$

or population of R

$$\left(4N_0 - \frac{N_0}{4}\right) + \left(N_0 - \frac{N_0}{4}\right) = \frac{9N_0}{2}$$

5. **(b)** $N_1 = N_0\, e^{-\lambda t}$ $\quad N_1 = \frac{1}{3}N_0$

$$\frac{N_0}{3} = N_0 e^{-\lambda t_2}$$

$$\Rightarrow \frac{1}{3} = e^{-\lambda t^2} \quad \text{...(i)}$$

$$N_2 = \frac{2}{3}N_0$$

$$\frac{2}{3}N_0 = N_0 e^{-\lambda t_1}$$

$$\Rightarrow \frac{2}{3} = e^{-\lambda t_1} \quad \text{...(ii)}$$

Dividing equation (i) by equation (ii)

$$\frac{1}{2} = e^{-\lambda(t_2 - t_1)}$$

$$\lambda(t_2 - t_1) = \ln 2$$

$$t_2 - t_1 = \frac{\ln 2}{\lambda} = T_{1/2} = 50 \text{ days}$$

6. **(d)** Let, the amount of the two in the mixture will become equal after t years.

The amount of A_1, which remains after t years

$$N_1 = \frac{N_{01}}{(2)^{t/20}}$$

The amount of A_2, which remains, after t years

$$N_2 = \frac{N_{02}}{(2)^{t/10}}$$

According to the problem

$N_1 = N_2$

$$\frac{40}{(2)^{t/20}} = \frac{160}{(2)^{t/10}}$$

$$2^{t/20} = 2^{\left(\frac{t}{10} - 2\right)}$$

$$\frac{t}{20} = \frac{t}{10} - 2$$

$$\frac{t}{20} - \frac{t}{10} = 2$$

$$\frac{t}{20} = 2$$

$t = 40$ s

7. **(c)** According to question,

Half life of X, $T_{1/2} = \tau_{av}$, mean life of Y

$$\Rightarrow \frac{0.693}{\lambda_X} = \frac{1}{\lambda_Y}$$

$$\Rightarrow \lambda_X = (0.693).\lambda_Y$$

$$\therefore \lambda_X > \lambda_Y.$$

Now, the rate of decay is given by

$$-\left(\frac{dN}{dt}\right) = \lambda_X N_0$$

$$-\left(\frac{dN}{dt}\right)_4 = \lambda_4 N_0$$

Y will decay faster than X.

8. **(a)** $^1_0n \longrightarrow {}^1_1H + {}_{-1}e^0 + \bar{\nu} + Q$

The mass defect during the process

$$\Delta m = m_n - m_H - m_e$$

$= 1.6725 \times 10^{-27} - (1.6725 \times 10^{-27} + 9 \times 10^{-31}\text{kg})$

$= -9 \times 10^{-31}$ kg

The energy released during the process

$E = \Delta mc^2$

$E = 9 \times 10^{-31} \times 9 \times 10^{16} = 81 \times 10^{-15}$ Joules

$$E = \frac{81 \times 10^{-15}}{1.6 \times 10^{-19}} = 0.511\text{MeV}$$

28 Semiconductor Electronics: Materials, Devices and Simple Circuits

Fill in the Blanks

1. Holes; Electrons in n-type semiconductor.
2. Reverse at a particular reverse voltage in PN-junction, a huge current flows in reverse direction known as avlanche current.
3. 1 eV
4. Stabilization, Zener diode is used as a voltage regulator i.e. for stabilization purposes.
5. emitter
6. Forward, reverse; The biasing of the transistor is done differently for different uses. The transistor works as an amplifier with its emitter-base junction forward biased and the base-collector junction reverse biased.
7. Positive feed back
8. Universal gates; Combination of NAND & NOR gates can produce OR, AND & NOT gates.

True/ False

1. False; Due to large concentration of electrons in N-side and holes in P-side, they diffuses from their own side to other side. Hence depletion region produces.
2. False; Rectifier converts a.c. into d.c.
3. True; Energy gap least for conductors and maximum for insulators.
4. False
5. True, In forward biasing due to the applied voltage, electrons from n-sdie cross the depletion region and reach P-side (where they are minority carriers).
6. False, When an electlron diffuses from $n \to$ P, it leaves behind an ionised donor (species which has becomes ion by donating electron) on n-side. This ionised donor (positive charge) is immobile as it is bonded to the surrounding atoms. As the electrons continue to diffuse from n-P, a layer of positive charge (or positive space-charge region) on n-side of the juction is developed. On P-side atom receiving electrons is ionised acceptor.
7. False, Base of a transistor is thin and lightly doped, base-emitter region is in forward biased whereas collector is in reverse biased.

Conceptual MCQs

1. **(d)** In full wave rectifier, we get the output for the positive and negative cycle of input a.c. Hence the frequency of the ripple of the output is twice than that of input a.c. i.e. 100 Hz
2. **(c)** Forward resistance =

$$\frac{\Delta V}{\Delta I} = \frac{0.7 - 0.5}{1.0 \times 10^{-3}} = 200\Omega$$

3. **(c)** $\beta = \frac{\alpha}{1-\alpha} = \frac{0.95}{1-0.95} = \frac{0.95}{0.05} = 19$
4. **(c)** $I_C = I_E - I_B = 90 - 1 = 89$ m A
5. **(c)** Current gain, $\alpha = \frac{A_V}{A_R} = \frac{2800}{3000} = 0.93$
6. **(a)** Current gain $(\alpha) = 0.96$

$I_e = 7.2$ mA

$$\frac{I_c}{I_e} = \alpha = 0.96$$

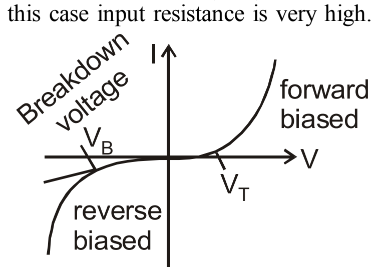
$$I_c = 0.96 \times 7.2\,\text{mA} = 6.91 \text{ mA}$$

$I_e = I_c + I_b$

$\Rightarrow I_b = I_e - I_c = 7.2 - 6.91 = 0.29$ mA

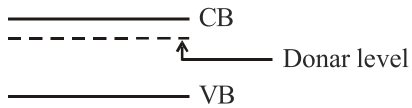
7. **(b)** In half wave rectifier only half of the wave is rectified
8. **(b)** At 0K (–273°C) motion of free electron stop i.e., there is no electron in conduction band therefore at 0K intrinsic semiconductor becomes insulator.
9. **(b)** For easy flow of current the P side must be connected to +ive terminal of battery i.e., it is connected to higher potential in comparison to N. This connection is called forward biased. In this case the input resistance is very low.

In reverse-biased, the P-side is connected to –ive terminal & N side to (+ive) terminal to battery. In this case input resistance is very high.



10. **(b)** Barrier potential depends on, doping density, temperature, forward/reverse bias but does not depend on diode design.]
11. **(c)** Maximum in insulators and overlaping in metals
12. **(a)**
13. **(d)** Holes move from base to emmitter
14. **(a)** The phase difference between output voltage and input signal voltage in common base transistor circuit is zero
15. **(c)** Silicon is an indirect-Band gap seniconductor.

16. (d)



17. (b) NAND + NAND
$\Rightarrow$ AND

18. (b) $\frac{V_0}{V_1} = \beta \frac{R_C}{R_B}$

$\frac{2.5}{0.01} = \beta \times \frac{5}{1}$

$\Rightarrow \beta = 50$

19. (b) $E_g = 2.0\text{ eV} = 2 \times 1.6 \times 10^{-19}$ J
$E_g = h\nu$

$\therefore \nu = \frac{E_g}{h} = \frac{2 \times 1.6 \times 10^{-19}\,\text{J}}{6.62 \times 10^{-34}\,\text{Js}}$

$= 0.4833 \times 10^{15}\,\text{s}^{-1} = 4.833 \times 10^{14}$ Hz

$\simeq 5 \times 10^{14}\,\text{Hz}$

20. (b) NOT + NAND = AND.

21. (b) When *p-n* junction is reverse biased, the flow of current is due to drifting of minority charge carriers across the junction.

Diagram Based Questions

1. (d) Positive terminal is at lower potential (0V) and negative terminal is at higher potential 5V.

2. (d) The input signal should be connected between two points of bridge rectifier such that in positive half wave of input signal, one p-n junction should be forward biased and other should be reverse biased and in negative half wave of input signal, the reverse should take place. It will be so when input is connected between B and D.

3. (d) (A) is a NAND gate so output is

$\overline{1 \times 1} = \bar{1} = 0$

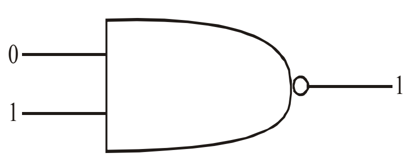
(B) is a NOR gate so output is

$\overline{0 + 1} = \bar{1} = 0$

(C) is a NAND gate so output is

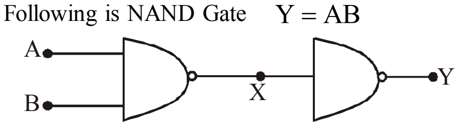
$\overline{0 \times 1} = \bar{0} = 1$

(D) is a XOR gate so output is $0 \oplus 0 = 0$



Following is NAND Gate $Y = \overline{AB}$

4. (b)



$X = \overline{AB}$

$\therefore Y = \overline{X} = \overline{\overline{AB}}$

Y = AB by Demorgan theorem

$\therefore$ This diagram performs the function of AND gate.

5. (a)

A	0	1	1	0
B	0	0	1	1
C	1	1	1	1

OR gate

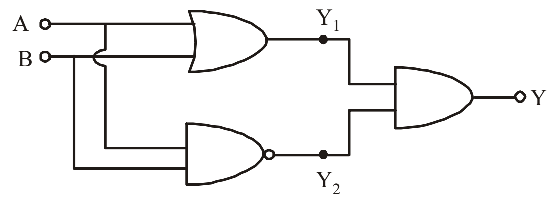
6. (b) Output of upper AND gate $= \overline{A}B$

Output of lower AND gate $= A\overline{B}$

$\therefore$ Output of OR gate, $Y = A\overline{B} + B\overline{A}$

This is boolean expression for XOR gate.

7. (b)



$Y_1 = A + B,\ Y_2 = \overline{A.B}$

$Y = (A + B) \bullet \overline{AB}$

$= A \bullet \overline{A} + A \bullet \overline{B} + B \bullet \overline{A} + B \bullet \overline{B}$

$= 0 + A \bullet \overline{B} + B \bullet \overline{A} + 0 = A \bullet \overline{B} + B \bullet \overline{A}$

This expression is for XOR

Assertion/ Reason

1. (a) In semiconductors, by increasing temperature, covalent bond breaks and conduction hole and electrons increase.

2. (a) In semiconductors the energy gap between conduction band and valence band is small ($\approx$1 eV). Due to temperature rise, electron in the valence band gain thermal energy and may jumpy across the small energy gap, (to the conduction band). Thus conductivity increases and hence resistance decreases.

3. (d) There is no charge on P-type semiconductor, because each atom of semiconductor is itself neutral.

4. (c) Silicon is cheaper than germanium, so it is preferred over germanium. But energy gap in germanium is smaller than silicon.

5. (b) Study of junction diode characteristics shows that the junction diode offers a low resistance path, when forward biased and high resistance path when reverse biased. This feature of the junction diode enables it to be used as a rectifier.

6. (b) Diffusion current is due to the migration of holes and electrons into opposite regions, so it will be from p-side to n-side. Also in forward bias it will increases.

7. **(a)** Input impedance of common emitter configuration.

$$= \left|\frac{\Delta V_{BE}}{\Delta i_B}\right|_{V_{CE} = \text{constant}}$$

where ΔV_{BE} = voltage across base and emitter (base emitter region is forward biased)
Δi_B = base current which is order of few microampere.

8. **(a)** A NOT gate puts the input condition in the opposite order, means for high input it give low output and for low input it give high output. For this reason NOT gate is known as invertor circuit.

9. **(a)** These gates are called digital building blocks because using these gates only (either NAND or NOR) we can compile all other gates also (like OR, AND, NOT, XOR)

Matching Based Questions

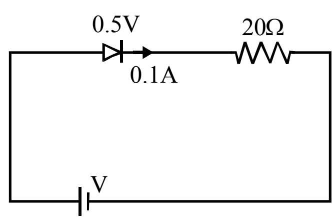
1. **(a)** 2. **(d)** 3. **(c)** 4. **(b)**

Critical Thinking Type Questions

1. **(d)** $n_i^2 = n_e n_h$
$(1.5 \times 10^{16})^2 = n_e (4.5 \times 10^{22})$
$\Rightarrow \quad n_e = 0.5 \times 10^{10}$
or $\quad n_e = 5 \times 10^9$
Given $\quad n_h = 4.5 \times 10^{22}$
$\Rightarrow n_h >> n_e$
$\therefore$ Semiconductor is p-type and
$n_e = 5 \times 10^9\ m^{-3}$.

2. **(b)** Given : $\mu_e = 2.3\ m^2\ V^{-1}\ s^{-1}$
$\mu_h = 0.01\ m^2\ V^{-1}\ s^{-1}$, $n_e = 5 \times 10^{12}$ / cm^3
$= 5 \times 10^{18}/m^3$ $n_h = 8 \times 10^{13}/cm^3 = 8 \times 10^{19}/m^3$.
Conductivity $\sigma = e[n_e\mu_e + n_h\mu_h]$
$= 1.6 \times 10^{-19}\ [5 \times 10^{18} \times 2.3 + 8 \times 10^{19} \times 0.01]$
$= 1.6 \times 10^{-1}\ [11.5 + 0.8]$
$= 1.6 \times 10^{-1} \times 12.3 = 1.968\ \Omega^{-1}\ m^{-1}$.

3. **(c)** $V' = V + IR = 0.5 + 0.1 \times 20 = 2.5$ V



4. **(d)** In common emitter configuration current gain

$$A_i = \frac{-h_{fe}}{1 + h_{oe}R_L} = \frac{-50}{1 + 25 \times 10^{-6} \times 1 \times 10^3} =$$

– 48.78
Where h_{fe} = forward current ratio
h_{oe} = output admittance.

5. **(d)** Current gain in common emitter mode

$$= \frac{\alpha}{1-\alpha} = \frac{0.995}{1-0.995} = \frac{0.995}{0.005} = 199.$$

6. **(c)** No. of electrons reaching the collector,

$$n_C = \frac{96}{100} \times 10^{10} = 0.96 \times 10^{10}$$

Emitter current, $I_E = \dfrac{n_E \times e}{t}$

Collector current, $I_C = \dfrac{n_C \times e}{t}$

$\therefore$ Current transfer ratio,

$$\alpha = \frac{I_C}{I_E} = \frac{n_C}{n_E} = \frac{0.96 \times 10^{10}}{10^{10}} = 0.96$$

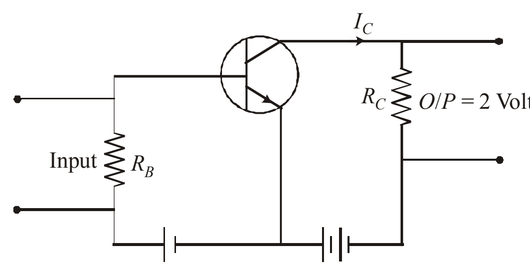
7. **(c)** Power gain = voltage gain × current gain

$$= V_G \cdot I_G = \frac{V_0}{V_i} \cdot \frac{I_0}{I_i}$$

$$= \frac{V_0^2}{V_i^2} \cdot \frac{R_i}{R_0} = 50 \times 50 \times \frac{100}{200}$$

$$= \frac{2500}{2} = 1250$$

8. **(d)**



The output voltage, across the load R_C
$V_0 = I_C R_C = 2$
The collector current (I_C)

$$I_C = \frac{2}{2 \times 10^3} = 10^{-3}\ \text{Amp}$$

Current gain (β)

$$(\beta)\ \text{current gain} = \frac{I_C}{I_B} = 100$$

$$I_B = \frac{I_C}{100} = \frac{10^{-3}}{100} = 10^{-5}\ \text{Amp}$$

Input voltage (V_i)
$V_i = R_B I_B = 1 \times 10^3 \times 10^{-5} = 10^{-2}$ Volt
$V_i = 10$ mV

29 Communication Systems

Fill in the Blanks

1. Point to point
2. Amplitude modulation.
3. Transmitter; The purpose of **transmitter** is to convert the message signal produced by source of information into a form suitable for transmission through the **channel**.
4. High or radio.
5. Resonant circuit.
6. 840 – 935 MHz
7. Modulation; Carrier + signal $\rightarrow$ modulation.
8. Line of sight

True/ False

1. False; In fact varying the local oscillator frequency.
2. False, Optical fibres are not subjected to electromagnetic interference from outside.
3. True
4. False, Digital signals are the values in the form of 0 or 1. It represents discrete values in the binary bits which are non-continuous set of values.
5. False, In statellite communication, the frequency used is more than 40 MHz.
6. True
7. False; UHF
8. True, In standard AM broadcast, ground based vertical towers are generally used as transmitting antennas. For such antennas ground has a strong influence on the propagation of the signal.

Conceptual MCQs

1. **(b)**

$$m_a = \frac{E_{max} - E_{min}}{E_{max} + E_{min}} = \frac{90-30}{90+30} = \frac{60}{120} = \frac{6}{12} = 0.5$$

2. **(c)** Line of sight mode of communication for carrier waves around 100 MHz.
3. **(d)** The required wavelength should be from 10^{-3}m to 0.1m.
4. **(c)** $\lambda = 3\text{m},\ H = 100\text{ m},\ h = 60\text{ m}$

Path difference between direct wave and wave obtained after reflection from earth surface is

$$\frac{2\pi}{\lambda}\left(\frac{2Hh}{d}\right) + \pi = 2\pi$$

or $\frac{4Hh}{\lambda d} = 1$ or $d = \frac{4Hh}{\lambda}$

$$\Rightarrow d = \frac{4 \times 100 \times 60}{3} = 8 \times 10^3\text{ m} \quad \text{or} \quad 8\text{km}$$

5. **(b)** Ground waves have the property of being polarized normal to the earth's surface.
6. **(b)** Critical frequency $f_c = 9\sqrt{N_m}$

where N_m represents election density of layers

$\because f_c \propto \sqrt{N_m}$

$\Rightarrow f_c$ is different for different layers.

7. **(d)** $\text{Electric Field} = -\frac{4\pi HhE}{\lambda d^2}$

$\Rightarrow$ E.F. $\propto \frac{1}{d^2}$

8. **(d)** Skip distance is the minimum distance on earth's surface from the transmitter where e.m. wave of a definite frequency can reach after reflection from the ionosphere

It is given by $D_{skip} = 2h\sqrt{\frac{f^2}{f_c^2} - 1}$

$\Rightarrow D_{skip}$ is dependent on h, f and fc.

9. **(d)** Since maximum part of the power of modulated wave is contained with the carrier wave which does not transmit any desired information, hence to avoid wastage of power to suppress carrier balanced modulator is used.

10. **(b)** 100% modulation $\Rightarrow m_a = 1$

$$\frac{\text{useful power}}{\text{total power radiated}} = \frac{m_a^2}{2 + m_a^2} = \frac{1}{2+1} = \frac{1}{3}$$

$\Rightarrow$ Useful power

$$= \frac{1}{3}(\text{total power radiated})$$

11. **(b)** For given transmission band 88-108 MHz

$(\Delta f)_{max} = 75$ kHz

given $(\Delta f)_{actual} = 18.75$ kHz

$\therefore$ % modulation

$$m = \frac{(\Delta f)_{actual}}{(\Delta f)_{max}} \times 100 = \frac{18.75}{75} = 25\%$$

12. **(b)** $E_c = 100$ V, $m_a = 0.4$, $R = 100\ \Omega$,

$$P_c = \frac{E_c^2}{2R} = \frac{(100)^2}{2 \times 100} = 50 \text{ watt}$$

$$P = \left(1 + \frac{m_a^2}{2}\right)P_c = \left[1 + \frac{(0.4)^2}{2}\right] \times 50 = 54 \text{ watt}$$

13. **(d)** Frequencies present in the output $= 100 \pm 0.3$

1000 ± 21 i.e. $\rightarrow$

999.7 KHz, 100.3 KHz, 999.2 KHz

1000.8 KHz, 998 KHz, 1002 KHz

14. **(a)** $G = 10\log_{10}\left(\frac{P_0}{P_n}\right)$dbs

$G \propto P_0$ ($\rightarrow$ power radiated by isotropic antenna)

$G \propto \frac{1}{P_n}$ ($\rightarrow$ power radiated by practical antenna)

15. **(c)** Average side-band power $P_{av} = \frac{m_a}{4} P_c^2$

Here $m_a = 0.5$

$P_c = 10$

$$\therefore P_{av} = \frac{0.5 \times 10 \times 10}{4} = 6.25$$

16. **(b)** Bandwidth is reduced using VSB

SSB is not used because removal of one side band is practically impossible.

Bandwidth is reduced because same information is present in both for picture signal is amplitude modulated.

17. **(d)** When transmission path is long more repeater stations are needed at intermediate points as repeater receives signal, remove the noise, amplify it and retransmit it along the channel.

18. **(a)** Electric field strength $E = \frac{88\sqrt{p}\, h_t\, h_r}{\lambda d^2}$

$$\Rightarrow E \propto \frac{1}{\lambda}$$

19. **(a)** For total internal reflection of sky waves, the refractive index of the ionosphere should be less. If $f > f_c$, the refractive index will increase. By this waves will just pass without reflection taking place.

20. **(a)** $P = P_c\left[1+\frac{m_a^2}{2}\right] = 1\left[1+\frac{(0.8)^2}{2}\right] = 1.32\text{kW}.$

21. **(b)** $m_a = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} = \frac{10-4}{10+4} = \frac{6}{14} = 0.43$

Diagram Based Questions

1. **(b)**

2. **(b)** **Given :** Resistance R = 100 kilo ohm

$= 100 \times 10^3\ \Omega$

Capacitance C = 250 picofarad

$= 250 \times 10^{-12}$F

$\tau = RC = 100 \times 10^3 \times 250 \times 10^{-12}$ sec

$= 2.5 \times 10^7 \times 10^{-12}$ sec

$= 2.5 \times 10^{-5}$ sec

The higher frequency whcih can be detected with tolerable distortion is

$$f = \frac{1}{2\pi m_a RC} = \frac{1}{2\pi \times 0.6 \times 2.5 \times 10^{-5}} Hz$$

$$= \frac{100 \times 10^4}{25 \times 1.2\pi} Hz = \frac{4}{1.2\pi} \times 10^4 Hz$$

= 10.61 KHz

This condition is obtained by applying the condition that rate of decay of capacitor voltage must be equal or less than the rate of decay modulated singnal voltage for proper detection of mdoulated signal.

Assertion/ Reason

1. **(a)** Amplification is necessary to compensate for the attenuation of the signal in communication systems.

2. **(c)** A transmitter processes the incoming message signal, so as make it suitable for transmission through a channel and subseqeuent reception.

3. **(a)** For transmitting a signal, we need an antenna or an aerial. This antenna should have a size comparable to the wavelength of the signal so that the antenna properly senses the time variation of the signal. For an electromagnetic wave frequency 20 kHz, the wavelength is 15 km. Obviously such a long antenna is not possible to cosntruct and operate. Hence direct transmission of such baseband signals is not practical. Therefore there is a need of translating the information constained in our original low frequency baseband signal into high or radio frequencies before trasnsmission.

4. **(c)** The range covered is not proportional to the height of the TV transmission tower. The range depends directly on square root of the height of the antenna *i.e.*

$S \propto \sqrt{h}$.

Let the height of the TV transmission tower be h and h' which covers the range S and S' respectively.

$\therefore \quad S = \sqrt{2hR}$ and $S' = \sqrt{2h'R}$

For $S' = 2S$ *i.e.* $\sqrt{2h'R} = 2\sqrt{2h'R}$

5. **(a)** Microwave communication is preferred over optical communication because microwave provide large number of channels and wide badwidth compared to optical signals as infromation carrying capacity is directly proportional to bandwidth. So wider the bandwidth greater the information carrying capacity.

6. **(c)** Long distance communication between two points on the earth is achieved through reflection of electromagnetic waves by ionosphere. Such waves are called sky waves Sky wave propagation takes place up to frequency of about 30 MHz.

7. **(d)** As television signals being of frequency 100 MHz to 200 MHz cannot be reflected by ionosphere but they penetrate it, so they are not propagated through sky waves. In fact, television signals are propagated through space wave propagation.

8. **(a)** A space wave travels in a straight line from transmitting antenna to the receiving antenna. Space waves are used for line-of-sight communication as well as satellite communication. At frequencies above 40 MHz communication is essentially limited to line of sight paths.

9. **(d)** The ionosphere layer acts as a reflector for a certain range of frequencies *i.e.* 3 to 30 MHz.Electromagnetic waves of frequencies higher than 30 MHz penetrate the ionosphere and escape.

10. **(d)** The process of retrieval of information from the carrier wave at the receiver is termed as demodulation. Repeater is a combination of a receiver and a transmitter, a repeater picks up the signal from the transmitter, amplifies and retransmist it to the receiver sometimes with a change in carrier frequency.

Matching Based Questions

1. **(a)** **2.** **(c)**

Critical Thinking Type Questions

1. **(b)** $P_c = P_t\left(1+\frac{m^2}{2}\right)$

$\Rightarrow \quad 11.8 = 10\left(1+\frac{m^2}{2}\right)$

$\Rightarrow \quad m = 0.6 \Rightarrow$ % modulation = 60%.

2. **(b)** For given transmission band 88-108 MHz

$(\Delta f)_{max} = 75$ kHz

given $(\Delta f)_{actual} = 18.75$ kHz

$\therefore$ % modulation

$$m = \frac{(\Delta f)_{actual}}{(\Delta f)_{max}} \times 100 = \frac{18.75}{75} = 25\%$$

3. **(d)** Total signal B.W= $12 \times 5 = 60$ kHz

11 guard band are required between 12 signal

$\therefore$ guard bandwidth $= 11 \times 1\text{kHz} = 11\text{kHz}$

$\therefore$ total bandwidth $= 60 + 11 = 71\text{kHz}$

4. **(b)** $P_t = P_c\left[1+\frac{m_a^{\,2}}{2}\right]$

$$\Rightarrow \frac{V^2_{rms}}{2} = \frac{V^2_c}{2}\left[1+\frac{m_a^{\,2}}{2}\right]$$

$$V^2_{rms} = V^2_c\left[1+\frac{m_a^{\,2}}{2}\right]$$

$$\Rightarrow V_{rms} = V_c\sqrt{1+\frac{m_a^{\,2}}{2}}$$

$$\Rightarrow V_{rms} = 100\sqrt{1+\frac{(0.3)^2}{2}}$$

= 104.5 volts.

5. **(d)** $P_T = P_C\left(1+\frac{m_a^{\,2}}{2}\right)$

$$\therefore\ 600 = 400\left(1+\frac{m_a^{\,2}}{2}\right) \Rightarrow \frac{3}{2} = 1+\frac{m_a^{\,2}}{2}$$

or $\frac{m_a^{\,2}}{2} = \frac{1}{2} \Rightarrow m_a = 1$

6. **(b)** 100% modulation $\Rightarrow m_a = 1$

$$\frac{\text{useful power}}{\text{total power radiated}} = \frac{m_a^{\,2}}{2+m_a^{\,2}} = \frac{1}{2+1} = \frac{1}{3}$$

$\Rightarrow$ Useful power

$= \frac{1}{3}(\text{total power radiated})$

7. (c) Average side-band power $P_{av} = \frac{m_a}{4} P_c^{\;2}$

Here $m_a = 0.5$

$P_c = 10$

$\therefore P_{av} = \frac{0.5 \times 10 \times 10}{4} = 6.25$

8. (a) Modulating signal frequency $\rightarrow$ 10kHz

Carrier signal frequency$\rightarrow$ 10 MHz

$\therefore$ Side band frequency are

USB = 10 MHz + 10 kHz = 10010 kHz

LSB = 10MHz – 10 kHz = 9990 kHz

9. (c) FM (I.F)=11.5MHz

F(image) = f_s+2 f_{IF}

$= 98.6 + 2 \times 11.5 = 121.6$ MHz

10. (b) $P_c = \frac{E_c^{\;2}}{2} = 10$ kW

$m_a = \sqrt{m_1^2 + m_2^2} = \sqrt{0.30^2 + 0.40^2} = 0.50$

$P_t = P_c.\left(1 + \frac{m_a{}^2}{2}\right) = 10\left(1 + \frac{(0.5)^2}{2}\right) = 11.25$ kW

11. (b) $m_a = \frac{E_{max} - E_{min}}{E_{max} + E_{min}} = \frac{10-4}{10+4} = \frac{6}{14} = 0.428$

$= 42.8\%$

1 Some Basic Concepts of Chemistry

Fill in the Blanks :

1. The modern atomic mass unit is based on _______ .
2. The total number of electrons present in 18 ml of water is _______ .
3. 3 g of a salt of molecular weight 30 is dissolved in 250 g of water. The molality of the solution is _______ .
4. The weight of 1×10^{22} molecules of $CuSO_4.5H_2O$ is _______ .
5. A mixture contains two or more substances in _______ which are called its _______ .
6. The weight of one molecule of a compound $C_{60}H_{122}$ is _______ .
7. _______ volume of oxygen gas (O_2) measured at 0°C and 1 atm, is needed to burn completely 1L of propane gas (C_3H_8) measured under the same conditions.
8. The Statue of Liberty is made of 2.0×10^5 lbs of copper sheets bolted to a framework. (1lb = 454 g) _______ atoms of copper are on the statue. (Atomic weight: Cu = 63.5).
9. Equal volumes of two gases A and B are kept in a container at the same temperature and pressure. The gases A and B contain _______ no of molecules.
10. A compound contains 54.55 % carbon, 9.09% hydrogen , 36.36% oxygen. The empirical formula of this compound is _______ .

True/ False :

1. Homogeneous mixture has uniform composition throughout.
2. All solutions are homogeneous in nature.
3. Mass and weight of a substance vary from one place to another due to change in gravity.
4. SI unit of mass is kilogram and while SI unit of weight is gram.
5. Moon takes 27.3 days and 1638 minutes to complete one orbit around the Earth.
6. Gay-Lussac's law of gaseous volumes is actually the law of definite proportion by volume.
7. The percentage of oxygen in H_2O_2 is different from that in H_2O. Hence, it violates law of definite proportions.
8. Fixed mass of A reacts with two different masses of B (say x and y), then the ratio of x/y can be any positive integer.
9. Atoms of H, O, N and C have identical properties but different mass.
10. Matter is divisible into atoms which are further indivisible.
11. The ratio of N: H in NH_3 is 1 : 3 and N : O in nitric oxide is 2 : 1.
12. Dalton's atomic theory support law of conservation of mass.

Conceptual MCQs :

1. Two students performed the same experiment separately and each one of them recorded two readings of mass which are given below. Correct reading of mass is 3.0 g. On the basis of given data, mark the correct option out of the following statements.

Students	Readings (i)	Readings (ii)
A	3.01	2.99
B	3.05	2.95

(a) Results of both the students are neither accurate nor precise.
(b) Results of student A are both precise and accurate.
(c) Results of student B are neither precise nor accurate.
(d) Results of student B are both precise and accurate.

2. The number of atoms in 0.1 mol of a triatomic gas is :
($N_A = 6.02 \times 10^{23}$ mol^{-1})
(a) 6.026×10^{22} (b) 1.806×10^{23}
(c) 3.600×10^{23} (d) 1.800×10^{22}

3. Which of the following is an example of a heterogeneous substance?
(a) Bottled water (b) Table salt
(c) Pieces of copper (d) Candle

4. Which of the following statements about a compound is incorrect ?
(a) A molecule of a compound has atoms of different elements.
(b) A compound cannot be separated into its constituent elements by physical methods of separation.
(c) A compound retains the physical properties of its constituent elements.
(d) The ratio of atoms of different elements in a compound is fixed.

5. In a hydrocarbon, mass ratio of hydrogen and carbon is 1:3, the empirical formula of hydrocarbon is
(a) CH_4 (b) CH_2
(c) C_2H (d) CH_3

6. Given the numbers : 161 cm, 0.161 cm, 0.0161 cm. The number of significant figures for the three numbers are
(a) 3, 4 and 5 respectively
(b) 3, 3 and 4 respectively
(c) 3, 3 and 3 respectively
(d) 3, 4 and 4 respectively

7. If the density of a solution is 3.12 g mL^{-1}, the mass of 1.5 mL solution in significant figures is______.
(a) 4.7 g (b) 4680×10^{-3} g
(c) 4.680 g (d) 46.80 g

8. $KMnO_4$ reacts with oxalic acid according to the equation:

$$2MnO_4^- + 5C_2O_4^{-} + 16H^+ \rightarrow 2Mn^{++} + 10CO_2 + 8H_2O$$

Here 20 mL of 0.1 M $KMnO_4$ is equivalent to:
(a) 20 mL of 0.5 M $H_2C_2O_4$
(b) 50 mL of 0.5 M $H_2C_2O_4$
(c) 50 mL of 0.1 M $H_2C_2O_4$
(d) 20 mL of 0.1 M $H_2C_2O_4$

9. Which of the following statements is correct about the reaction given below ?

$$4Fe(s) + 3O_2(g) \longrightarrow 2Fe_2O_3(g)$$

(a) Total mass of iron and oxygen in reactants = total mass of iron and oxygen in product therefore, it follows law of conservation of mass.
(b) Total mass of reactants = total mass of product; therefore, law of multiple proportions is followed.
(c) Amount of Fe_2O_3 can be increased by reducing the amount of any one of the reactants (iron or oxygen).
(d) Amount of Fe_2O_3 produced will decrease if the amount of any one of the reactants (iron or oxygen) is taken in excess.

10. Two samples of lead oxide were separately reduced to metallic lead by heating in a current of hydrogen. The weight of lead from one oxide was half the weight of lead obtained from the other oxide. The data illustrates –
(a) law of reciprocal proportions
(b) law of constant proportions
(c) law of multiple proportions
(d) law of equivalent proportions

11. In compound A, 1.00g of nitrogen unites with 0.57g of oxygen. In compound B, 2.00g of nitrogen combines with 2.24g of oxygen. In compound C, 3.00g of nitrogen combines with 5.11g of oxygen. These results obey the following law
(a) law of constant proportion
(b) law of multiple proportion
(c) law of reciprocal proportion
(d) Dalton's law of partial pressure

12. 0.1 mol HCl is equal to
(a) 3.65 g (b) 36.5 g
(c) 18 g (d) 1.8 g

13. Molecular mass is defined as the
(a) mass of one atom compared with the mass of one molecule
(b) mass of one atom compared with the mass of one atom of hydrogen
(c) mass of one molecule of any substance compared with the mass of one atom of C-12
(d) None of the above

14. Two containers P and Q of equal volume (1 litre each) contain 6 g of O_2 and SO_2 respectively at 300 K and 1 atmosphere, then
(a) Number of molecules in P is less than that in Q
(b) Number of molecules in P and Q is same
(c) Number of molecules in Q is less than that in P
(d) Either (a) or (b)

15. 50 ml 10 N H_2SO_4, 25 ml 12 N HCl and 40 ml 5 N HNO_3 were mixed together and the volume of the mixture was made 1000 ml by adding water. The normality of the resultant solution will be
(a) 2 N (b) 1 N
(c) 3 N (d) 4 N

16. In a chemical reaction

$$K_2Cr_2O_7 + xH_2SO_4 + ySO_2 \longrightarrow K_2SO_4 + zCr_2(SO_4)_3 + H_2O$$

the values of x, y, z are
(a) 4, 1, 4 (b) 1, 3, 1
(c) 3, 2, 3 (d) 2, 1, 2

17. A gas mixture contains O_2 and N_2 in the ratio of 1 : 4 by weight. The ratio of their number of molecules is
(a) 1 : 8 (b) 1 : 4
(c) 3 : 16 (d) 7 : 32

18. The Statue of Liberty is made of 2.0×10^5 lbs of copper sheets bolted to a framework. (1lb = 454 g) How many atoms of copper are on the statue?
(Atomic weight: Cu = 63.5).
(a) 2.1×10^{27} (b) 8.6×10^{29}
(c) 4.3×10^{26} (d) 8.6×10^{26}

19. The empirical formula and molecular mass of a compound are CH_2O and 180 g respectively. What will be the molecular formula of the compound ?
(a) $C_9H_{18}O_9$ (b) CH_2O
(c) $C_6H_{12}O_6$ (d) $C_2H_4O_2$

20. What is the mass percent of carbon in carbon dioxide ?
(a) 0.034% (b) 27.27%
(c) 3.4% (d) 28.7%

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*
(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Significant figures for 0.200 is 3 whereas for 200 it is 1.
Reason : Zero at the end or right of a number are significant provided they are not on the right side of the decimal point.

2. **Assertion :** 1.231 has three significant figures.
Reason : All numbers right to the decimal point are significant.

3. **Assertion :** One atomic mass unit is defined as one twelfth of the mass of one carbon - 12 atom.
Reason : Carbon-12 isotope is the most abundunt isotope of carbon and has been chosen as standard.

4. **Assertion :** Volume of a gas is inversely proportional to the number of moles of gas.
Reason : The ratio by volume of gaseous reactants and products is in agreement with their mole ratio.

5. **Assertion :** Equal moles of different substances contain same number of constituent particles.
Reason : Equal weights of different substances contain the same number of constituent particles.

6. **Assertion :** The empirical mass of ethene is half of its molecular mass.
Reason : The empirical formula represents the simplest whole number ratio of various atoms present in a compound.

7. **Assertion :** Atoms can neither be created nor destroyed.
Reason : Under similar condition of temperature and pressure, equal volume of gases does not contain equal number of atoms.

8. **Assertion :** The normality of 0.3 *M* aqueous solution of H_3PO_3 is equal to 0.6 *N*.
Reason : Equivalent weight of H_3PO_3

$$= \frac{\text{Molecular weight of } H_3PO_3}{3}$$

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.m*

1. Match the items of Column I, II and III appropriately and choose the correct option from the codes given below.

Column I (Multiple)	Column II (Prefix)	Column III (Symbol)
(A) 10^{-15}	(1) Kilo	(i) m
(B) 10^{-3}	(2) yotta	(ii) f
(C) 10^{3}	(3) milli	(iii) k
(D) 10^{24}	(4) femto	(iv) Y

(a) A – (4), (ii); B – (3), (i); C – (1), (iii); D – (2), (iv)
(b) A – (1), (ii); B – (2), (iii); C – (3), (i); D – (4), (iv)
(c) A – (2), (iv); B – (1), (ii); C – (1), (i); D – (3), (iii)
(d) A – (3), (iii); B – (1), (ii); C – (4), (i); D – (2), (iv)

2. Match the columns

Column-I (Number)	Column-II (Significant figures)
(A) 29900.	(1) 2
(B) 290	(2) 1
(C) 1.23×1.331	(3) 4
(D) 20.00	(4) 3
(E) $2.783 - 1$	(5) 5

(a) A – (3), B – (2), C – (5), D – (1), E – (4)
(b) A – (5), B – (1), C – (4), D – (3), E – (2)
(c) A – (1), B – (5), C – (4), D – (3), E – (2)
(d) A – (5), B – (4), C – (3), D – (2), E – (1)

3. Match the columns

Column-I (Laws of chemical combinations)	Column-II (Scientist)
(A) Law of definite proportions	(1) Antoine Lavoisier
(B) Law of multiple proportions	(2) Gay Lussac
(C) Law of conservation of mass	(3) Dalton
(D) Law of gaseous volumes	(4) Joseph Proust

(a) A – (s), B – (r), C – (p), D – (q)
(b) A – (p), B – (r), C – (s), D – (q)
(c) A – (r), B – (p), C – (s), D – (q)
(d) A – (q), B – (s), C – (r), D – (p)

4. Match the columns

Column-I	Column-II
(A) $C_6H_5NH_2$	(1) 84
(B) C_6H_6	(2) 100
(C) C_6H_{12}	(3) 93
(D) $CaCO_3$	(4) 78

(a) A – (4), B – (3), C – (1), D – (2)
(b) A – (1), B – (3), C – (4), D – (2)
(c) A – (3), B – (1), C – (4), D – (2)
(d) A – (4), B – (4), C – (3), D – (1)

5. Match the columns.

Column-I	Column-II
(A) 88 g of CO_2	(1) 0.25 mol
(B) 6.022×10^{23} molecules of H_2O	(2) 2 mol
(C) 5.6 litres of O_2 at STP	(3) 1 mol
(D) 96 g of O_2	(4) 6.022×10^{23} molecules
(E) 1 mol of any gas	(5) 3 mol

(a) A – (2), B – (3), C – (1), D – (5), E – (4)
(b) A – (3), B – (2), C – (1), D – (5), E – (4)
(c) A – (2), B – (1), C – (3), D – (5), E – (4)
(d) A – (2), B – (3), C – (1), D – (4), E – (5)

6. Match the mass of elements given in Column I with the number of moles given in Column II and mark the appropriate choice. Choose the correct codes formt he options given below.

Column-I	Column-II
(A) 28 g of He	(1) 2 moles
(B) 46 g of Na	(2) 7 moles
(C) 60 g of Ca	(3) 1 mole
(D) 27 g of Al	(4) 1.5 mole

(a) A – (4), B – (3), C – (2), D – (1)
(b) A – (1), B – (3), C – (2), D – (4)
(c) A – (3), B – (2), C – (1), D – (4)
(d) A – (2), B – (1), C – (4), D – (3)

7. Match the columns.

Column-I (Physical quantity)	Column-II (Unit)
(A) Molarity	(1) mol
(B) Mole fraction	(2) Unitless
(C) Mole	(3) mol L^{-1}
(D) Molality	(4) mol kg^{-1}

(a) A – (3), B – (2), C – (4), D – (1)
(b) A – (3), B – (1), C – (2), D – (4)
(c) A – (3), B – (2), C – (1), D – (4)
(d) A – (2), B – (3), C – (1), D – (4)

Critical Thinking Type Questions :

1. What are the significant figure(s) in a broken "ruler" show below?

(A) 1 (B) 2
(C) 3 (D) 0
(a) A, B and C (b) A, B, D
(c) A only (d) A and B

2. Volume occupied by one molecule of water (density = 1 g cm^{-3}) is :]
(a) 9.0×10^{-23} cm^3 (b) 6.023×10^{-23} cm^3
(c) 3.0×10^{-23} cm^3 (d) 5.5×10^{-23} cm^3

3. Arrange the following in the order of increasing mass (atomic mass: O = 16, Cu = 63, N = 14)
I. one atom of oxygen
II. one atom of nitrogen
III. 1×10^{-10} mole of oxygen
IV. 1×10^{-10} mole of copper
(a) II < I < III < IV (b) I < II < III < IV
(c) III < II < IV < I (d) IV < II < III < I

4. In a compound C, H and N atoms are present in 9 : 1 : 3.5 by weight. Molecular weight of compound is 108. Molecular formula of compound is
(a) $C_2H_6N_2$ (b) C_3H_4N
(c) $C_6H_8N_2$ (d) $C_9H_{12}N_3$.

5. Liquid benzene (C_6H_6) burns in oxygen according to the equation

$$2C_6H_6(l) + 15O_2(g) \longrightarrow 12CO_2(g) + 6H_2O(g)$$

How many litres of O_2 at STP are needed to complete the combustion of 39 g of liquid benzene?(Mol. wt. of O_2 = 32, C_6H_6 = 78)
(a) 74 L (b) 11.2 L
(c) 22.4 L (d) 84 L

6. Which of the following is the correct empirical and molecular formulae of a compound, if the molecular mass of a compound is 80 and compound contains 60% of C, 5% of H and 35% of N ?
(a) C_2H_2N ; $C_4H_4N_2$
(b) $C_3H_4N_2$; $C_6H_8N_4$
(c) $C_2H_4N_2$; $C_4H_8N_4$
(d) C_2H_2N ; C_2H_2N

7. Fat is an important source of energy and water, this is important for the desert animals like camel which store fat in its hump and provide water and energy. How many grams and moles of H_2O are produced from the combustion of fat $C_{57}H_{110}O_6$ from 450 gram of fat stored in hump of camel?

$$C_{57}H_{110}O_6 + \frac{163}{2}O_2 \rightarrow 57CO_2 + 55H_2O$$

(a) 500.56 , 27.80 (b) 450, 26.80
(c) 580, 25.0 (d) 400, 26.6

8. The increasing order of molarity with 25 gm each of NaOH, LiOH, $Al(OH)_3$, KOH, $B(OH)_3$ in same volume of water?
(a) $Al(OH)_3$ < $B(OH)_3$ < KOH < NaOH < LiOH
(b) LiOH < NaOH < KOH < $B(OH)_3$ < $Al(OH)_3$
(c) LiOH < NaOH < $B(OH)_3$ < KOH < $Al(OH)_3$
(d) NaOH < LiOH < $B(OH)_3$ < $Al(OH)_3$ < KOH

2 STRUCTURE OF ATOM

Fill in the Blanks :

1. The mass of a hydrogen atom is _______ kg.
2. Isotopes of an element differ in the number of _______ in their nuclei.
3. When there are two electrons in the same orbital, they have _______ spins.
4. Elements of the same mass number but of different atomic numbers are known as _______.
5. The uncertainty principle and the concept of wave nature of matter were proposed by _______ and _______ respectively. (Heisenberg, Schrodinger, Maxwell, de Broglie)
6. The light radiations with discrete quantities of energy are called _______ .
7. Wave functions of electrons in atoms and molecules are called _______ .
8. The $2p_x$, $2p_y$ and $2p_z$ orbitals of atom have identical shapes but differ in their _______ .
9. The outermost electronic configuration of Cr is _______ .
10. The shortest wavelength in hydrogen spectrum of Lyman series when R_H = 109678 cm^{-1} is _______ .

True/ False :

1. The outer electronic configuration of the ground state chromium atom is $3d^4 4s^2$.
2. Gamma rays are electromagnetic radiations of wavelengths of 10^{-6} cm to 10^{-5} cm.
3. The energy of the electron in the $3d$-orbital is less than that in the $4s$-orbital in the hydrogen atom.
4. In a given electric field, β-particles are deflected more than α-particles in spite of α-particles having larger charge.
5. Angular quantum number determines the three-dimensional shape of the orbital.
6. Magnetic quantum number determines the size of the orbital.
7. In photo electric effect kinetic energy of ejected electrons depends upon the brightness of light.
8. In electromagnetic radiation oscillating electric and magnetic fields produced by oscillating charged particles are perpendicular to each other, but not to the direction of propagation.

Conceptual MCQs

1. Which of the following statement is not correct about the characteristics of cathode rays?
   (a) They start from the cathode and move towards the anode.
   (b) They travel in straight line in the absence of an external electrical or magnetic field.
   (c) Characteristics of cathode rays do not depend upon the material of electrodes in cathode ray tube.
   (d) Characteristics of cathode rays depend upon the nature of gas present in the cathode ray tube.
2. If n = 6, the correct sequence for filling of electrons will be :
   (a) ns → (n – 2) f → (n – 1) d → np
   (b) ns → (n – 1) d → (n – 2) f → np
   (c) ns → (n – 2) f → np → (n – 1) d
   (d) ns → np (n – 1) d → (n – 2) f
3. Which of the following properties of atom could be explained correctly by Thomson Model of atom?
   (a) Overall neutrality of atom.
   (b) Spectra of hydrogen atom.
   (c) Position of electrons, protons and neutrons in atom.
   (d) Stability of atom.

4. Rutherford's α-particle dispersion experiment concludes
   (a) all positive ions are deposited at small part
   (b) all negative ions are deposited at small part
   (c) proton moves around the electron
   (d) neutrons are charged particles.
5. Number of protons, neutrons and electrons in the element ${}_{89}X^{231}$ is
   (a) 89, 89, 242 (b) 89, 142, 89
   (c) 89, 71, 89 (d) 89, 231, 89
6. Based on equation $E = -2.178 \times 10^{-18}\ J\left(\frac{Z^2}{n^2}\right)$, certain conclusions are written. Which of them is not correct ?
   (a) Larger the value of n, the larger is the orbit radius.
   (b) Equation can be used to calculate the change in energy when the electron changes orbit.
   (c) For n = 1, the electron has a more negative energy than it does for n = 6 which mean that the electron is more loosely bound in the smallest allowed orbit.
   (d) The negative sign in equation simply means that the energy or electron bound to the nucleus is lower than it would be if the electrons were at the infinite distance from the nucleus.
7. Which one of the following constitutes a group of the isoelectronic species?
   (a) C_2^{2-}, O_2^-, CO, NO
   (b) $CN^-, N_2, O_2^{2-}, C_2^{2-}$
   (c) $NO^+, C_2^{2-}, CN^-, N_2$
   (d) N_2, O_2^-, NO^+, CO
8. Which of the following combinations of quantum numbers is allowed?

	n	l	m	m_s
(a)	3	2	1	0
(b)	2	0	0	$-\frac{1}{2}$
(c)	3	–3	–2	$+\frac{1}{2}$
(d)	1	0	1	$+\frac{1}{2}$

9. If E_1, E_2, and E_3 represent respectively the kinetic energies of an electron and an alpha particle and a proton each having same de-broglie wavelength then
   (a) $E_1 > E_3 > E_2$ (b) $E_2 > E_3 > E_1$
   (c) $E_1 > E_2 > E_3$ (d) $E_1 = E_2 = E_3$
10. If travelling at same speeds, which of the following matter waves have the shortest wavelength?
   (a) Electron
   (b) Alpha particle (He^{2+})
   (c) Neutron
   (d) Proton
11. The first emission line in the atomic spectrum of hydrogen in the Balmer series appears at
   (a) $\frac{9R}{400}\ cm^{-1}$ (b) $\frac{7R}{144}\ cm^{-1}$
   (c) $\frac{3R}{4}\ cm^{-1}$ (d) $\frac{5R}{36}\ cm^{-1}$
12. Heisenberg uncertainty principle can be explained as
   (a) $\Delta x \geq \frac{\Delta P \times h}{4\pi}$ (b) $\Delta x \times \Delta P \geq \frac{h}{4\pi}$
   (c) $\Delta x \times \Delta P \geq \frac{h}{\pi}$ (d) $\Delta P \geq \frac{\pi h}{\Delta x}$
13. In a Bohr model of an atom, when an electron jumps from $n = 3$ to $n = 1$, how much energy will be emitted?
   (a) 2.15×10^{-11} ergs
   (b) 2.389×10^{-12} ergs
   (c) 0.239×10^{-10} ergs
   (d) 0.1936×10^{-10} ergs
14. The radius of hydrogen atom in the ground state is 0.53Å. The radius of Li^{2+} ion (atomic number = 3) in a similar state is
   (a) 0.17 Å (b) 1.06 Å
   (c) 0.53 Å (d) 0.265 Å
15. The uncertainty in the momentum of an electron is 1.0×10^{-5} kg ms^{-1}. The uncertainty in its position will be ($h = 6.62 \times 10^{-34}$ kg m^{2}s^{-1})
   (a) 1.05×10^{-26} m (b) 1.05×10^{-28} m
   (c) 5.27×10^{-30} m (d) 5.25×10^{-28} m
16. Which one of the following set of quantum numbers is not possible for 4p electron?
   (a) $n = 4, l = 1, m = -1, m_s = +\frac{1}{2}$

(b) $n = 4, l = 1, m = 0, m_s = +\frac{1}{2}$

(c) $n = 4, l = 1, m = 2, m_s = +\frac{1}{2}$

(d) $n = 4, l = 1, m = -1, m_s = -\frac{1}{2}$

17. The electrons, identified by quantum numbers n and l (i) $n = 4, l = 1$ (ii) $n = 4, l = 0$ (iii) $n = 3, l = 2$ (iv) $n = 3, l = 1$ can be placed in order of increasing energy, from the lowest to highest, as

(a) (iv) < (ii) < (iii) < (i)
(b) (ii) < (iv) < (i) < (iii)
(c) (i) < (iii) < (ii) < (iv)
(d) (iii) < (i) < (iv) < (ii)

18. What is X in the following nuclear reaction?

$${}_{7}N^{14} + {}_{1}H^{1} \rightarrow {}_{8}O^{15} + X$$

(a) ${}_{0}n^{1}$ (b) ${}_{-1}e^{0}$
(c) ${}_{+1}e^{0}$ (d) γ

19. The correct order of increasing energy of atomic orbitals is

(a) $5p < 4f < 6s < 5d$ (b) $5p < 6s < 4f < 5d$
(c) $5p < 5d < 4f < 6s$ (d) None of these

20. If the nitrogen atom had electronic configuration $1s^7$ it would have energy lower than that of the normal ground state configuration $1s^2\ 2s^2\ 2p^3$ because the electrons would be closer to the nucleus. Yet $1s^7$ is not observed. It violates

(a) Heisenberg's uncertainty principle
(b) Hund's rule
(c) Pauli exclusion principle
(d) Bohr postulate of stationary orbits

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The position of an electron can be determined exactly with the help of an electron microscope.
Reason : The product of uncertainty in the measurement of its momentum and the uncertainty in the measurement of the position cannot be less than a finite limit.

2. **Assertion :** The radius of the first orbit of hydrogen atom is 0.529Å.
Reason : Radius of each circular orbit (r_n) - 0.529Å (n^2/Z), where n = 1, 2, 3 and Z = atomic number.

3. **Assertion :** All isotopes of a given element show the same type of chemical behaviour.
Reason : The chemical properties of an atom are controlled by the number of electrons in the atom.

4. **Assertion :** Black body is an ideal body that emits and absorbs radiations of all frequencies.
Reason : The frequency of radiation emitted by a body goes from a lower frequency to higher frequency with an increase in temperature.

5. **Assertion :** It is impossible to determine the exact position and exact momentum of an electron simultaneously.
Reason : The path of an electron in an atom is clearly defined.

6. **Assertion :** Energy of photon is independent from intensity of the radiation.
Reason : Energy of photon does not depend upon wavelength of light used.

7. **Assertion :** For Balmer series of hydrogen spectrum, the value $n_1 = 2$ and $n_2 = 3, 4, 5$.
Reason : The value of n for a line in Balmer series of hydrogen spectrum having the highest wavelength is 4 and 6.

8. **Assertion :** Absorption spectrum consists of some bright lines separated by dark spaces.
Reason : Emission spectrum consists of bright lines.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns.

Column-I	Column-II
(A) $_1^1H, _1^2H$ and $_1^3H$	(1) Isobars
(B) $_6^{14}C$ and $_7^{14}N$	(2) Isotopes
(C) Na^+ and Mg^{2+}	(3) Isoelectronic species

(a) A – (1), B – (2), C – (3)
(b) A – (2), B – (1), C – (3)
(c) A – (3), B – (2), C – (1)
(d) A – (1), B – (3), C – (2)

2. Match the columns.

Column-I	Column-II
(A) X-rays	(1) $v = 10^0 - 10^4$ Hz
(B) UV	(2) $v = 10^{10}$ Hz
(C) Long radio waves	(3) $v = 10^{16}$ Hz
(D) Microwave	(4) $v = 10^{18}$ Hz

(a) A – (4), B – (3), C – (1), D – (2)
(b) A – (3), B – (4), C – (1), D – (2)
(c) A – (4), B – (1), C – (3), D – (2)
(d) A – (4), B – (3), C – (2), D – (1)

3. Match the columns.

Column-I	Column-II
(A) $\|\Psi\|^2$	(1) Energy can be emitted or absorbed in packets
(B) de Brolie	(2) Significant only for motion of microscopic objects.
(C) Heisenberg	(3) The probability of finding an electron at a point within an atom
(D) Planck's	(4) Every object in motion has a wave character.

(a) A – (2), B – (4), C – (3), D – (1)
(b) A – (3), B – (1), C – (2), D – (4)
(c) A – (3), B – (4), C – (2), D – (1)
(d) A – (4), B – (1), C – (3), D – (2)

4. Match the columns.

Column-I (Quantum number)	Column-II (Information provided)
(A) Principal quantum number	(1) orientation of the orbital
(B) Azimuthal quantum number	(2) energy and size of orbital
(C) Magnetic quantum number	(3) spin of electron
(D) Spin quantum number	(4) shape of the orbital

(a) A – (2), B – (4), C – (1), D – (3)
(b) A – (4), B – (2), C – (1), D – (3)
(c) A – (2), B – (1), C – (4), D – (3)
(d) A – (2), B – (4), C – (3), D – (1)

5. Match the columns.

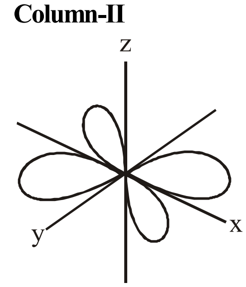
Column-I (Sub shell)	Column-II (Number of orbitals)	Column-III (Angular/ Azimuthal Quantum Number)
(A) d	(1) 1	(i) 1
(B) f	(2) 3	(ii) 2
(C) s	(3) 5	(iii) 0
(D) p	(4) 7	(iv) 3

(a) A – (3) – (ii), B – (4) – (iv), C – (1) – (iii), D – (2) – (i)
(b) A – (2) – (i), B – (4) – (iv), C – (1) – (iii), D – (3) –(ii)
(c) A – (1) – (iii), B – (4) – (iv), C – (3) – (ii), D – (2) – (i)
(d) A – (3) – (ii), B – (1) – (iii), C – (4) – (iv), D – (2) – (i)

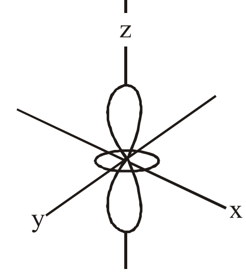
6. Match the columns.

Column-I **Column-II**

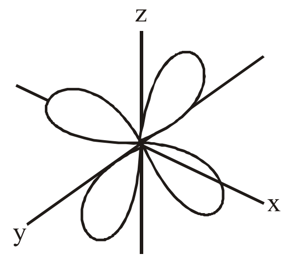
(A) $d_{x^2-y^2}$ (1)



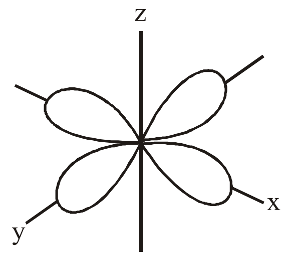
(B) d_{xy} (2)



(C) d_{yz} (3)



(D) d_{z^2} (4)



(a) A – (1), B – (4), C – (3), D – (2)
(b) A – (4), B – (1), C – (3), D – (2)
(c) A – (4), B – (1), C – (2), D – (3)
(d) A – (4), B – (3), C – (1), D – (2)

7. Match the columns

Column-I (Rules)	Column-II (Statements)
(A) Hund's Rule	(1) No two electrons in an atom can have the same set of four quantum numbers.
(B) Aufbau Principle	(2) Half-filled and completely filled orbitals have extra stablity.
(C) Paull Exclusion Principle	(3) Pairing of electrons in the orbitals belonging to the same subshell does not take place until each orbital is singly occupied.
(D) Heisenberg's Uncertainty Principle	(4) It is impossible to determine the exact position and exact momentum of a subatomic particle simultaneously.
	(5) In the ground state of atoms, orbitals are filled in the order of their increasing energies.

(a) A – (3), B – (1), C – (5), D – (4)
(b) A – (3), B – (5), C – (4), D – (1)
(c) A – (3), B – (5), C – (1), D – (4)
(d) A – (5), B – (3), C – (1), D – (4)

8. Match the columns.

Column-I (Atom / Ion)	Column-II (Electronic configuration)
(A) Cu	(1) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$
(B) Cu^{2+}	(2) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2$
(C) Zn^{2+}	(3) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$
(D) Cr^{3+}	(4) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9$
	(5) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3$

(a) A – (4), B – (3), C – (1), D – (5)
(b) A – (3), B – (4), C – (1), D – (5)
(c) A – (3), B – (4), C – (5), D – (1)
(d) A – (3), B – (4), C – (1), D – (4)

Critical Thinking Type Questions :

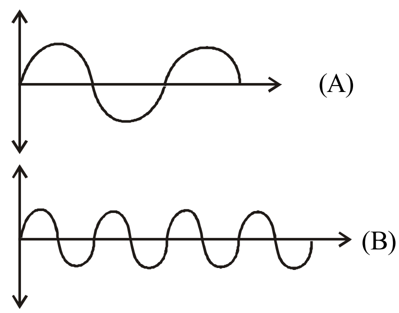
1. Arrange the electromagnetic radiations a, b, c, d and e in increasing order of energy. Frequencies of a, b and c are 10^{15}, 10^{14} and 10^{17} respectively whereas wavelength of (d) and (e) are 350 nm and 100 nm respectively ?
(a) a, b, c, d, e (b) a, b, d, e, c
(c) a, d, b, e, c (d) b, d, a, e, c

2. An electron, e_1 is moving in the fifth stationary state, and another electron e_2 is moving in the fourth stationary state. The radius of orbit of electron, e_1 is five times the radius of orbit of electron, e_2 calculate the ratio of velocity of electron e_1 (v_1) to the velocity of electron e_2 (v_2).
(a) 5 : 1 (b) 4 : 1 (c) 1 : 5 (d) 1 : 4

3. The potential energy of electron present in ground state of Li^{2+} ion is represented by :
(a) $\dfrac{+3e^2}{4\pi\varepsilon_0 r}$ (b) $\dfrac{-3e}{4\pi\varepsilon_0 r}$
(c) $\dfrac{-3e^2}{4\pi\varepsilon_0 r^2}$ (d) $\dfrac{-3e^2}{4\pi\varepsilon_0 r}$

4. A 600 W mercury lamp emits monochromatic rediation of wavelength 331.3 nm. How many photons are emitted from the lamp per second ? ($h = 6.626 \times 10^{-34}$ Js; velocity of light $= 3 \times 10^8$ ms^{-1})
(a) 1×10^{19} (b) 1×10^{20}
(c) 1×10^{21} (d) 1×10^{23}

5. What will be the difference between electromagnetic radiation shown in A and B respectively ?



(i) Velocity (ii) Wavelength
(iii) Frequency (iv) Energy

(a) (ii) only (b) (ii) and (iv)
(c) (ii), (iii) and (iv) (d) (iv) only

6. If the alpha-particles are projected against the following atoms Fe, Be, Mg, Al then increasing order in which the alpha-particle feel repulsion will be

(a) Be, Mg, Al, Fe (b) Be, Al, Mg, Fe
(c) Mg, Al, Mg, Fe (d) Al, Mg, Fe, Be

7. The velocity of particle A is 0.1 ms^{-1} and that of particle B is 0.05 ms^{-1}. If the mass of particle B is five times that of particle A, then the ratio of de-Broglie wavelengths associated with the particles A and B is

(a) 2 : 5 (b) 3 : 4 (c) 6 : 4 (d) 5 : 2

8. In an atom, an electron is moving with a speed of 600 m/s with an accuracy of 0.005%. Certainity with which the position of the electron can be located is (h = 6.6 × 10^{-34} kg m^2s^{-1}, mass of electron, $e_m = 9.1 \times 10^{-31}$ kg)

(a) 5.10×10^{-3} m (b) 1.92×10^{-3} m
(c) 3.84×10^{-3} m (d) 1.52×10^{-4} m

9. Which combinations of quantum numbers, n, ℓ, m and s for the electron in an atom does not provide a permissible solution of the wave equation ?

(a) $3, 2, 1, \frac{1}{2}$ (b) $3, 1, 1, -\frac{1}{2}$
(c) $3, 3, 1, -\frac{1}{2}$ (d) $3, 2, -2, \frac{1}{2}$

10. The five d-orbitals are designated as $d_{xy}, d_{yz}, d_{xz}, d_{x^2-y^2}$ and d_{z^2}. Choose the correct statement.

(a) The shapes of the first three orbitals are similar but that of the fourth and fifth orbitals are different
(b) The shapes of all five d-orbitals are similar
(c) The shapes of the first four orbitals are similar but that of the fifth orbital is different
(d) Ths shapes of all five d-orbitals are different

3 Classification of Elements and Periodicity in Properties

Fill in the Blanks :

1. The energy released when an electron is added to a neutral gaseous atom is called _______ of the atom.
2. On Mulliken scale, the average of ionization potential and electron affinity is known as _______ .
3. In 1800, only _______ elements were known.
4. Lothar Meyer plotted the physical properties such as atomic volume, melting point and _______ against atomic weight.
5. The symbol and IUPAC name for the element with atomic number _______, respectively are Ubn and unbinilium
6. The elements with atomic numbers 9, 17, 35, 53 and _______ belong to halogens
7. Element having atomic no. of 56 belongs to _______ of periodic table.
8. Halogens and chalcogens family have highly _______ electron gain enthalpy.
9. In the long form of the periodic table all the non-metals are placed in _______ *p*-block elements
10. _______ of the periodic table contains coinage metal.

True/ False :

1. In group IA, of alkali metals, the ionisation potential decreases on moving down the group. Therefore, lithium is a strongest reducing agent.
2. The decreasing order of electron affinity of F, Cl, Br is F > Cl > Br.
3. The basic nature of the hydroxides of group 13 (Gr. III B) decreases progressively down the group.
4. Successive filling of 3*s* and 3*p* orbitals gives rise to the third period of 8 elements from sodium to argon.
5. Fifth period begins with rubidium with the filling of 5*s* orbital and ends at xenon with the filling up of the 5*p* orbital.
6. Germanium was placed in place of Eka-aluminium and gallium was placed in place of Eka silicon.
7. The elements in the modern periodic table are arranged on the basis of their increasing atomic masses
8. Isotopes are placed in adjoining group(s) in the periodic table
9. Metalloids have properties quite different from those of metals and non-metals.
10. Metals will be found on the right side of the periodic table.
11. The element P, S and O belong to the same period.
12. Although the order of elements is based on atomic numbers, vertical families share similar chemical properties.
13. Noble gases are placed extremely left in periodic table.
14. Magnesium is more metallic in nature than sodium.
15. Electro-negativity in a period increases right from the alkali metal to the inert gas element.

Conceptual MCQs

1. The most significant contribution towards the development of periodic table was made by
   (a) Mendeleev (b) Avogadro
   (c) Dalton (d) Cavendish
2. The statement that is not correct for the periodic classification of elements is
   (a) The properties of elements are the periodic functions of their atomic number
   (b) Non-metallic elements are lesser in number than metallic elements

(c) The first ionization energies of elements along a period do not vary in a regular manner with increase in atomic number.
(d) For transition elements the d-sub shells are filled with electrons monotonically with increase in atomic number

3. The correct order of the decreasing ionic radii among the following isoelectronic species are :
(a) $Ca^{2+} > K^+ > S^{2-} > Cl^{-1}$
(b) $Cl^- > S^{2-} > Ca^{2+} > K^+$
(c) $S^{2-} > Cl^- > K^+ > Ca^{2+}$
(d) $K^+ > Ca^{2+} > Cl^- > S^{2-}$

4. Consider the isoelectronic species, Na^+, Mg^{2+}, F^- and O^{2-}. The correct order of increasing length of their radii is ________.
(a) $F^- < O^{2-} < Mg^{2+} < Na^+$
(b) $Mg^{2+} < Na^+ < F^- < O^{2-}$
(c) $O^{2-} < F^- < Na^+ < Mg^{2+}$
(d) $O^{2-} < F^- < Mg^{2+} < Na^+$

5. The screening effect of 'd' electrons is
(a) Much less than s- electrons
(b) Much more than s- electrons
(c) Equal to s- electrons
(d) Equal to p- electrons

6. Consider the following statements
I. The radius of an anion is larger than that of the parent atom.
II. The ionization energy generally increases with increasing atomic number in a period.
III. The electronegativity of elements increases on moving down across a group.
Which of the above statements is/are correct?
(a) I alone (b) II alone
(c) I and II (d) II and III

7. Among the elements Ca, Mg, P and Cl, the order of increasing atomic radii is :
(a) Ca < Mg < P < Cl (b) Mg < Ca < Cl < P
(c) Cl < P < Mg < Ca (d) P < Cl < Ca < Mg

8. The formation of the oxide ion, $O^{2-}(g)$, from oxygen atom requires first an exothermic and then an endothermic step as shown below :

$$O(g) + e^- \longrightarrow O^-(g); \Delta H^\ominus = -141 \text{ kJ mol}^{-1}$$
$$O^-(g) + e^- \longrightarrow O^{2-}(g); \Delta H^\ominus = +780 \text{ kJ mol}^{-1}$$

Thus process of formation of O^{2-} in gas phase is unfavourable even though O^{2-} is isoelectronic with neon. It is due to the fact that,
(a) oxygen is more electronegative.
(b) addition of electron in oxygen results in larger size of the ion.
(c) electron repulsion outweighs the stability gained by achieving noble gas configuration.
(d) O^- ion has comparatively smaller size than oxygen atom.

9. Electronic configurations of four elements A, B, C and D are given below :
(A) $1s^2 2s^2 2p^6$ (B) $1s^2 2s^2 2p^4$
(C) $1s^2 2s^2 2p^6 3s^1$ (D) $1s^2 2s^2 2p^5$
Which of the following is the correct order of increasing tendency to gain electron ?
(a) A < C < B < D (b) A < B < C < D
(c) D < B < C < A (d) D < A < B < C

10. The period number in the long form of the periodic table is equal to
(a) magnetic quantum number of any element of the period.
(b) atomic number of any element of the period.
(c) maximum Principal quantum number of any element of the period.
(d) maximum Azimuthal quantum number of any element of the period.

11. What is the value of electron gain enthalpy of Na^+ if IE_1 of Na = 5.1 eV ?
(a) –5.1 eV (b) –10.2 eV
(c) +2.55 eV (d) +10.2 eV

12. Consider the following changes
$A \rightarrow A^+ + e^- : E_1$ and $A^+ \rightarrow A^{2+} + e^- : E_2$
The energy required to pull out the two electrons are E_1 and E_2 respectively. The correct relationship between two energies would be
(a) $E_1 < E_2$ (b) $E_1 = E_2$
(c) $E_1 > E_2$ (d) $E_1 \geq E_2$

13. Consider the following statements
I. The radius of an anion is larger than that of the parent atom.
II. The ionization energy generally increases with increasing atomic number in a period.
III. The electronegativity of an element is the tendency of an isolated atom to attract an electron.

Which of the above statements is/are correct?
(a) I alone (b) II alone
(c) I and II (d) II and III

14. Which of the following order is wrong?
(a) $NH_3 < PH_3 < AsH_3$ — Acidic
(b) $Li < Be < B < C$ — IE_1
(c) $Al_2O_3 < MgO < Na_2O < K_2O$ — Basic
(d) $Li^+ < Na^+ < K^+ < Cs^+$ — Ionic radius

15. The valence shell of element A contains 3 electrons while the valence shell of element B contains 6 electrons . If A combines with B, the probable formula of the compound formed will be
(a) AB_2 (b) A_2B
(c) A_2B_3 (d) A_3B_2

16. An element having electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ forms
(a) Acidic oxide (b) Basic oxide
(c) Amphoteric oxide (d) Neutral oxide

17. A sudden jump between the values of second and third ionization energies of an element would be associated with the electronic configuration
(a) $1s^2 2s^2 2p^6 3s^1$
(b) $1s^2 2s^2 2p^6 3s^2 3p^1$
(c) $1s^2 2s^2 2p^6 3s^2 3p^2$
(d) $1s^2 2s^2 2p^6 3s^2$

18. Elements upto atomic number 103 have been discovered till now. If an element with atomic number 106 were ever discovered which of the following electronic configuration will it possess –
(a) [Rn] $5f^{14} 6d^4 7s^2$ (b) [Rn] $5f^{14} 6d^5 7s^1$
(c) [Rn] $5f^{14} 6d^7 7s^0$ (d) [Rn] $5f^{14} 6d^5 7s^2$

19. Among Al_2O_3, SiO_2, P_2O_3 and SO_2 the correct order of acidic strength is
(a) $Al_2O_3 < SiO_2 < SO_2 < P_2O_3$
(b) $SiO_2 < SO_2 < Al_2O_3 < P_2O_3$
(c) $SO_2 < P_2O_3 < SiO_2 < Al_2O_3$
(d) $Al_2O_3 < SiO_2 < P_2O_3 < SO_2$

20. Following statements regarding the periodic trends of chemical reactivity of the alkali metals and the halogens are given. Which of these statements gives the correct picture?
(a) Chemical reactivity increases with increase in atomic number down the group in both the alkali metals and halogens
(b) In alkali metals the reactivity increases but in the halogens it decreases with increase in atomic number down the group
(c) The reactivity decreases in the alkali metals but increases in the halogens with increase in atomic number down the group
(d) In both the alkali metals and the halogens the chemical reactivity decreases with increase in atomic number down the group**1.** The most significant contribution towards the development of periodic table was made by
(a) Mendeleev (b) Avogadro
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2. The statement that is not correct for the periodic classification of elements is
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(c) $1s^2 2s^2 2p^6 3s^2 3p^2$
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18. Elements upto atomic number 103 have been discovered till now. If an element with atomic number 106 were ever discovered which of the following electronic configuration will it possess –

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(c) $[Rn]\, 5f^{14}\, 6d^7\, 7s^0$ (d) $[Rn]\, 5f^{14}\, 6d^5\, 7s^2$

19. Among Al_2O_3, SiO_2, P_2O_3 and SO_2 the correct order of acidic strength is

(a) $Al_2O_3 < SiO_2 < SO_2 < P_2O_3$
(b) $SiO_2 < SO_2 < Al_2O_3 < P_2O_3$
(c) $SO_2 < P_2O_3 < SiO_2 < Al_2O_3$
(d) $Al_2O_3 < SiO_2 < P_2O_3 < SO_2$

20. Following statements regarding the periodic trends of chemical reactivity of the alkali metals and the halogens are given. Which of these statements gives the correct picture?

(a) Chemical reactivity increases with increase in atomic number down the group in both the alkali metals and halogens
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(c) The reactivity decreases in the alkali metals but increases in the halogens with increase in atomic number down the group
(d) In both the alkali metals and the halogens the chemical reactivity decreases with increase in atomic number down the group

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** In a triad, the three elements present have same gaps of atomic masses.
Reason : Elements in a triad have similar properties.

2. **Assertion :** According to Mendeleev, periodic properties of elements is a function of their atomic number.
Reason : Atomic number is equal to the number of protons.

3. **Assertion :** Atomic number of the element ununbium is 112.
Reason : Name for digits 1 and 2 is un- and bi- respectively in latin words.

4. **Assertion :** Second period consists of 8 elements.
Reason : Number of elements in each period is four times the number of atomic orbitals available in the energy level that is being filled.

5. **Assertion :** Helium is placed in group 18 along with p-block elements.
Reason : It shows properties similar to p-block elements.

6. **Assertion :** Hydrogen can be placed in group 1.
Reason : Hydrogen can gain an electron to achieve a noble gas arrangement.

7. **Assertion :** Atomic size increases along a period.
Reason : Effective nuclear charge increases as the atomic number increases resulting in the increased attraction of electrons to the nucleus.

8. **Assertion :** Second ionization enthalpy will be higher the first ionization enthalpy.
Reason : Ionization enthalpy is a quantitative measure of the tendency of an element to lose electron.

9. **Assertion :** Alkali metals have least value of ionization energy within a period.
Reason : They precede alkaline earth metals in periodic table.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the Column-I and Column-II and select correct answer by given codes.

Column-I (Year)	Column-II (The number of elements discovered)
(A) 1800	(1) 118
(B) 1865	(2) 63
(C) At present	(3) 31

(a) A – (2), B – (1), C – (3)
(b) A – (3), B – (1), C – (2)
(c) A – (2), B – (3), C – (1)
(d) A – (3), B – (2), C – (1)

2. Match the columns.

Column-I	Column-II
(A) Newland law of octaves	(1) Atomic mass vs Atomic volume
(B) Mendeleev	(2) Li, Na, K
(C) Electronic configuration	(3) One to seven groups sub-divided into group A and B
(D) Lother Meyer	(4) Periodic repetition of properties of elements
(E) Dobereiner's triad	(5) Only 56 elements known

(a) A–(5); B–(4); C–(3); D–(1); E–(2)
(b) A–(5); B–(3); C–(4); D–(1); E–(2)
(c) A–(5); B–(3); C–(4); D–(2); E–(1)
(d) A–(3); B–(5); C–(4); D–(1); E–(2)

3. Match the columns :

Column-I	Column-II
(A) On arraging in order of atomic weights, physical and chemical properties are repeated at regular intervals.	(1) Mendeleev
(B) Elements are arranged in the order of increasing atomic weights.	(2) Lothar Meyer
(C) Elements were arranged on the basis of similar properties ignoring order of atomic weights	(3) Moseley
(D) Atomic number is a more fundamental property of an element than its atomic mass	(4) Chancourtois

(a) A – (1), B – (2), C – (4), D – (3)
(b) A – (3), B – (4), C – (2), D – (1)
(c) A – (2), B – (1), C – (4), D – (3)
(d) A – (2), B – (4), C – (1), D – (3)

4. Match Column-I (IUPAC nomenclature of element) with Column-II (IUPAC official name).

Column-I	Column-II
(A) Unnilhexium	(1) Lawrencium
(B) Unniltrium	(2) Dubnium
(C) Unnilunium	(3) Seaborgium
(D) Unnilpentium	(4) Mendelevium

(a) A – (4), B – (1), C – (3), D – (2)
(b) A – (3), B – (1), C – (4), D – (2)
(c) A – (3), B – (4), C – (1), D – (2)
(d) A – (2), B – (3), C – (1), D – (4)

5. Match the columns.

Column-I (Name of element)	Column-II (Group of element)
(A) Nitrogen	(1) 15
(B) Aluminium	(2) 16
(C) Chlorine	(3) 17
(D) Oxygen	(4) 13
(E) Copper	(5) 11

(a) A – (1), B – (4), C – (3), D – (2), E – (5)
(b) A – (4), B – (1). C – (3), D – (2), E – (5)
(c) A – (1), B – (4), C – (2), D – (3), E – (5)
(d) A – (1), B – (4), C – (3), D – (5), E – (2)

6. Match the columns.

Column-I (Name of element)		Column-II (Period of element)	
(A)	Hydrogen	(1)	3
(B)	Sodium	(2)	4
(C)	Calcium	(3)	6
(D)	Barium	(4)	1
(E)	Iodine	(5)	5

(a) A – (1), B – (4), C – (2), D – (3), E – (5)
(b) A – (4), B – (1), C – (2), D – (3), E – (5)
(c) A – (4), B – (2), C – (1), D – (3), E – (5)
(d) A – (4), B – (1), C – (2), D – (5), E – (3)

7. Match the columns.

Column-I		Column-II	
(A)	's' block elements	(1)	Cr
(B)	'p' block elements	(2)	Na
(C)	'd' block elements	(3)	Ce
(D)	'f' block elements	(4)	Si

(a) A – (4), B – (2), C – (1), D – (3)
(b) A – (2), B – (4), C – (3), D – (1)
(c) A – (2), B – (1), C – (4), D – (3)
(d) A – (2), B – (4), C – (1), D – (3)

8. Match the columns.

Column-I		Column-II	
(A)	Element with largest size in second period	(1)	Boron
(B)	Element with smallest size in group 13	(2)	Fluorine
(C)	Element with maximum non-metallic character	(3)	Bromine
(D)	Element with smallest size in fourth period	(4)	Lithium
(E)	Element with most metallic character in group 14	(5)	Lead

(a) A – (4), B – (1), C – (2), D – (5), E – (3)
(b) A – (1), B – (4), C – (2), D – (3), E – (5)
(c) A – (4), B – (2), C – (1), D – (3), E – (5)
(d) A – (4), B – (1), C – (2), D – (3), E – (5)

9. Match the columns.

Column-I		Column-II	
(A)	Electronegativity	(1)	Isotopes
(B)	Lanthanides	(2)	increases along a period
(C)	Transition elements	(3)	*f*-group of elements
(D)	Ionisation energy	(4)	*d*-group of elements
(E)	Elements of same atomic number but different mass number	(5)	decreases along a group

(a) A – (2), B – (3), C – (4), D – (1), E – (5)
(b) A – (3), B – (2), C – (4), D – (5), E – (1)
(c) A – (2), B – (3), C – (4), D – (5), E – (1)
(d) A – (2), B – (4), C – (3), D – (5), E – (1)

10. Match Column-I with Column-II and select the correct answer by the given codes.

Columnn-I (Atoms)		Column-II (Properties)	
(A)	He	(1)	High electronegative
(B)	F	(2)	Most electropositive
(C)	Rb	(3)	Strongest reducing agent
(D)	Li	(4)	Highest ionisation energy

(a) A – (4), B – (2), C – (3), D – (1)
(b) A – (1), B – (4), C – (2), D – (3)
(c) A – (4), B – (1), C – (3), D – (2)
(d) A – (4), B – (1), C – (2), D – (3)

Critical Thinking Type Questions :

1. Which of the following is correct about Eka-Aluminium and Eka-Silicon ?
(a) Oxides of Eka-Aluminium is Al_2O_3 and Eka-Silicon is Si_2O_3
(b) Oxides of Eka-Aluminium is Ga_2O_3 and Eka-Silicon is GeO_2
(c) Melting point of Eka-Aluminium is lower than the melting point of Eka-Silicon
(d) Both (a) and (c)

2. In the Mendeleev periodic table, which of the following element instead of having lower atomic weight was placed after the element of higher atomic weight thereby ignoring the order of increasing atomic weights.
(a) Iodine (b) Antimony
(c) Bromine (d) Molybdenum

3. Which of the following elements show the given properties?
(i) All elements are metals.
(ii) Most of the elements form coloured ions, exhibit variable valence and paramagnetism.
(iii) Oftently used as catalysts.

(a) Chalcogens
(b) Transition elements
(c) Inner transition elements
(d) Representative elements

4. An element X belongs to fourth period and fifteenth group of the periodic table. Which one of the following is true regarding the outer electronic configuration of X ? It has
(a) Partially filled *d*-orbitals and completely filled *s*-orbitals
(b) Completely filled *s*-orbital and completely filled *p*-orbitals
(c) Completely filled *s*-orbital and half-filled *p*-orbitals
(d) Half-filled *d*-robitals and completely filled *s*-orbitals

5. In which of the following arrangements, the order is NOT according to the property indicated against it?
(a) $Li < Na < K < Rb$:
Increasing metallic radius
(b) $I < Br < F < Cl$:
Increasing electron gain enthalpy (with negative sign)
(c) $B < C < N < O$
Increasing first ionization enthalpy
(d) $Al^{3+} < Mg^{2+} < Na^{+} < F^{-}$
Increasing ionic size

4

Chemical Bonding and Molecular Structure

Fill in the Blanks :

1. The angle between two covalent bonds is maximum in _______ . (CH_4, H_2O, CO_2)
2. Pair of molecules which forms strongest intermolecular hydrogen bond is _______ .

   (SiH_4 and SiF_4, $CH_3—\underset{\overset{||}{O}}{C}—CH_3$ and

   $CHCl_3$, $H—\underset{\overset{||}{O}}{C}—OH$ and $CH_3—\underset{\overset{||}{O}}{C}—OH$)
3. There are _______ π bonds in a nitrogen molecule.
4. _______ hybrid orbitals of nitrogen atom are involved in the formation of ammonium ion.
5. The shape of $[CH_3]^+$ is _______ .
6. The two types of bonds present in B_2H_6 are covalent and _______ .
7. When N_2 goes to N_2^+ , the N–N bond distance ..., and when O_2 goes to O_2^+ the O–O bond distance _______ .
8. Ionic bonds will be formed more easily between elements with comparatively _______ and elements with comparatively high negative value of _______ .
9. _______ is measured as the radius of an atom's core which is in contact with the core of an adjacent atom in a bonded situation.
10. With _______ in bond order, _______ increases and _________ decreases.

True/ False :

1. Linear overlap of two atomic p-orbitals leads to a sigma bond.
2. All molecules with polar bonds have dipole moment.
3. $SnCl_2$ is a non-linear molecule.
4. In benzene, carbon uses all the three p-orbitals for hybridisation.
5. sp^2 hybrid orbitals have equal *s* and *p* character.
6. The presence of polar bonds in a poly-atomic molecule suggests that the molecule has non-zero dipole moment.
7. The dipole moment of CH_3F is greater than that of CH_3Cl.
8. Group valence is given as 8 minus the number of inner shell electrons.
9. Half-filled *s*-orbital of one atom and half filled *p*-orbitals of another atom forms. π bond on overlapping.
10. In general, as the number of lone pair of electrons on central atom increases, value of bond angle from normal bond angle also increases

Conceptual MCQs :

1. Chemical bond implies
   (a) repulsion
   (b) attraction
   (c) attraction and repulsion balanced at a particular distance
   (d) attraction and repulsion
2. Sodium chloride is an ionic compound whereas hydrogen chloride is mainly covalent because
   (a) Sodium is less reactive
   (b) Hydrogen is non-metal
   (c) Hydrogen chloride is a gas
   (d) Electronegativity difference in the case of hydrogen and chlorine is less than 2.1.
3. In PO_4^{3-} , the formal charge on each oxygen atom and the P—O bond order respectively are
   (a) $-0.75, 0.6$ (b) $-0.75, 1.0$
   (c) $-0.75, 1.25$ (d) $-3, 1.25$

4. Bond order of 1.5 is shown by :

(a) O_2^+ (b) O_2^-

(c) O_2^{2-} (d) O_2

5. Match List I (Molecules) with List II (Bond order) and select the correct answer using the codes

List I		List II	
I.	Li_2	A.	3
II	N_2	B.	1.5
III	Be_2	C.	1.0
IV	O_2	D.	0
		E.	2

Codes

(a) I - B, II - C, III - A, IV - E
(b) I - C, II - A, III - D, IV - E
(c) I - D, II - A, III - E, IV - C
(d) I - C, II - B, III - E, IV - A

6. During change of O_2 to O_2^- ion, the electron adds on which one of the following orbitals ?

(a) π^* orbital (b) π orbital
(c) σ^* orbital (d) σ orbital

7. N_2 and O_2 are converted into monoanions, N_2^- and O_2^- respectively. Which of the following statements is wrong ?

(a) In N_2^-, N – N bond weakens

(b) In O_2^-, O - O bond order increases

(c) In O_2^-, O - O bond order decreases

(d) N_2^- becomes paramagnetic

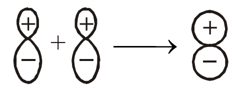
8. No. of b.p. and l.p. in NO_3^- is

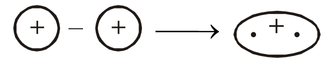
(a) 3 b.p. + 1 l.p. (b) 4 b.p. + 0 l.p.
(c) 2 b.p. + 2 l.p. (d) 1 b.p. + 1 l.p.

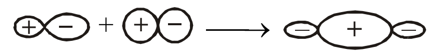
9. The molecular shapes of SF_4, CF_4 and XeF_4 are

(a) different with 1, 0 and 2 lone pairs of electrons on the central atom, respectively
(b) different with 0, 1 and 2 lone pairs of electrons on the central atom, respectively
(c) the same with 1, 1 and 1 lone pair of electrons on the central atoms, respectively
(d) the same with 2, 0 and 1 lone pairs of electrons on the central atom, respectively

10. Which of the following overlap is correct ?

(a) 

(b) 

(c) 

(d) None of the above

11. Consider the following statements:

(i) A sigma (σ) bond is formed when two *s* - orbitals overlap
(ii) A *pi* (π) bond is formed when two *p*- orbitals axially overlap
(iii) A σ-bond is weaker than π -bond.

Which of the above statements is/are correct ?

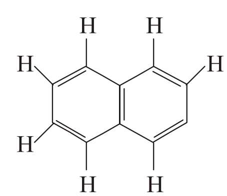
(a) i and ii (b) ii and iii
(c) i alone (d) ii alone

12. Which of the following statements is/are true?

1. PH_5 and $BiCl_5$ do not exist
2. $p\pi - d\pi$ bond is present in SO_2
3. I_3^+ has bent geometry
4. SeF_4 and CH_4 have same shape

(a) 1, 2, 3 (b) 1, 3
(c) 1, 3, 4 (d) 1, 2, 4

13. Number of π bonds and σ bonds in the following structure is



(a) 6, 19 (b) 4, 20
(c) 5, 19 (d) 5, 20

14. The types of hybrid orbitals of nitrogen in NO_2^+, NO_3^- and NH_4^+ respectively are expected to be

(a) *sp*, *sp*^{3} and *sp*^{2}
(b) *sp*, *sp*^{2} and *sp*^{3}
(c) *sp*^{2}, *sp* and *sp*^{3}
(d) *sp*^{2}, *sp*^{3} and *sp*

15. Which one of the following pairs is isostructural (i.e., having the same shape and hybridization)?

(a) $\left[BCl_3 \text{ and } BrCl_3^-\right]$

(b) $\left[NH_3 \text{ and } NO_3^-\right]$

(c) $\left[NF_3 \text{ and } BF_3\right]$

(d) $\left[BF_4^- \text{ and } NH_4^+\right]$

16. The pair of species having identical shapes for molecules of both species is

(a) XeF_2, CO_2 (b) BF_3, PCl_3
(c) PF_5, IF_5 (d) CF_4, SF_4

17. Which of the following order of energies of molecular orbitals of N_2 is correct?

(a) $(\pi 2p_y) < (\sigma 2p_z) < (\pi^* 2p_x) \approx (\pi^* 2p_y)$
(b) $(\pi 2p_y) > (\sigma 2p_z) > (\pi^* 2P_x) \approx (\pi^* 2p_y)$
(c) $(\pi 2p_y) < (\sigma 2p_z) > (\pi^* 2p_x) \approx (\pi^* 2p_y)$
(d) $(\pi 2p_y) > (\sigma 2p_z) < (\pi^* 2p_x) \approx (\pi^* 2p_y)$

18. Which of the following statement is not correct from the view point of molecular orbital theory?

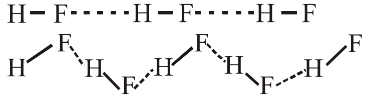
(a) Be_2 is not a stable molecule.
(b) He_2 is not stable but He_2^+ is expected to exist.
(c) Bond strength of N_2 is maximum amongst the homonuclear diatomic molecules belonging to the second period.
(d) The order of energies of molecular orbitals in N_2 molecule is
$\sigma 2s < \sigma^* 2s < \sigma 2p_z < (\pi 2p_x = \pi 2p_y)$
$< (\pi^* 2p_x = \pi^* 2p_y) < \sigma^* 2p_z$

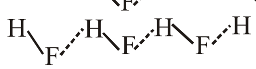
19. Hydrogen bonds are formed in many compounds e.g., H_2O, HF, NH_3. The boiling point of such compounds depends to a large extent on the strength of hydrogen bond and the number of hydrogen bonds. The correct decreasing order of the boiling points of above compounds is:

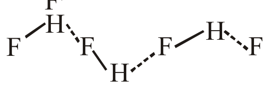
(a) $HF > H_2O > NH_3$ (b) $H_2O > HF > NH_3$
(c) $NH_3 > HF > H_2O$ (d) $NH_3 > H_2O > HF$

20. The correct representation of H-bond in solid HF

(a) H – F·····H – F·····H – F

(b) 

(c) 

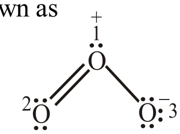
(d) 

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The correct Lewis structure of O_3 may be drawn as



Reason : The formal charges on atom 1, 2 and 3 are +1, 0 and –1 respectively.

2. **Assertion :** Atoms can combine either by transfer of valence of electrons from one atom to another or by sharing of valence electrons.
Reason : Sharing and transfer of valence electrons is done by atoms to have an octet in their valence shell.

3. **Assertion :** The lesser the lattice enthalpy more stable is the ionic compound.
Reason : The lattice enthalpy is greater, for ions of highest charge and smaller radii.

4. **Assertion :** Sulphur compounds like SF_6 and H_2SO_4 have 12 valence electrons around S atom.
Reason : All sulphur compounds do not follow octet rule.

5. **Assertion :** BF_3 molecule has zero dipole moment.
Reason : F is electronegative and B–F bonds are polar in nature.

6. **Assertion :** CH_2Cl_2 is non-polar and CCl_4 is polar molecule.
Reason : Molecule with zero dipole moment is non-polar in nature.

7. **Assertion :** Lone pair-lone pair repulsive interactions are greater than lone pair-bond pair and bond pair-bond pair interactions.
Reason : The space occupied by lone pair electrons is more as compared to bond pair electrons.

8. **Assertion :** In NH_3, N is sp^3 hybridised, but angle is found to be 107°.

Reason : The decrease in bond angle is due to repulsion between the lone pair.

9. **Assertion :** Shape of NH_3 molecule is tetrahedral.

Reason : In NH_3 nitrogen is sp^3 hybridized.

10. **Assertion :** pi bonds are weaker than σ bonds.

Reason : pi bonds are formed by the overlapping of p-p orbitals along their axes.

11. **Assertion :** The bond order of helium is always zero.

Reason : The number of electrons in bonding molecular orbital and antibonding molecular orbital is equal.

12. **Assertion :** Bonding molecular orbital has greater stability than corresponding antibonding molecular orbital.

Reason : The electron density in a bonding molecular orbital is located away from the space between the nuclei while in antibonding molecular orbital it is located between the nuclei of the bonded atoms.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I	Column-II
(A) BeH_2	(1) Odd electron molecules
(B) SF_6	(2) Expanded octet
(C) NO_2	(3) Incomplete octet of central atom

(a) A – (1), B – (2), C – (3)
(b) A – (2), B – (3), C – (1)
(c) A – (3), B – (2), C – (1)
(d) A – (3), B – (1), C – (2)

2. Match the columns

Column-I	Column-II
(A) HCl	(1) Covalent compound with directional bond
(B) CO_2	(2) Ionic compound with non-directional bonds
(C) NaCl	(3) Polar molecule
(D) CCl_4	(4) Non-polar molecule

(a) A – (1, 2, 3), B – (2, 3), C – (1, 2), D – (3)
(b) A – (2), B – (3), C – (1), D – (4)
(c) A – (1, 3), B – (1, 4), C – (2), D – (1, 4)
(d) A – (2), B – (3), C – (1, 2), D – (4)

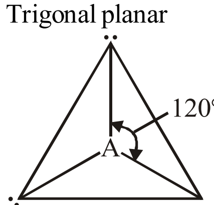
3. Match Column-I with Column-II and Column-III and choose the correct option from the given codes.

Column-I Molecule	Column-II (No. of lone pairs and bond pairs)	Column-III (Shape of molecule)
(A) NH_3	(i) 1, 2	(1) Bent
(B) SO_2	(ii) 1, 4	(2) Trigonal pyramidal
(C) SF_4	(iii) 2, 3	(3) T-shape
(D) ClF_3	(iv) 1, 3	(4) See-Saw

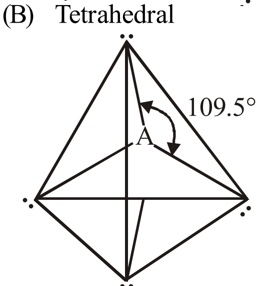
(a) A – (iv, 2); B – (ii, 1); C – (i, 3); D – (iii, 4)
(b) A – (iv, 2); B – (i, 1); C – (ii, 4); D – (iii, 3)
(c) A – (i, 1); B – (iii, 4); C – (iv, 3); D – (ii, 2)
(d) A – (iv, 1); B – (i, 3); C – (iii, 2); D – (ii, 4)

4. Match the columns

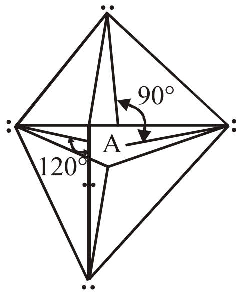
Column-I	Column-II
(A) Trigonal planar	(1) PCl_5



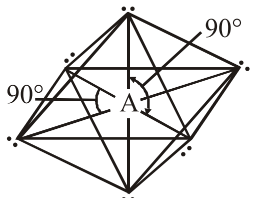
(B) Tetrahedral	(2) NH_4^+



(C) Trigonal bipyramidal (3) SF_6



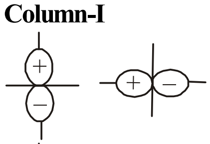
(D) Octahedral (4) BF_3

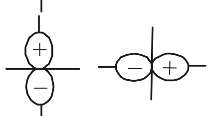


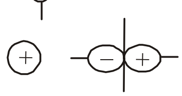
(a) A – (1), B – (2), C – (3), D – (4)
(b) A – (4), B – (3), C – (2), D – (1)
(c) A – (4), B – (2), C – (1), D – (3)
(d) A – (3), B – (1), C – (2), D – (4)

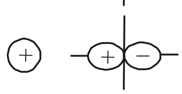
5. Match the columns

Column-I **Column-II**

(A)  (1) negative overlap

(B)  (2) zero overlap

(C)  (3) positive overlap

(D) 

(a) A – (1), B – (2), C – (1), D – (3)
(b) A – (1), B – (3), C – (2), D – (1)
(c) A – (2), B – (2), C – (1), D – (3)
(d) A – (3), B – (1), C – (2), D – (1)

6. Match Column-I (molecule) with Column-II (type of hybridisation) and choose the correct option from the codes given below.

Column-I (Molecule)	**Column-II (Type of hybridisation)**
(A) SF_6	(1) sp^3d
(B) PF_5	(2) sp^3
(C) BCl_3	(3) sp^3d^2
(D) C_2H_6	(4) sp^2

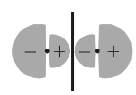
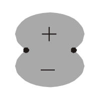
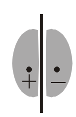
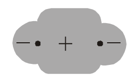
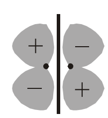
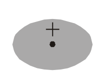
(a) A – (3), B – (1), C – (4), D – (2)
(b) A – (3), B – (1), C – (2), D – (4)
(c) A – (1), B – (3), C – (2), D – (4)
(d) A – (1), B – (3), C – (4), D – (2)

7. Match the columns

Column-I	**Column-II**
(A) Valence bond theory	(1) Nyholm and Gillespie
(B) Octet rule	(2) F. Hund & R. S Mulliken
(C) Molecular orbital theory	(3) Heitler and London
(D) The valence shell electron pair repulsion theory	(4) Kössel and Lewis

(a) A – (1), B – (2),C – (3), D – (4)
(b) A – (2), B – (3),C – (4), D – (1)
(c) A – (1), B – (4),C – (2), D – (3)
(d) A – (4), B – (3), C – (2), D – (1)

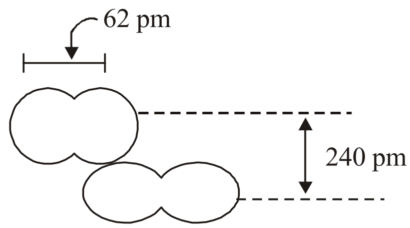
8. Match the columns

Column-I	**Column-II**	**Column-III**
(A) 1s	(1) 	(i) 
(B) $2p_z$	(2) 	(ii) 
(C) $2p_x$	(3) 	(iii) 

(a) A – (2, iii), B – (3, i), C – (1, ii)
(b) A – (2, iii), B – (1, ii), C – (3, i)
(c) A – (1, iii), B – (2, ii), C – (3, i)
(d) A – (1, ii), B – (2, iii), C – (3, i)

Critical Thinking Type Questions :

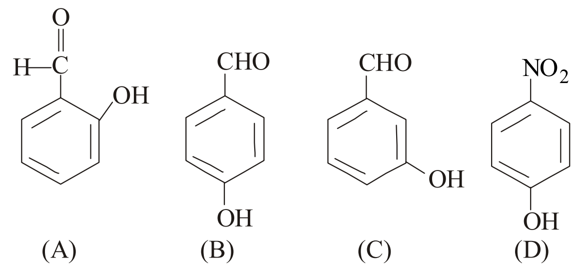
1. From the given figure the van der Waal radius and covalent radius of the hydrogen atom respectively are



(a) 151, 31 (b) 120, 31
(c) 31, 100 (d) 30, 120

2. Among the following species, identify the pair having same bond order CN^-, O_2^-, NO^+, CN^+
(a) CN^- and O_2^- (b) O_2^- and NO^+
(c) CN^- and NO^+ (d) CN^- and CN^+

3. Which among the following can form intermolecular H – bonding ?



(a) A (b) B and D
(c) B, C and D (d) A and C

4. The type of hybridization in xenon atom and the number of lone pairs present on xenon atom in xenon hexafluoride molecule are respectively
(a) sp^3d^3 , one (b) sp^3d^3 , two
(c) sp^3d^3 , two (d) sp^3d^2 , zero

5. In which of the following species, all the three types of hybrid carbons are present?
(a) $CH_2=C=CH_2$
(b) $CH_3-CH=CH-CH_2^+$
(c) $CH_3-C\equiv C-CH_2^+$
(d) $CH_3-CH=CH-CH_2^-$

5

STATES of MATTER

Fill in the Blanks :

1. $C_p - C_v$ for an ideal gas is _______ .
2. The rate of diffusion of gas is _______ proportional to both _______ and square root of molecular mass.
3. The value of PV for 5.6 litres of an ideal gas is _______ RT, at N.T.P.
4. The first reliable measurement on properties of gases was made by _______ .
5. The lowest hypothetical or imaginary temperature at which gases are supposed to occupy zero volume is called ____ .
6. At STP molar volume of an ideal gas or a combination of ideal gases is _______ .
7. Pressure exerted by saturated water vapour is called _______ .
8. If there were loss of kinetic energy, the motion of gas molecules will _______ and gas will _______ .
9. Above Boyle point, real gases show _______ from ideality and Z values are _______ than one.
10. At 1 atm pressure boiling temperature is called _________. If pressure is 1 bar then the boiling point is called _______ of the liquid.

True/ False :

1. Kinetic energy of a molecule is zero at 0ºC.
2. A gas in a closed container will exert much higher pressure due to gravity at the bottom than at the top.
3. In the van der Waal's equation $\left(P+\frac{n^2a}{V^2}\right)(V-nb)=nRT$ the constant 'a' reflects the actual volume of the gas molecules.
4. A mixture of ideal gases is cooled upto liquid helium temperature (4.22 K) to form an ideal solution.
5. Dipole - dipole forces act between the molecules possessing permanent dipole.
6. Dipole - dipole interaction is weaker than London forces and ion - ion interaction.
7. Strength of the hydrogen bond is determined by the coulombic interaction between the lone-pair electrons of the electronegative atom of one molecule and the hydrogen atom of other molecule.
8. Gases mix evenly and completely in all proportion without any mechanical aid.
9. Value of R in units of Pa m^3 K^{-1} mol^{-1} is 8.314×10^{-2}
10. Greater the viscosity, the more slowly the liquid flows.
11. Viscosity of liquid increases as the temperature rise.
12. At any particular time, different particles in the gas have different speeds and hence different kinetic energies.

True/ False :

1. The interaction energy of London force is inversely proportional to sixth power of the distance between two interacting particles but their magnitude depends upon
   (a) charge of interacting particles
   (b) mass of interacting particles
   (c) polarisability of interacting particles
   (d) strength of permanent dipoles in the particles.
2. Dipole-dipole forces act between the molecules possessing permanent dipole. Ends of dipoles possess 'partial charges'. The partial charge is

(a) more than unit electronic charge
(b) equal to unit electronic charge
(c) less than unit electronic charge
(d) double the unit electronic charge

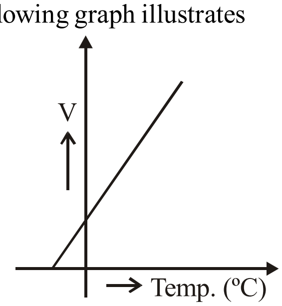
3. A bubble of air is underwater at temperature 15°C and the pressure 1.5 bar. If the bubble rises to the surface where the temperature is 25°C and the pressure is 1.0 bar, what will happen to the volume of the bubble ?
(a) Volume will become greater by a factor of 1.6.
(b) Volume will become greater by a factor of 1.1.
(c) Volume will become smaller by a factor of 0.70.
(d) Volume will become greater by a factor of 2.5.

4. Use of hot air balloons in sports and meteorological observations is an application of
(a) Boyle's law (b) Charle's law
(c) Kelvin's (d) Gay-Lussac's law

5. "Equal volumes of all gases at the same temperature and pressure contain equal number of particles." This statement is a direct consequece of
(a) Perfect gas law (b) Avogadro's law
(c) Charle's law (d) Boyle's law

6. A certain gas takes three times as long to effuse out as helium. Its molecular mass will be :
(a) 27 u (b) 36 u
(c) 64 u (d) 9 u

7. The following graph illustrates



(a) Dalton's law
(b) Charle's law
(c) Boyle's law
(d) Gay-Lussac's law

8. For real gases van der Waals equation is written as

$$\left(p+\frac{an^2}{V^2}\right)(V-nb)=nRT$$

where 'a' and 'b' are van der Waals constants. Two sets of gases are :
(I) O_2, CO_2, H_2 and He
(II) CH_4, O_2 and H_2
The gases given in set-I in increasing order of 'b' and gases given in set-II in decreasing order of 'a', are arranged below. Select the correct order from the following :
(a) (I) $He < H_2 < CO_2 < O_2$ (II) $CH_4 > H_2 > O_2$
(b) (I) $O_2 < He < H_2 < CO_2$ (II) $H_2 > O_2 > CH_4$
(c) (I) $H_2 < He < O_2 < CO_2$ (II) $CH_4 > O_2 > H_2$
(d) (I) $H_2 < O_2 < He < CO_2$ (II) $O_2 > CH_4 > H_2$

9. Boyle's law, according to kinetic equation can be expressed as
(a) $PV = KT$ (b) $PV = RT$
(c) $PV = \frac{3}{2}kT$ (d) $PV = \frac{2}{3}kT$

10. The pressure of a 1 : 4 mixture of dihydrogen and dioxygen enclosed in a vessel is one atmosphere. What would be the partial pressure of dioxygen ?
(a) 0.8×10^5 atm (b) 0.008 Nm^{-2}
(c) 8×10^4 Nm^{-2} (d) 0.25 atm

11. Which of the following expression correctly represents the relationship between the average molar kinetic energy $\overline{KE}$ of CO and N_2 molecules at the same temperature?
(a) $\overline{KE}_{CO} = \overline{KE}_{N_2}$
(b) $\overline{KE}_{CO} > \overline{KE}_{N_2}$
(c) $\overline{KE}_{CO} < \overline{KE}_{N_2}$
(d) Can not be predicted unless the volumes of the gases are not given

12. The compressibility factor for H_2 and He is usually :
(a) >1 (b) =1
(c) <1 (d) Either of these

13. The r.m.s velocity of hydrogen is $\sqrt{7}$ times the r.m.s velocity of nitrogen. If T is the temperature of the gas , then
(a) $T_{(H_2)} = T_{(N_2)}$
(b) $T_{(H_2)} > T_{(N_2)}$
(c) $T_{(H_2)} < T_{(N_2)}$
(d) $T_{(H_2)} = \sqrt{7}T_{(N_2)}$

14. The ratio of Boyle's temperature and critical temperature for a gas is :

(a) $\frac{8}{27}$ (b) $\frac{27}{8}$

(c) $\frac{1}{2}$ (d) $\frac{2}{1}$

15. Gases possess characteristic critical temperature which depends upon the magnitude of intermolecular forces between the particles. Following are the critical temperature of some gases.

Gases	H_2	He	O_2	N_2
Critical temperature in Kelvin	33.2	5.3	154.3	126

From the above data what would be the order of liquefaction of these gases ?

Start writing the order from the gas liquefying first

(a) H_2, He, O_2, N_2 (b) He, O_2, H_2, N_2

(c) N_2, O_2, He, H_2 (d) O_2, N_2, H_2, He

16. Atmospheric pressures recorded in different cities are as follows :

Cities	***p* in N/m²**
Shimla	1.01×10^5
Bangalore	1.2×10^5
Delhi	1.02×10^5
Mumbai	1.21×10^5

Consider the above data and mark the place at which liquid will boil first.

(a) Shimla (b) Bangalore

(c) Delhi (d) Mumbai

17. A solution having volume '*V*' at temperature '*T*' and pressure '*P*' is mixed with other solution with same volume '*V*', temperature '*T*' and pressure '*P*'. The resulting solution after mixing both solutions has volume '*V*', temperature '*T*' and pressure

(a) 2 *P* (b) 4 *P*

(c) *P*/2 (d) *P*

18. Increase in kinetic energy can overcome intermolecular forces of attraction. How will the viscosity of liquid be affected by the increase in temperature ?

(a) Increase

(b) No effect

(c) Decrease

(d) No regular pattern will be followed

19. Generally , liquid drops assume spherical shape because:

(a) a sphere has maximum surface area

(b) a sphere has minimum surface area

(c) sphere is symmetrical in shape

(d) None of these

20. A volume V of a gas at temperature T_1 and a pressure P is enclosed in a sphere. It is connected to another sphere of volume V/2 by a tube and stopcock. The second sphere is initially evacuated and the stopock is closed. If the stopcock is opened the temperature of the gas in the second sphere becomes T_2. The first sphere is maintained at a temperature T_1. What is the final pressure p_1 within the apparatus ?

(a) $\frac{2pT_2}{2T_2 + T_1}$ (b) $\frac{2pT_2}{T_2 + 2T_1}$

(c) $\frac{pT_2}{2T_2 + T_1}$ (d) $\frac{2pT_2}{T_1 + T_2}$

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.

(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion

(c) Assertion is correct, reason is incorrect

(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Three states of matter are the result of balance between intermolecular forces and thermal energy of the molecules.

Reason : Intermolecular forces tend to keep the molecules together but thermal energy of molecules tends to keep them apart.

2. **Assertion :** Gases expand and occupy all the space available to them

Reason : There is no force of attraction between the particles of a gas at ordinary temperature and pressure.

3. **Assertion :** Gases do not liquefy above their critical temperature, even on applying high pressure.

Reason : Above critical temperature, the molecular speed is high and intermolecular attractions cannot hold the molecules together because they escape because of high speed.

4. **Assertion :** At critical temperature liquid passes into gaseous state imperceptibly and continuously.

Reason : The density of liquid and gaseous phase is equal to critical temperature.

5. **Assertion :** The temperature at which vapour pressure of a liquid is equal to the external pressure is called boiling temperature.

Reason : At high altitude atmospheric pressure is high.

6. **Assertion :** Liquids tend to have maximum number of molecules at their surface.

Reason : Small liquid drops have spherical shape.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I	Column-II
(A) Attractive force that operates between the polar molecules having permanent dipole and the molecule lacking permanent dipole	(1) Dipole-dipole force
(B) Interaction in which interaction energy between stationary polar molecules is proportional to $\frac{1}{r^3}$	(2) London force
(C) Force that are important only at short distances (~ 500 pm)	(3) Dipole-induced dipole force

(a) A – (3), B – (1), C – (2)
(b) A – (1), B – (3), C – (2)
(c) A – (3), B – (2), C – (1)
(d) A – (2), B – (3), C – (1)

2. Match the columns

Column-I	Column-II
(A) Volume of a fixed mass of a gas at constant pressure is directly proportional to its absolute temperature	(1) Boyle's Law
(B) At constant volume, pressure of a fixed amount of a gas varies directly with the temperature.	(2) Avogadro's Law
(C) Equal volumes of all gases under the same conditions of temperature and pressure contain equal number of molecules.	(3) Charle's Law
(D) At constant temperature, the pressure of a fixed amount (i. e., number of moles *n*) of gas varies inversely with its volume.	(4) Gay Lussac's Law

(a) A – (4), B – (3), C – (2), D – (1)
(b) A – (3), B – (4), C – (2), D – (1)
(c) A – (3), B – (2), C – (1), D – (4)
(d) A – (2), B – (1), C – (4), D – (3)

3. Match the columns

Column-I		**Column-II**
(A) Boyle's law	(1)	$V \propto n$ at constant T and P
(B) Charle's law	(2)	$p_{total} = p_1 + p_2 + p_3 + ...$ at constant T, V
(C) Dalton's law	(3)	$\frac{pV}{T}$ Constant
(D) Avogadro law	(4)	$V \propto T$ at constant n and p
	(5)	$p \quad \frac{1}{V}$ at constant n and T

(a) A – (5), B – (4), C – (2), D – (1)
(b) A – (4), B – (2), C – (1), D – (5)
(c) A – (3), B – (5), C – (2), D – (1)
(d) A – (5), B – (2), C – (4), D – (3)

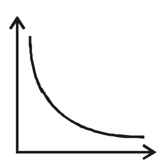
4. Match the graphs between the following variables (Column-I) with their names (Column-II) :

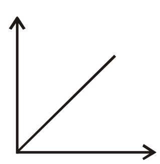
Column-I (Graphs)	**Column-II (Names)**
(A) Pressure vs temperature graph at constant molar volume.	(1) Isotherms
(B) Pressure vs volume graph at constant temperature	(2) Constant temperature curve
(C) Volume vs temperature graph at constant pressure	(3) Isochores
	(4) Isobars

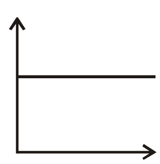
(a) A – (1), B – (3), C – (4)
(b) A – (3), B – (1), C – (4)
(c) A – (3), B – (2), C – (1)
(d) A – (4), B – (2), C – (3)

5. Match the following graphs of ideal gas (Column-I) with their co-ordinates (Column-II) :

Column-I (Graphical representation) — **Column-II (x and y co-ordinates)**

(A)  (1) pV vs. V

(B)  (2) p vs. V

(C)  (3) p vs. $\frac{1}{V}$

(a) A – (3), B – (1), C – (2)
(b) A – (3), B – (2), C – (1)
(c) A – (2), B – (3), C – (1)
(d) A – (1), B – (3), C – (2)

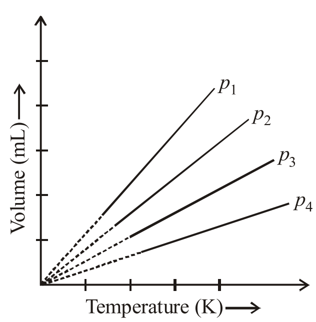
Critical Thinking Type Questions :

1. When a sample of gas is compressed at constant temperature from 15 atm to 60 atm, its volume changes from 76 cm^3 to 20.5 cm^3. Which of the following statements are possible explanations of this behaviour?
(1) The gas behaves non-ideally
(2) The gas dimerises
(3) The gas is adsorbed into the vessel walls
(a) 1, 2 and 3 (b) 1 and 2 only
(c) 2 and 3 only (d) 1 only

2. Three different gases X, Y and Z of molecular masses 2, 16 and 64 were enclosed in a vessel at constant temperature till equilibrium is reached. Which of the following statement is correct?
(a) Gas Z will be at the top of the vessel
(b) Gas Y will be at the top of the vessel
(c) Gas Z will be at the bottom and X will be at the top
(d) Gases will form homogenous mixture

3. Consider the case of hot air balloon, density of air at 20° C is 1.2Kg/m^3, if the air was heated to 99°C, density of air becomes 0.94kg/m^3. What would be the volume (in m^3) at 20°C if the volume at 99°C is 2800 m^3 and how much air (in kg) has been escaped at 99°C, if the air in inflated balloon was heated to 99°C (if the inflated volume of balloon was found to be 2800m^3) respectively are
(a) 2243, 728 (b) 3495.3, 596
(c) 2687, 593 (d) 2956, 771

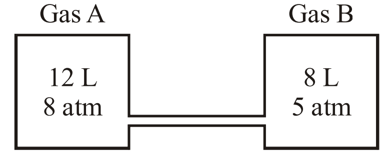
4. A plot of volume (V) versus temperature (T) for a gas at constant pressure is a straight line passing through the origin. The plots at different values of pressure are shown in figure. Which of the following order pressure is correct for this gas ?



(a) $p_1 > p_2 > p_3 > p_4$
(b) $p_1 = p_2 = p_3 = p_4$
(c) $p_1 < p_2 < p_3 < p_4$
(d) $p_1 < p_2 = p_3 < p_4$

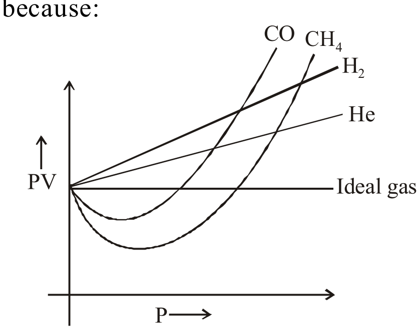
5. Cyclopropane and oxygen at partial pressures 170 torr and 570 torr respectively are mixed in a gas cylinder. What is the ratio of the number of moles of cyclopropane to the number of moles of oxygen (nC_3H_6/nO_2)?
(a) $\frac{170 \times 42}{570 \times 32} = 0.39$
(b) $\frac{170}{42} \Big/ \left(\frac{170}{42} + \frac{570}{32}\right) \approx 0.19$
(c) $\frac{170}{740} = 0.23$
(d) $\frac{170}{570} = 0.30$

6. Two vessels containing gases A and B are interconected as shown in the figure. The stopper is opened, the gases are allowed to mix homogeneously. The partial pressures of A and B in the mixture will be, respectively



(a) 8 and 5 atom (b) 9.6 and 4 atm
(c) 4.8 and 2 atm (d) 6.4 and 4 atm

7. In case of CO and CH_4 curve goes to minima then increases with increase in pressure but in case of H_2 and He the curve is linear because:



(a) Intermolecular interactions for H_2 and He are very low.
(b) Molecular size or atomic size for H_2 and He is small.
(c) Both (a) and (b)
(d) Neither (a) nor (b)

6 Thermodynamics

Fill in the Blanks :

1. A system is said to be _______ if it can neither exchange matter nor energy with the surroundings.
2. The heat content of the products is more than that of the reactants in an _______ reaction.
3. Enthalpy is an _______ property.
4. A _______ in thermodynamics refers to that part of universe in which observations are made and remaining universe constitutes the……………...
5. _______ is a quantity which represents the total energy of the system
6. The q is _______ when heat is transferred from the surroundings to the system and q is _______ When heat is transferred from system to the surroundings.
7. The work done during the expansion of a gas from a volume of 4 dm^3 to 6 dm^3 against a constant external pressure of 3 atm is (1 L atm = 101.32 J) _______ .
8. For most of the ionic compounds, ΔH_{sol} is _______ and the dissociation process is _______ .
9. Heat of neutralisation of strong acid and strong base is – 57.1 kJ. The heat produced when 0.25 mole of HCl is neutralised with 0.25 mole of NaOH in aqueous solution is _______ .
10. A reaction occurs _______ if $T\Delta S > \Delta H$ and both ΔH and ΔS are + ve

True/ False :

1. First law of thermodynamics is not adequate in predicting the direction of a process.
2. Heat capacity of a diatomic gas is higher than that of a monoatomic gas.
3. The standard enthalpy of reaction is the enthalpy change for a reaction when all the participating substances are in their standard states.
4. Standard conditions are denoted by adding the superscript $\ominus$ to the symbol ΔH e.g., $-\Delta H^{\ominus}$
5. In case of expansion maximum amount of work can be obtained under isothermal conditions by reversibly carrying out the process rather than through irreversible route.
6. In case polyatomic molecules, bond dissociation enthalpy is different for different bonds within the same molecule.
7. Internal energy, U, of the system is a state function.
8. +w shows, that work is done by the system
9. Variables like P, V and T are called state variables or state functions

Conceptual MCQs :

1. For vaporization of water at 1 atmospheric pressure, the values of ΔH and ΔS are 40.63 $kJmol^{-1}$ and 108.8 JK^{-1} mol^{-1}, respectively. The temperature when Gibbs energy change (ΔG) for this transformation will be zero, is:
   (a) 293.4 K (b) 273.4 K
   (c) 393.4 K (d) 373.4 K.
2. Equal volumes of two monoatomic gases, A and B, at same temperature and pressure are mixed. The ratio of specific heats (C_p/C_v) of the mixture will be :
   (a) 0.83 (b) 1.50
   (c) 3.3 (d) 1.67
3. In which of the following reactions, standard entropy change ($\Delta S°$) is positive and standard Gibb's energy change ($\Delta G°$) decreases sharply with increasing temperature ?

(a) $C\ graphite + \frac{1}{2}O_2(g) \rightarrow CO(g)$

(b) $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

(c) $Mg(s) + \frac{1}{2}O_2(g) \rightarrow MgO(s)$

(d) $\frac{1}{2}C\ graphite + \frac{1}{2}O_2(g) \rightarrow \frac{1}{2}CO_2(g)$

4. Which one of the following statements is false?

(a) Work is a state function

(b) Temperature is a state function

(c) Change in the state is completely defined when the initial and final states are specified

(d) None of the above

5. In an adiabatic process, no transfer of heat takes place between system and surroundings. Choose the correct option for free expansion of an ideal gas under adiabatic condition from the following.

(a) $q = 0, \Delta T \neq 0, w = 0$

(b) $q \neq 0, \Delta T = 0, w = 0$

(c) $q = 0, \Delta T = 0, w = 0$

(d) $q = 0, \Delta T < 0, w \neq 0$

6. A heat engine absorbs heat Q_1 at temperature T_1 and heat Q_2 at temperature T_2. Work done by the engine is J $(Q_1 + Q_2)$. This data

(a) violates 1st law of thermodynamics

(b) violates 1st law of thermodynamics if Q_1 is –ve

(c) violates 1st law of thermodynamics of Q_2 is –ve

(d) does not violate 1st law of thermodynamics.

7. An ideal gas is allowed to expand both reversibly and irreversibly in an isolated system. If T_i is the initial temperature and T_f is the final temperature, which of the following statements is correct?

(a) $(T_f)_{rev} = (T_f)_{irrev}$

(b) $T_f = T_i$ for both reversible and irreversible processes

(c) $(T_f)_{irrev} > (T_f)_{rev}$

(d) $T_f > T_i$ for reversible process but $T_f = T_i$ for irreversible process

8. The pressure-volume work for an ideal gas can be calculated by using the expression

$$w = -\int_{V_i}^{V_f} p_{ex} dV.$$

The work can also be calculated from the pV–plot by using the area under the curve within the specified limits. When an ideal gas is compressed (a) reversibly or (b) irreversibly from volume V_i to V_f. Choose the correct option.

(a) w (reversible) = w (irreversible)

(b) w (reversible) < w (irreversible)

(c) w (reversible) > w (irreversible)

(d) w (reversible) = w (irreversible) + $p_{ex} . \Delta V$

9. For the reaction $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$ Which one of the statement is correct at constant T and P ?

(a) $\Delta H = \Delta E$

(b) $\Delta H < \Delta E$

(c) $\Delta H > \Delta E$

(d) ΔH is independent of physical state of the reactants

10. Which is an extensive property of the system ?

(a) Volume (b) Viscosity

(c) Temperature (d) Refractive index

11. If a reaction involves only solids and liquids which of the following is true ?

(a) $\Delta H < \Delta E$ (b) $\Delta H = \Delta E$

(c) $\Delta H > \Delta E$ (d) $\Delta H = \Delta E + RT\Delta n$

12. 2 moles of an ideal gas at 27ºC temperature is expanded reversibly from 2 lit to 20 lit. Find entropy change (R = 2 cal/mol K)

(a) 92.1 (b) 0

(c) 4 (d) 9.2

13. During complete combustion of one mole of butane, 2658 kJ of heat is released. The thermochemical reaction for above change is

(a) $2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$ $\Delta_c H = -2658.0\ kJ\ mol^{-1}$

(b) $C_4H_{10}(g)+\frac{13}{2}O_2(g)\rightarrow 4CO_2(g)+5H_2O(g)$
$\Delta_cH=-1329.0\ kJ\ mol^{-1}$

(c) $C_4H_{10}(g)+\frac{13}{2}O_2(g)\rightarrow 4CO_2(g)+5H_2O(l)$
$\Delta_cH=-2658.0\ kJ\ mol^{-1}$

(d) $C_4H_{10}(g)+\frac{13}{2}O_2(g)\rightarrow 4CO_2(g)+5H_2O(l)$
$\Delta_cH=+2658.0\ kJ\ mol^{-1}$

14. On the basis of thermochemical equations (a), (b) and (c), find out which of the algebric relationships given in options (i) to (iv) is correct.

(1) $C\ (graphite)+O_2(g)\rightarrow CO_2(g);$
$\Delta_rH=x\ kJ\ mol^{-1}$

(2) $C(graphite)+\frac{1}{2}O_2(g)\rightarrow CO\ (g);$
$\Delta_rH=y\ kJ\ mol^{-1}$

(3) $CO\ (g)+\frac{1}{2}O_2\ (g)\rightarrow CO_2\ (g);$
$\Delta_rH=z\ kJ\ mol^{-1}$

(a) $z=x+y$ (b) $x=y-z$
(c) $x=y+z$ (d) $y=2z-x$

15. The enthalpy changes for the following processes are listed below :

$Cl_2(g)=2Cl(g),$	$242.3\ kJ\ mol^{-1}$
$I_2(g)=2I(g),$	$151.0\ kJ\ mol^{-1}$
$ICl(g)=I(g)+Cl(g),$	$211.3\ kJ\ mol^{-1}$
$I_2(s)=I_2(g),$	$62.76\ kJ\ mol^{-1}$

Given that the standard states for iodine and chlorine are $I_2(s)$ and $Cl_2(g)$, the standard enthalpy of formation for ICl(g) is :

(a) $+16.8\ kJ\ mol^{-1}$ (b) $+244.8\ kJ\ mol^{-1}$
(c) $-14.6\ kJ\ mol^{-1}$ (d) $-16.8\ kJ\ mol^{-1}$

16. Oxidising power of chlorine in aqueous solution can be determined by the parameters indicated below:

$$\frac{1}{2}Cl_2(g)\xrightarrow{\frac{1}{2}\Delta_{diss}H^{\ominus}}Cl(g)\xrightarrow{\Delta_{eg}H^{\ominus}}Cl^-(g)\xrightarrow{\Delta_{Hyd}H^{\ominus}}Cl^-(aq)$$

using the data,

$\Delta_{diss}H^{\ominus}_{Cl_2}=240\ kJ\ mol^{-1},$

$\Delta_{eg}H^{\ominus}_{Cl}=-349\ kJ\ mol^{-1},$

$\Delta_{hyd}H^{\ominus}_{Cl^-}=-381\ kJ\ mol^{-1}$, will be

(a) $+152\ kJ\ mol^{-1}$ (b) $-850\ kJ\ mol^{-1}$
(c) $-610\ kJ\ mol^{-1}$ (d) $+120\ kJ\ mol^{-1}$

17. Identify the correct statement regarding a spontaneous process:

(a) Lowering of energy in the process is the only criterion for spontaneity.
(b) For a spontaneous process in an isolated system, the change in entropy is positive.
(c) Endothermic processes are never spontaneous.
(d) Exothermic processes are always spontaneous.

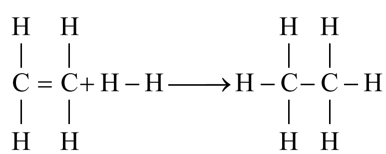
18. The enthalpies of elements in their standard states are taken as zero. The enthalpy of formation of a compound

(a) is always negative
(b) is always positive
(c) may be positive or negative
(d) is never negative

19. From the following bond energies:

$H-H$ bond energy: $431.37\ kJ\ mol^{-1}$
$C=C$ bond energy: $606.10\ kJ\ mol^{-1}$
$C-C$ bond energy: $336.49\ kJ\ mol^{-1}$
$C-H$ bond energy: $410.50\ kJ\ mol^{-1}$

Enthalpy for the reaction,



will be:

(a) $-243.6\ kJ\ mol^{-1}$ (b) $-120.0\ kJ\ mol^{-1}$
(c) $553.0\ kJ\ mol^{-1}$ (d) $1523.6\ kJ\ mol^{-1}$

20. The enthalpy of fusion of water is 1.435 kCal/mol. The molar entropy change for the melting of ice at 0°C is :

(a) 10.52 cal / (mol K)
(b) 21.04 cal / (mol K)
(c) 5.260 cal / (mol K)
(d) 0.526 cal / (mol K)

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** T, P and V are state variables or state functions.
Reason : Their values depend on the state of the system and how it is reached.

2. **Assertion :** At constant temperature and pressure whatever heat absorbed by the system is used in doing work.
Reason : Internal energy change is zero.

3. **Assertion :** For an isothermal reversible process Q = –W i.e. work done by the system equals the heat absorbed by the system.
Reason : Enthalpy change (ΔH) is zero for isothermal process.

4. **Assertion :** Absolute value of internal energy of a substance cannot be determined.
Reason : It is impossible to determine exact values of constitutent energies of the substances.

5. **Assertion :** A process is called adiabatic if the system does not exchange heat with the surroundings.
Reason : It does not involve increase or decrease in temperature of the system.

6. **Assertion :** There is exchange in internal energy in a cyclic process.
Reason : Cyclic proces is the one in which the sytem returns to its initial state after a number of reactions.

7. **Assertion :** Internal energy is an extensive property.
Reason : Internal energy depends upon the amount of the system.

8. **Assertion :** The mass and volume of a substance are the extensive properties and are proportional to each other.
Reason : The ratio of mass of a sample to its volume is an intensive property.

9. **Assertion :** First law of thermodynamics is applicable to an electric fan or a heater.
Reason : In an electric fan, the electrical energy is converted into mechanical work that moves the blades. In a heater, electrical energy is converted into heat energy.

10. **Assertion :** The value of enthalpy of neutralization of weak acid and strong base is numerically less than 57.1 kJ.
Reason : All the OH^- ions furnished by 1 g equivalent of strong base are not completely neutralized.

11. **Assertion :** When a solid melts, decrease in enthalpy is observed.
Reason : Melting of a solid is endothermic.

12. **Assertion :** Many endothermic reactions that are not spontaneous at room temperature become spontaneous at high temperature.
Reason : Entropy of the system increases with increase in temperature.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I	Column-II
(A) C_m	(1) $C_v \Delta T$
(B) q	(2) C/n
(C) ΔU	(3) $C_p \Delta T$
(D) ΔH	(4) $C \Delta T$

(a) A – (2), B – (4), C – (3), D – (1)
(b) A – (2), B – (4), C – (1), D – (3)
(c) A – (4), B – (2), C – (1), D – (3)
(d) A – (2), B – (1), C – (3), D – (4)

2. Match the columns

Column-I	Column-II
(A) Free expansion at $\Delta V = 0$	(1) $q = -w = nRT \ \ell n \dfrac{V_f}{V_i}$
(B) Isothermal irreversible change	(2) $\Delta U = w_{ad}$
(C) Isothermal reversible change	(3) $\Delta U = q_v$
(D) For adiabatic change	(4) $q = -w = P_{ex}(V_f - V_i)$

(a) A – (4), B – (1), C – (3), D – (2)
(b) A – (3), B – (2), C – (1), D – (4)
(c) A – (3), B – (4), C – (1), D – (2)
(d) A – (2), B – (3), C – (4), D – (1)

3. Match the columns

Column-I	Column-II
(A) $p_{ext} = 0$	(1) Free expansion of an ideal gas
(B) $q = p_{ext}(V_f - V_i)$	(2) Adiabatic change
(C) $q = 2.303\, nRT \log (V_f / V_i)$	(3) Isothermal reversible change
(D) $\Delta U = W_{ad}$	(4) Isothermal irreversible change

(a) A – (1), B – (4), C – (3), D – (2)
(b) A – (1), B – (2), C – (3), D – (4)
(c) A – (1), B – (3), C – (4), D – (2)
(d) A – (1), B – (3), C – (2), D – (4)

4. Match the columns

Column-I	Column-II
(A) $H_2(g) + Br_2(g) \rightarrow 2HBr(g)$	(1) $\Delta H = \Delta U - 2RT$
(B) $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$	(2) $\Delta H = \Delta U + 3RT$
(C) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	(3) $\Delta H = \Delta U$
(D) $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$	(4) $\Delta H = \Delta U + RT$

(a) A – (3), B – (1), C – (2), D – (4)
(b) A – (3), B – (4), C – (1), D – (2)
(c) A – (2), B – (1), C – (4), D – (3)
(d) A – (4), B – (2), C – (1), D – (3)

5. Match the columns

Column-I	Column-II
(A) $C_4H_{10} + \dfrac{13}{2}O_2 \rightarrow 4CO_2 + 5H_2O; \Delta H = -w$	(1) Enthalpy of atomisation
(B) $CH_4 \rightarrow C + 4H\,; \Delta H = x$	(2) Enthalpy of formation
(C) $H_2 + Br_2 \rightarrow 2HBr\,; \Delta H = y$	(3) Enthalpy of combustion
(D) $Na^-(s) \rightarrow Na(g)\,; \Delta H = z$	(4) Enthalpy of sublimation

(a) A – (4), B – (1), C – (2), D – (3)
(b) A – (2), B – (3), C – (1), D – (4)
(c) A – (3), B – (1), C – (2), D – (4)
(d) A – (1), B – (2), C – (4), D – (3)

6. Match the columns

Column-I	Column-II
(A) Exothermic	(1) $\Delta H = 0, \Delta E = 0$
(B) Spontaneous	(2) $\Delta G = 0$
(C) Cyclic process	(3) ΔH is negative
(D) Equilibrium	(4) ΔG is negative

(a) A – (2), B – (3), C – (1), D – (4)
(b) A – (4), B – (1), C – (3), D – (2)
(c) A – (1), B – (2), C – (4), D – (3)
(d) A – (3), B – (4), C – (1), D – (2)

7. Match the columns

Column-I	Column-II
(A) $\Delta H = -ve$; $\Delta S = -ve$ $\Delta G = -ve$	(1) Reaction will be non-spontaneous at high temperature
(B) $\Delta H = -ve$; $\Delta S = -ve$	(2) Reaction will be non-spontaneous at low temperature
(C) $\Delta H = +ve$; $\Delta S = +ve$ $\Delta G = +ve$	(3) Reaction will be spontaneous at low temperature
(D) $\Delta H = +ve$; $\Delta S = +ve$ $\Delta G = -ve$	(4) Reaction will be spontaneous at high temperature

(a) A – (2), B – (3), C – (1), D – (4)
(b) A – (3), B – (1), C – (2), D – (4)
(c) A – (3), B – (2), C – (4), D – (1)
(d) A – (2), B – (4), C – (1), D – (3)

Critical Thinking Type Questions :

1. According to the first law of thermodynamics which of the following quantities represents change in a state function ?
(a) q_{rev} (b) $q_{rev} - W_{rev}$
(c) q_{rev}/W_{rev} (d) $q_{rev} + W_{rev}$

2. For an isothermal reversible expansion process, the value of q can be calculated by the expression
(a) $q = 2.303nRT \log \frac{V_2}{V_1}$
(b) $q = -2.303nRT \log \frac{V_2}{V_1}$
(c) $q = -P_{exp} nRT \log \frac{V_1}{V_2}$
(d) None of these

3. A piston filled with 0.04 mol of an ideal gas expands reversibly from 50.0 mL to 375 mL at a constant temperature of 37.0ºC. As it does so, it absorbs 208 J of heat. The values of q and w for the process will be:
(R = 8.314 J/mol K) (ln 7.5 = 2.01)
(a) q = + 208 J, w = – 208 J
(b) q = – 208 J, w = – 208 J
(c) q = – 208 J, w = + 208 J
(d) q = + 208 J, w = + 208 J

4. The internal energy change when a system goes from state A to B is 40 kJ/mole. If the system goes from A to B by a reversible path and returns to state A by an irreversible path what would be the net change in internal energy ?
(a) > 40 kJ (b) < 40 kJ
(c) Zero (d) 40 kJ

5. Under isothermal condition for one mole of ideal gas what is the ratio of work done under reversible to irreversible process, initially held at 20 atm undergoes expansion from 1L to 2L, at 298K, under external pressure of 10 atm?
(a) 1.7 (b) 2.0
(c) 1.4 (d) 1.0

6. Consider the reaction :

$$4NO_2(g) + O_2(g) \rightarrow 2N_2O_5(g),$$
$$\Delta_r H = -111 \text{ kJ}.$$

If $N_2O_5(s)$ is formed instead of $N_2O_5(g)$ in the above reaction, the $\Delta_r H$ value will be :
(given, ΔH of sublimation for N_2O_5 is –54 kJ mol^{-1})
(a) + 54 kJ (b) + 219 kJ
(c) – 219 J (d) – 165 kJ

7. Given

Reaction	Energy Change (in kJ)
$Li(s) \rightarrow Li(g)$	161
$Li(g) \rightarrow Li^+(g)$	520
$\frac{1}{2}F_2(g) \rightarrow F(g)$	77
$F(g) + e^- \rightarrow F^-(g)$	(Electron gain enthalpy)
$Li^+(g) + F^-(g) \rightarrow LiF(s)$	– 1047
$Li(s) + \frac{1}{2}F_2(g) \rightarrow LiF(s)$	– 617

Based on data provided, the value of electron gain enthalpy of fluorine would be :
(a) – 300 kJ mol^{-1} (b) – 350 kJ mol^{-1}
(c) – 328 kJ mol^{-1} (d) – 228 kJ mol^{-1}

8. For complete combustion of ethanol,

$C_2H_5OH(l)+3O_2(g)\longrightarrow 2CO_2(g)+3H_2O(l)$,

the amount of heat produced as measured in bomb calorimeter, is 1364.47 kJ mol^{-1} at 25°C. Assuming ideality the enthalpy of combustion, Δ_cH, for the reaction will be:
(R = 8.314 kJ mol^{-1})

(a) -1366.95 kJ mol^{-1}

(b) -1361.95 kJ mol^{-1}

(c) -1460.95 kJ mol^{-1}

(d) -1350.50 kJ mol^{-1}

9. Diborane is a potential rocket fuel which undergoes combustion according to the equation

$B_2H_6(g)+3O_2(s)\longrightarrow B_2O_3(s)+3H_2O(g)$

Calculate the enthalpy change for the combustion of diborane. Given

(i) $2B(s)+\frac{3}{2}O_2(g)\longrightarrow B_2O_3(s)$;
$\Delta H = -1273$ kJ per mol

(ii) $H_2(g)+\frac{1}{2}O_2(g)\longrightarrow H_2O(l)$;
$\Delta H = -286$ kJ per mol

(iii) $H_2O(l)\longrightarrow H_2O(g)$; $\Delta H = 44$ kJ per mol

(iv) $2B(s)+3H_2(g)\longrightarrow B_2H_6(g)$;
$\Delta H = 36$ kJ per mol

(a) +2035 kJ per mol
(b) −2035 kJ per mol
(c) +2167 kJ per mol
(d) −2167 kJ per mol

10. The enthalpy changes for the following processes are listed below :

$Cl_2(g)\rightarrow 2Cl(g)$,	242.3 kJ mol^{-1}
$I_2(g)\rightarrow 2I(g)$,	151.0 kJ mol^{-1}
$ICl(g)\rightarrow I(g)+Cl(g)$,	211.3 kJ mol^{-1}
$I_2(s)\rightarrow I_2(g)$,	62.76 kJ mol^{-1}

Given that the standard states for iodine and chlorine are $I_2(s)$ and $Cl_2(g)$, the standard enthalpy of formation for $ICl(g)$ is :

(a) +16.8 kJ mol^{-1} (b) +244.8 kJ mol^{-1}
(c) −14.6 kJ mol^{-1} (d) −16.8 kJ mol^{-1}

11. In an irreversible process taking place at constant T and P and in which only pressure-volume work is being done, the change in Gibbs free energy (dG) and change in entropy (dS), satisfy the criteria

(a) $(dS)_{V,E} > 0, (dG)_{T,P} < 0$
(b) $(dS)_{V,E} = 0, (dG)_{T,P} = 0$
(c) $(dS)_{V,E} = 0, (dG)_{T,P} > 0$
(d) $(dS)_{V,E} < 0, (dG)_{T,P} < 0$

7 Equilibrium

Fill in the Blanks :

1. The conjugate base of HSO_4^- in aqueous solution is _______ .
2. An element which can exist as a positive ion in acidic solution and also as a negative ion in basic solution is said to be _______ .
3. For a given reversible reaction at a fixed temperature, equilibrium constants K_p and K_c are related by _______ .
4. A ten-fold increase in pressure on the reaction, $N_2(g)+3H_2(g) \rightleftharpoons 2NH_3(g)$ at equilibrium results in _______ in K_P.
5. In the reaction $I^- + I_2 \rightarrow I_3^-$, the Lewis acid is _______ .
6. If K_c is in the range of _______ appreciable concentrations of both reactants and products are present.
7. The liquid which has a _______ vapour pressure is more volatile and has a _______ boiling point.
8. Boiling point of the liquid depends on the atmospheric pressure. It depends on the altitude of the place; at high altitude the boiling point _______ .
9. In the following equilibrium reaction
   $2A \rightleftharpoons B + C,$
   the equilibrium concentrations of A, B and C are 1×10^{-3} M, 2×10^{-3} M and 3×10^{-3} M respectively at 300 K. The value of K_c for this equilibrium at the same temperature is _______.
10. The K_{sp} for $Cr(OH)_3$ is 1.6×10^{-30}. The solubility of this compound in water is _______ .

True/ False :

1. Aluminium chloride ($AlCl_3$) is a Lewis acid because it can donate electrons.
2. If equilibrium constant for the reaction $A_2 + B_2 \rightleftharpoons 2AB$, is K, then for the backward reaction $AB \rightleftharpoons \frac{1}{2} A_2 + \frac{1}{2} B_2$, the equilibrium constant is 1/K.
3. When a liquid and its vapour are at equilibrium and the pressure is suddenly decreased, cooling occurs.
4. Solubility of sodium hydroxide increases with increase in temperature.
5. Water and water vapour remain in equilibrium position at atmospheric pressure (1.013 bar) and at 100°C in a closed vessel.
6. Boiling point depends on the altitude of the place; at high altitude the boiling point increases.
7. The value of equilibrium constant is independent of initial concentrations of the reactants and products.
8. The equilibrium constant for the reverse reaction is equal to the inverse of the equilibrium constant for the forward reaction.
9. If $K_c > 10^3$, products predominate over reactants, i.e., if K_c is very large, the reaction proceeds nearly to completion.
10. In pure water one H_2O molecule donate proton and acts an acid and another water molecule accepts a proton and acts as a base.
11. Smaller the value of K_a, the stronger is the acid
12. In a tribasic acid 2nd and 3rd (K_{a_2}, K_{a_3}) ionization constants are smaller than the first ionisation (K_{a_1})
13. Molarity of pure water = 55.55M
14. The extent of dissociation of an acid depends on the strength and polarity of the H — A bond (where A is an electronegative element.)

Conceptual MCQs :

1. Which of the following is not a general characteristic of equilibria involving physical processes ?
(a) Equilibrium is possible only in a closed system at a given temperature.
(b) All measurable properties of the system remain constant.
(c) All the physical processes stop at equilibrium.
(d) The opposing processes occur at the same rate and there is dynamic but stable condition.

2. A reaction is $A + B \rightleftharpoons C + D$. Initially we start with equal concentrations of A and B. At equilibrium we find that the moles of C is two times of A. What is the equilibrium constant of the reaction?
(a) $\frac{1}{4}$ (b) $\frac{1}{2}$
(c) 4 (d) 2

3. Which of the following molecules acts as a Lewis acid ?
(a) $(CH_3)_2O$ (b) $(CH_3)_3P$
(c) $(CH_3)_3N$ (d) $(CH_3)_3B$

4. In which of the following equilibrium K_c and K_p are not equal?
(a) $2NO_{(g)} \rightleftharpoons N_{2(g)} + O_{2(g)}$
(b) $SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g)$
(c) $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$
(d) $2C_{(s)} + O_{2(g)} \rightleftharpoons 2CO_{2(g)}$

5. For the reaction $C(s) + CO_2(g) \rightleftharpoons 2CO(g)$, the partial pressures of CO_2 and CO are 2.0 and 4.0 atm respectively at equilibrium. The K_p for the reaction is.
(a) 0.5 (b) 4.0
(c) 8.0 (d) 32.0

6. The reaction quotient (Q) for the reaction

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

is given by $Q = \frac{[NH_3]^2}{[N_2][H_2]^3}$. The reaction will proceed from right to left if
(a) $Q < K_c$ (b) $Q > K_c$
(c) $Q = 0$ (d) $Q = K_c$

where K_c is the equilibrium constant.

7. $\Delta G°$ for the reaction $X + Y \rightleftharpoons Z$ is -4.606 kcal. The equilibrium constant for the reaction at 227°C is
(a) 100 (b) 10
(c) 2 (d) 0.01

8. Buffer solutions have constant acidity and alkalinity because
(a) these give unionised acid or base on reaction with added acid or alkali.
(b) acids and alkalies in these solutions are shielded from attack by other ions.
(c) they have large excess of H^+ or OH^- ions
(d) they have fixed value of pH

9. In which of the following reactions, the equilibrium remains unaffected on addition of small amount of argon at constant volume?
(a) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$
(b) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
(c) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
(d) The equilibrium will remain unaffected in all the three cases.

10. Which of the following statements is incorrect?
(a) In equilibrium mixture of ice and water kept in perfectly insulated flask mass of ice and water does not change with time.
(b) The intensity of red colour increases when oxalic acid is added to a solution containing iron (III) nitrate and potassium thiocyanate.
(c) On addition of catalyst the equilibrium constant value is not affected.
(d) Equilibrium constant for a reaction with negative ΔH value decreases as the temperature increases.

11. Steam reacts with iron at high temperature to give hydrogen gas and Fe_3O_4 (s). The correct expression for the equilibrium constant is
(a) $\frac{P_{H_2}^2}{P_{H_2O}^2}$ (b) $\frac{(P_{H_2})^4}{(P_{H_2O})^4}$
(c) $\frac{(P_{H_2})^4[Fe_3O_4]}{(P_{H_2O})^4[Fe]}$ (d) $\frac{[Fe_3O_4]}{[Fe]}$

12. Which of the following can act both as Bronsted acid and Bronsted base?
(a) Na_2CO_3 (b) OH^-
(c) HCO_3^- (d) NH_3

13. Which equilibrium can be described as an acid-base reaction using the Lewis acid-base definition but not using the Bronsted-Lowry definition?
(a) $2NH_3 + H_2SO_4 \rightleftharpoons 2NH_4^+ + SO_4^{2-}$
(b) $NH_3 + CH_3COOH \rightleftharpoons NH_4^+ + CH_3COO^-$
(c) $H_2O + CH_3COOH \rightleftharpoons H_3O^+ + CH_3COO^-$
(d) $[Cu(H_2O)_4]^{2-} + 4\,NH_3 \rightleftharpoons [Cu(NH_3)_4]^{2+} + 4H_2O$

14. The ionisation constant of an acid, K_a, is the measure of strength of an acid. The K_a values of acetic acid, hypochlorous acid and formic acid are 1.74×10^{-5}, 3.0×10^{-8} and 1.8×10^{-4} respectively. Which of the following orders of pH of 0.1 mol dm^{-3} solutions of these acids is correct?
(a) acetic acid > hypochlorous acid > formic acid
(b) hypochlorous acid > acetic acid > formic acid
(c) formic acid > hypochlorous acid > acetic acid
(d) formic acid > acetic acid > hypochlorous acid

15. K_{a_1}, K_{a_2} and K_{a_3} are the respective ionisation constants for the following reactions.

$H_2S \rightleftharpoons H^+ + HS^-$

$HS^- \rightleftharpoons H^+ + S^{2-}$

$H_2S \rightleftharpoons 2H^+ + S^{2-}$

The correct relationship between K_{a_1}, K_{a_2} and K_{a_3} is
(a) $K_{a_3} = K_{a_1} \times K_{a_2}$
(b) $K_{a_3} = K_{a_1} + K_{a_2}$
(c) $K_{a_3} = K_{a_1} - K_{a_2}$
(d) $K_{a_3} = K_{a_1} / K_{a_2}$

16. The pK_a of a weak acid, HA, is 4.80. The pK_b of a weak base, BOH, is 4.78. The pH of an aqueous solution of the corresponding salt, BA, will be
(a) 9.58 (b) 4.79
(c) 9.22 (d) 7.01

17. What will be the value of pH of 0.01 mol dm^{-3} CH_3COOH $\left(K_a = 1.74 \times 10^{-5}\right)$?
(a) 3.4 (b) 3.6
(c) 3.9 (d) 3.0

18. The pH of a solution which is 0.1 M in HA and 0.5 M in NaA. K_a for HA is 1.8×10^{-6}
(a) 5.44 (b) 6.44
(c) 6.0 (d) 4.73

19. Which of the following will produce a buffer solution when mixed in equal volumes?
(a) 0.1 mol dm^{-3} NH_4OH and 0.1 mol dm^{-3} HCl
(b) 0.05 mol dm^{-3} NH_4OH and 0.1 mol dm^{-3} HCl
(c) 0.1 mol dm^{-3} NH_4OH and 0.05 mol dm^{-3} HCl
(d) 0.1 mol dm^{-3} CH_4COONa and 0.1 mol dm^{-3} NaOH

20. A solution which is 10^{-3} M each in Mn^{2+}, Fe^{2+}, Zn^{2+} and Hg^{2+} is treated with 10^{-6} M sulphide ion. If K_{sp} of MnS, FeS, ZnS and HgS are 10^{-15}, 10^{-23}, 10^{-20} and 10^{-54} respectively which one will precipitate first
(a) FeS (b) MgS
(c) HgS (d) ZnS

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*
(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** K_p can be less than, greater than or equal to K_c.
Reason : Relation between K_p and K_c depends on the change in number of moles of gaseous reactants and products (Δn).

2. **Assertion :** If a volume is kept constant and an inert gas such as argon is added which does not take part in the reaction, the equilibrium remains undisturbed.

Reason : It is because the addition of an inert gas at constant volume does not change the partial pressure or the molar concentrations of the substance involved in the reaction.

3. **Assertion :** Buffer system of carbonic acid and sodium bicarbonate is used for the precipitation of hydroxides of third group elements.
Reason : It maintains the pH to a constant value, about 7.4.

4. **Assertion :** Addition of silver ions to a mixture of aqueous sodium chloride and sodium bromide solution will first precipitate AgBr rather than AgCl.
Reason : K_{sp} of AgCl > K_{sp} of AgBr.

5. **Assertion :** Addition of silver ions to a mixture of aqueous sodium chloride and sodium bromide solution will first precipitate AgBr rather than AgCl
Reason : K_{sp} of AgCl < K_{sp} of AgBr ***[2004]***

6. **Assertion :** Addition of NH_4OH to an aqueous solution of $BaCl_2$ in the presence of NH_4Cl (excess) precipitates $Ba(OH)_2$.
Reason : $Ba(OH)_2$ is insoluble in water ***[2005]***

7. **Assertion :** For reaction
$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$
Unit of $K_C = L^2 mol^{-2}$
Reason : For the reaction
$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$
Equilibrium constant, $K_C = \dfrac{[NH_3]^2}{[N_2][H_2]^3}$ ***[2008]***

8. **Assertion :** Reaction quotient is defined in the same way as equilbrium constant at any stage of the reaction.
Reason : If Q_c (reaction quotient) < K_C (equilibrium constant) reaction moves in direction of reactants.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I	Column-II
(A) $H_2O(l) \rightleftharpoons H_2O(vap)$	(1) rate of melting = rate of freezing
(B) I_2 (solid) $\rightleftharpoons I_2$ (vapour)	(2) rate of evaporation = rate of condensation
(C) Ice $\rightleftharpoons$ water	(3) rate of sublimation= rate of condensation

(a) A – (1), B – (2), C – (3) (b) A – (3), B – (2), C – (1)
(c) A – (1), B – (3), C – (2) (d) A – (2), B – (3), C – (1)

2. Match the Column-I with Column-II and mark the appropriate choice.

Column-I	Column-II
(A) Liquid $\rightleftharpoons$ Vapour	(1) Saturated solution
(B) Solid $\rightleftharpoons$ Liquid	(2) Boiling point
(C) Solid $\rightleftharpoons$ Vapour	(3) Sublimation point
(D) Solute (s) $\rightleftharpoons$ Solute (solution)	(4) Melting point

(a) A – (1) ; B – (3) ; C – (2) ; D – (4) (b) A – (2) ; B – (4) ; C – (3) ; D – (1)
(c) A – (4) ; B – (2) ; C – (1) ; D – (3) (d) A – (3) ; B – (4) ; C – (2) ; D – (1)

3. Match the columns.

Column-I (Reactions)	Column-II (Effect of increase in pressure)
(A) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$	(1) Reaction proceed backward.
(B) $CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$	(2) No effect on reaction.

(C) $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

(3) Reaction proceed forward

(a) A – (2), B – (3), C – (1)
(b) A – (3), B – (2), C – (1)
(c) A – (1), B – (3), C – (2)
(d) A – (2), B – (1), C – (3)

4. Match the columns :

Column-I	**Column-II**
(A) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ (t = 300ºC)	(1) $\Delta n > 0$
(B) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ (t = 50ºC)	(2) $K_P < K_C$
(C) $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$	(3) K_P not defined
(D) $CH_3COOH(l) + C_2H_5OH(l) \rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$	(4) $\Delta n = 1$

5. Match the columns :

Column-I	**Column-II**
(A) For the equilibrium $NH_4I(s) \rightleftharpoons NH_3(g) + HI(g)$, if pressure is increased at equilibrium	(1) Forward shift
(B) For the equilibrium $N_2 + 3H_2 \rightleftharpoons 2NH_3$ If volume is increased at equilibrium	(2) No change
(C) For the equilibrium $H_2O(g) + CO(g) \rightleftharpoons H_2(g) + CO_2(g)$ inert gas is added at constant pressure at equilibrium	(3) Backward shift
(D) For the equilibrium $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ what happens if more PCl_5 is added	(4) More N_2 and H_2 is formed.

(a) A – (1), B – (2), C – (3), D – (4)
(b) A – (3), B – (4), C – (2), D – (1)
(c) A – (4), B – (1), C – (2), D – (3)
(d) A – (2), B – (4), C – (3), D – (1)

6. Match the columns

Column-I	**Column-II**
(A) $Q_c < K_c$,	(1) Net reaction goes from right to left.
(B) $Q_c > K_c$,	(2) Net reaction goes from left to right.
(C) $Q_c = K_c$,	(3) No net reaction occurs.

(a) A – (1), B – (1), C – (3)
(b) A – (3), B – (1), C – (1)
(c) A – (1), B – (3), C – (2)
(d) A – (2), B – (1), C – (3)

7. Match the columns

Column-I	**Column-II**
(A) Hydrochloric acid	(1) Lemon and orange
(B) Acetic acid	(2) Tamarind paste.
(C) Citric and ascorbic acids	(3) Digestive juice
(D) Tartaric acid	(4) Constituent of vinegar

(a) A – (1), B – (3), C – (1), D – (4)
(b) A – (3), B – (4), C – (1), D – (2)
(c) A – (4), B – (1), C – (2), D – (3)
(d) A – (3), B – (1), C – (4), D – (2)

8. Match the columns

Column-I	Column-II
(A) $HClO_4$	(1) Strong base
(B) HNO_2	(2) Strong acid
(C) NH_2^-	(3) Weak base
(D) HSO_4^-	(4) Weak acid

(a) A – (4), B – (2), C – (1), D – (3)
(b) A – (2), B – (4), C – (1), D – (3)
(c) A – (3), B – (1), C – (2), D – (4)
(d) A – (4), B – (2), C – (1), D – (3)

Critical Thinking Type Questions :

1. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g), K_1$ (1)
$N_2(g) + O_2(g) \rightleftharpoons 2NO(g), K_2$ (2)
$H_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons H_2O(g), K_3$ (3)
The equation for the equilibrium constant of the reaction
$2NH_3(g) + \frac{5}{2}O_2(g) \rightleftharpoons 2NO(g) + 3H_2O(g)$,
(K_4) in terms of K_1, K_2 and K_3 is :
(a) $\frac{K_1.K_2}{K_3}$ (b) $\frac{K_1.K_3^2}{K_2}$
(c) $K_1 K_2 K_3$ (d) $\frac{K_2.K_3^3}{K_1}$

2. Two equilibria, $AB \rightleftharpoons A^+ + B^-$ and $AB + B^- \rightleftharpoons AB_2^-$ are simultaneously maintained in a solution with equilibrium constants, K_1 and K_2 respectively. The ratio of $[A^+]$ to $[AB_2^-]$ in the solution is
(a) directly proportional to $[B^-]$
(b) inversely proportional to $[B^-]$
(c) directly proportional to the square of $[B^-]$
(d) inversely proportional to the square of $[B^-]$

3. For the reversible reaction,
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at 500°C, the value of K_p is 1.44×10^{-5} when partial pressure is measured in atmospheres. The corresponding value of K_C, with concentration in mole litre^{-1}, is
(a) $\frac{1.44 \times 10^{-5}}{(0.082 \times 500)^{-2}}$ (b) $\frac{1.44 \times 10^{-5}}{(8.314 \times 773)^{-2}}$
(c) $\frac{1.44 \times 10^{-5}}{(0.082 \times 773)^{2}}$ (d) $\frac{1.44 \times 10^{-5}}{(0.082 \times 773)^{-2}}$

4. For the decomposition of the compound, represented as
$NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$
the $K_p = 2.9 \times 10^{-5}$ atm^3.
If the reaction is started with 1 mol of the compound, the total pressure at equilibrium would be :
(a) 1.94×10^{-2} atm (b) 5.82×10^{-2} atm
(c) 7.66×10^{-2} atm (d) 38.8×10^{-2} atm

5. On increasing the pressure, the gas phase reaction proceed forward to re-establish equilibrium, as predicted by applying the Le Chatelier's principle. Consider the reaction.
$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$
Which of the following is correct, if the total pressure at which the equilibrium is established, is increased without changing the temperature?
(a) K will remain same
(b) K will decrease
(c) K will increase
(d) K will increase initially and decrease when pressure is very high

6. When hydrochloric acid is added to cobalt nitrate solution at room temperature, the following reaction takes place out the reaction mixture becomes blue. On cooling the mixture it becomes pink. On the basis of this information mark the correct answer.
$$\underset{\text{(pink)}}{\left[Co(H_2O)_6\right]^{3+}}(aq) + 4Cl^-(aq) \rightleftharpoons \underset{\text{(blue)}}{\left[CoCl_4\right]^{2-}}(aq) + 6H_2O(l)$$
(a) $\Delta H > 0$ for the reaction
(b) $\Delta H < 0$ for the reaction
(c) $\Delta H = 0$ for the reaction
(d) The sign of ΔH cannot be predicted on the basis of this information.

7. Equal volumes of three acid solutions of pH 3, 4 and 5 are mixed in a vessel. What will be the H^+ ion concentration in the mixture ?
(a) 1.11×10^{-4} M (b) 3.7×10^{-4} M
(c) 3.7×10^{-3} M (d) 1.11×10^{-3} M

8. Values of dissociation constant, K_a are given as follows :

Acid	K_a
HCN	6.2×10^{-10}
HF	7.2×10^{-4}
HNO_2	4.0×10^{-4}

Correct order of increasing base strength of the base CN^-, F^- and NO_2^- will be :
(a) $F^- < CN^- < NO_2^-$
(b) $NO_2^- < CN^- < F^-$
(c) $F^- < NO_2^- < CN^-$
(d) $NO_2^- < F^- < CN^-$

9. In qualitative analysis, the metals of Group I can be separated from other ions by precipitating them as chloride salts. A solution initially contains Ag^+ and Pb^{2+} at a concentration of 0.10 M. Aqueous HCl is added to this solution until the Cl^- concentration is 0.10 M. What will the concentrations of Ag^+ and Pb^{2+} be at equilibrium?
(K_{sp} for AgCl $= 1.8 \times 10^{-10}$, K_{sp} for $PbCl_2 = 1.7 \times 10^{-5}$)
(a) $[Ag^+] = 1.8 \times 10^{-7}$ M ; $[Pb^{2+}] = 1.7 \times 10^{-6}$ M
(b) $[Ag^+] = 1.8 \times 10^{-11}$ M ; $[Pb^{2+}] = 8.5 \times 10^{-5}$ M
(c) $[Ag^+] = 1.8 \times 10^{-9}$ M ; $[Pb^{2+}] = 1.7 \times 10^{-3}$ M
(d) $[Ag^+] = 1.8 \times 10^{-11}$ M ; $[Pb^{2+}] = 8.5 \times 10^{-4}$ M

10. The solubility product (K_{sp}) of the following compounds are given at 25°C.

Compound	K_{sp}
AgCl	1.1×10^{-10}
AgI	1.0×10^{-16}
$PbCrO_4$	4.0×10^{-14}
Ag_2CO_3	8.0×10^{-12}

The most soluble and least soluble compounds are respectively.
(a) AgCl and $PbCrO_4$ (b) AgI and Ag_2CO_3
(c) AgCl and Ag_2CO_3 (d) Ag_2CO_3 and AgI

8

REDOX REACTIONS

Fill in the Blanks :

1. The loss of electron is termed as _______ .
2. In reaction, $4Na + O_2 \longrightarrow 2Na_2O$, _______ behaves as reducing agent
3. $Co(s) + Cu^{2+}(aq) \longrightarrow Co^{2+}(aq) + Cu(s)$
   The above reaction is _______ .
4. The oxidation number of sulphur in S_8, S_2F_2, H_2S respectively, are 0, _______ and –2.
5. The correct name for _______ using stock notation is nitrogen (iv) oxide
6. The oxidation state of osmium (Os) in OsO_4 is _______ .
7. The number of electrons involved in the reduction of one nitrate ion to hydrazine is _______ .
8. The reaction, $2\overset{1}{H_2}\overset{2}{O}(l) \qquad 2\overset{0}{H_2}(g) \quad \overset{0}{O_2}(g)$ is an example of _______ .
9. Phosphorus, sulphur and chlorine undergo disproportion in the _______ medium.
10. Atomic number of an element is 22. The highest O.S. exhibited by it in its compounds is _______.
11. Given :
    $X\,Na_2HAsO_3 + Y\,NaBrO_3 + Z\,HCl \rightarrow NaBr + H_3AsO_4 + NaCl$
    The values of X, Y and Z in the above redox reaction are _______ respectively
12. The values of x and y in the following redox reaction
    $x\,Cl_2 + 6OH^- \longrightarrow ClO_3^- + y\,Cl^- + 3H_2O$
    are _______ and _______ .

True/ False :

1. Reducing agents lower the oxidation number of an element in a given substance. These reagents are also called as reductants
2. Loss of electron(s) by any species is called oxidation reaction
3. Oxidation and reduction always occur simultaneously.
4. All alkali metals and some alkaline earth metals (Ca, Sr and Ba) displace hydrogen from cold water.
5. Cadmium and tin do not react with steam but displace hydrogen from acids.
6. A metal M for which E° for the half life reaction $M^{n+} + ne^- \rightleftharpoons M$ is very negative will be a good reducing agent.
7. The oxidizing power of the halogens decreases from chlorine to iodine.
8. A negative value of E^- means that the redox couple is a weaker reducing agent than the H^+/H_2 couple.
9. A positive E^- means that the redox couple is weaker reducing agent than the H^+/H_2.
10. Oxidation state of carbon in C_3H_4 is –(4/3).
11. Electrons are never shared in fraction.

Conceptual MCQs

1. Which of the following is not an example of redox reaction?
   (a) $CuO + H_2 \rightarrow Cu + H_2O$
   (b) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
   (c) $2K + F_2 \rightarrow 2KF$
   (d) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$
2. Of the following reactions, only one is a redox reaction. Identify it
   (a) $Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$
   (b) $BaCl_2 + MgSO_4 \rightarrow BaSO_4 + MgCl_2$
   (c) $2S_2O_7^{2-} + 2H_2O \rightarrow 4SO_4^{2-} + 4H^+$
   (d) $Cu_2S + 2FeO \rightarrow 2Cu + 2Fe + SO_2$

3. The oxidation number of an element in a compound is evaluated on the basis of certian rules. Which of the following rules is not correct in this respect?
   (a) The oxidation number of hydrogen is always + 1.
   (b) The algebraic sum of all the oxidation numbers in a compound is zero.
   (c) An element in the free or the uncombined state bears oxidation number zero.
   (d) In all its compounds, the oxidation number of fluorine is – 1.
4. Standard reduction potentials of the half reactions are given below :
   $F_2(g) + 2e^- \rightarrow 2F^-(aq);\ E° = +2.85\ V$
   $Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq);\ E° = +1.36\ V$
   $Br_2(l) + 2e^- \rightarrow 2Br^-(aq);\ E° = +1.06\ V$
   $I_2(s) + 2e^- \rightarrow 2I^-(aq);\ E° = +0.53\ V$
   The strongest oxidising and reducing agents respectively are :
   (a) F_2 and I^- (b) Br_2 and Cl^-
   (c) Cl_2 and Br^- (d) Cl_2 and I_2
5. When $KMnO_4$ acts as an oxidising agent and ultimately forms MnO_4^{-2}, MnO_2, Mn_2O_3 and Mn^{+2}, then the number of electrons transferred in each case respectively is
   (a) 4, 3, 1, 5 (b) 1, 5, 3, 7
   (c) 1, 3, 4, 5 (d) 3, 5, 7, 1
6. Which of the following is a redox reaction ?
   (a) H_2SO_4 with NaOH
   (b) In atmosphere, O_3 from O_2 by lightening
   (c) Nitrogen oxides from nitrogen and oxygen by lightening
   (d) Evaporation of H_2O
7. In the reaction
   $$3Br_2 + 6CO_3^{2-} + 3H_2O \rightarrow 5Br^- + BrO_3^- + 6HCO_3^-$$
   (a) Bromine is oxidised and carbonate is reduced.
   (b) Bromine is reduced and water is oxidised
   (c) Bromine is neither reduced nor oxidised
   (d) Bromine is both reduced and oxidised
8. What products are expected from the disproportionation reaction of hypochlorous acid?
   (a) HCl and Cl_2O (b) HCl and $HClO_3$
   (c) $HClO_3$ and Cl_2O (d) $HClO_2$ and $HClO_4$
9. In the following reaction
   $$4P + 3KOH + 3H_2O \longrightarrow 3KH_2PO_2 + PH_3$$
   (a) only phosphorus is oxidised and reduced.
   (b) only phosphorus is reduced.
   (c) phosphorus is both oxidised and reduced.
   (d) phosphorus is neither oxidised nor reduced.
10. The standard reduction potentials at 298K for the following half reactions are given against each
   $Zn^{2+}(aq) + 2e \rightleftharpoons Zn(s);\ -0.762\ V$
   $Cr^{3+}(aq) + 3e \rightleftharpoons Cr(s);\ -0.740\ V$
   $2H^+(aq) + 2e \rightleftharpoons H_2(g);\ 0.00\ V$
   $Fe^{3+}(aq) + e \rightleftharpoons Fe^{2+}(aq)$;; 0.770 V
   Which is the strongest reducing agent?
   (a) Zn (s) (b) Cr (s)
   (c) $H_2(g)$ (d) $Fe^{3+}(aq)$
11. The oxidation number of sulphur in $Na_2S_4O_6$ is
   (a) 1.5 (b) 2.5
   (c) 3 (d) 2
12. Thiosulphate reacts differently with iodine and bromine in the reactions given below:
   $$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$$
   $$S_2O_3^{2-} + Br_2 + 5H_2O \rightarrow 2SO_4^{2-} + 2Br^- + 10H^+$$
   Which of the following statements justifies the above dual behaviour of thiosulphate?
   (a) Bromine is a stronger oxidant than iodine.
   (b) Bromine is a weaker oxidant than iodine.
   (c) Thiosulphate undergoes oxidation by bromine and reduction by iodine in these reactions.
   (d) Bromine undergoes oxidation and iodine undergoes reduction in these reactions.
13. The more positive the value of $E^\ominus$, the greater is the tendency of the species to get reduced. Using the standard electrode potential of redox couples given below find out which of the following is the strongest oxidising agent.
   $E^\ominus$ **Values :** $Fe^{3+}/Fe^{2+} = +0.77$; $I_2(s)/I^- = +0.54$; $Cu^{2+}/Cu = +0.34$; $Ag^+/Ag = +0.80V$
   (a) Fe^{3+} (b) $I_2(s)$
   (c) Cu^{2+} (d) Ag^+

14. $E^{\ominus}$ Values of some redox couples are given below. On the basis of these values choose the correct option.

$E^{\ominus}$ **values :** $Br_2/Br^- = +1.90$; $Ag^+/Ag(s) = +0.80$
$Cu^{2+}/Cu(s) = +0.34$; $I_2(s)/I^- = 0.54$

(a) Cu will reduce Br^-
(b) Cu will reduce Ag
(c) Cu will reduce I^-
(d) Cu will reduce Br_2

15. Electrode potential data are given below :

$Fe^{+3}_{(aq)} + e^- \longrightarrow Fe^{+2}_{(aq)}$; $E° = +0.77\ V$

$Al^{3+}_{(aq)} + 3e^- \longrightarrow Al_{(s)}$; $E° = -1.66\ V$

$Br_{2\ (aq)} + 2e^- \longrightarrow 2Br^-_{(aq)}$; $E° = +1.08V$

Based on the data, the reducing power of Fe^{2+}, Al and Br^- will increase in the order

(a) $Br^- < Fe^{2+} < Al$
(b) $Fe^{2+} < Al < Br^-$
(c) $Al < Br^- < Fe^{2+}$
(d) $Al < Fe^{2+} < Br^-$

16. Which of the following elements does not show disproportionation tendency?

(a) Cl (b) Br
(c) F (d) I

17. For the redox reaction

$MnO_4^- + C_2O_4^{2-} + H^+ \rightarrow Mn^{2+} + CO_2 + H_2O$

the correct coefficients of the reactants for the balanced reaction are:

	MnO_4^-	$C_2O_4^{2-}$	H^+
(a)	2	5	16
(b)	16	5	2
(c)	5	16	2
(d)	2	16	5

18. $(x)\,MnO_4^- + (y)H_2O_2 \rightarrow$

$2Mn^{+2} + 5H_2O + 13/2\,O_2 + (z)e^-$

In this reaction, value of (x), (y) and (z) are

(a) 2, 5, 6 (b) 5, 2, 9
(c) 3, 5, 5 (d) 2, 6, 6

19. For decolorization of 1 mole of $KMnO_4$, the moles of H_2O_2 required is

(a) 1/2 (b) 3/2
(c) 5/2 (d) 7/2

20. In the reaction

$Cr_2O_7^{2-} + 14H^+ + 6I^- \longrightarrow 2Cr^{3+} + 7H_2O + 3I_2$

Which element is reduced

(a) I (b) O
(c) H (d) Cr

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** In the reaction $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$ sodium is oxidised.
Reason : Sodium acts as an oxidising agent in given reaction.

2. **Assertion :** $HClO_4$ is a stronger acid than $HClO_3$.
Reason : Oxidation state of Cl in $HClO_4$ is +VII and in $HClO_3$ +V.

3. **Assertion :** The reaction :

$CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g)$ is an example of decomposition reaction.

Reason : Above reaction is not a redox reaction.

4. **Assertion :** In a reaction

$Zn(s) + CuSO_4\,(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

Zn is a reductant but itself get oxidized.

Reason : In a redox reaction, oxidant is reduced by accepting electrons and reductant is oxidized by losing electrons.

5. **Assertion :** Stannous chloride is a powerful oxidising agent which oxidises mercuric chloride to mercury.
Reason : Stannous chloride gives grey precipitate with mercuric chloride, but stannic chloride does not do so.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

	Column-I		**Column-II**
(A)	Addition of electronegative element	(1)	Oxidation reaction
(B)	Removal of hydrogen	(2)	Reduction reaction
(C)	Addition of electropositive element		
(D)	Removal of oxygen		

(a) (A) – (1), (B) – (2), (C) – (2), (D) – (1)
(b) (A) – (1), (B) – (1), (C) – (2), (D) – (2)
(c) (A) – (1), (B) – (2), (C) – (1), (D) – (2)
(d) (A) – (2), (B) – (2), (C) – (1), (D) – (1)

2. Match the columns

	Column-I		**Column-II**
(A)	$2Mg + O_2 \longrightarrow 2MgO$	(1)	Removal of hydrogen
(B)	$Mg + Cl_2 \longrightarrow MgCl_2$	(2)	Removal of electropositive element
(C)	$2H_2S + O_2 \longrightarrow 2S + 2H_2O$	(3)	Addition of oxygen
(D)	$2KI + H_2O + O_3 \longrightarrow 2KOH + I_2 + O_2$	(4)	Addition of electronegative element, chlorine

(a) A – (4), B – (2), C – (1), D – (3)
(b) A – (3), B – (4), C – (1), D – (2)
(c) A – (4), B – (3), C – (2), D – (1)
(d) A – (3), B – (1), C – (4), D – (2)

3. Match Column-I (compound) with Column-II (oxidation state of underlined element) and choose the correct option.

	Column - I		**Column - II**
(A)	$\underline{Cu}O$	(1)	4
(B)	$\underline{Mn}O_2$	(2)	3
(C)	$H\underline{Au}Cl_4$	(3)	2
(D)	$\underline{Tl}_2O$	(4)	1

(a) A – (3), B – (1), C – (2), D – (4)
(b) A – (4), B – (3), C – (1), D – (2)
(c) A – (3), B – (4), C – (1), D – (2)
(d) A – (4), B – (2), C – (1), D – (3)

4. Match the columns

	Column-I		**Column-II**
(A)	$V_2O_5(s) + 5\,Ca(s) \rightarrow 2V(s) + 5\,CaO(s)$	(1)	Disproportionation reaction
(B)	$CH_4(g) + 2O_2(g) \xrightarrow{\Delta} CO_2(g) + 2\,H_2O(l)$	(2)	Decomposition reaction
(C)	$P_4(s) + 3OH^-(aq) + 3H_2O(l) \rightarrow PH_3(g) + 3H_2PO_2^-(aq)$	(3)	Combination reaction
(D)	$2\,KClO_3(s) \xrightarrow{\Delta} 2KCl(s) + 3O_2(g)$	(4)	Displacement reaction

(a) A – (4), B – (2), C – (3), D – (1)
(b) A – (4), B – (3), C – (1), D – (2)
(c) A – (3), B – (4), C – (2), D – (1)
(d) A – (3), B – (4), C – (1), D – (2)

Critical Thinking Type Questions :

1. Among NH_3, HNO_3, NaN_3 and Mg_3N_2 the number of molecules having nitrogen in negative oxidation state is
(a) 1 (b) 2
(c) 3 (d) 4

2. Oxidation numbers of P in PO_4^{3-}, of S in SO_4^{2-} and that of Cr in $Cr_2O_7^{2-}$ are respectively
(a) $+3, +6$ and $+5$ (b) $+5, +3$ and $+6$
(c) $-3, +6$ and $+6$ (d) $+5, +6$ and $+6$

3. When Cl_2 gas reacts with hot and concentrated sodium hydroxide solution, the oxidation number of chlorine changes from
(a) zero to +1 and zero to –5
(b) zero to –1 and zero to +5
(c) zero to –1 and zero to +3
(d) zero to +1 and zero to –3

4. Which of the following arrangements represent increasing oxidation number of the central atom?
(a) $CrO_2^-, ClO_3^-, CrO_4^{2-}, MnO_4^-$
(b) $ClO_3^-, CrO_4^{2-}, MnO_4^-, CrO_2^-$
(c) $CrO_2^-, ClO_3^-, MnO_4^-, CrO_4^{2-}$
(d) $CrO_4^{2-}, MnO_4^-, CrO_2^-, ClO_3^-$

5. In the reaction shown below, oxidation state of the carbon in reactant and product are (*i*) and (*ii*) respectively? Is the given reaction a redox reaction?

$$Na_2CO_3(aq) + HCl\,(aq) \longrightarrow Na^{\oplus}(aq) + Cl^-(aq) + H_2O(\ell) + CO_2(g)$$

(a) (i) 6, (ii) 4, yes (b) (i) 6, (ii) 6, No
(c) (i) 4, (ii) 4, No (d) (i) 4, (ii) 4, yes

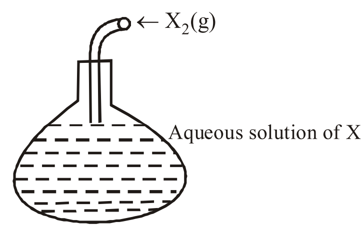
6. In the disproportionation reaction
$3\ HClO_3 \rightarrow HClO_4 + Cl_2 + 2O_2 + H_2O$, the equivalent mass of the oxidizing agent is (molar mass of $HClO_3 = 84.45$)
(a) 16.89 (b) 32.22
(c) 84.45 (d) 28.15

7. In the balanced chemical reaction

$$IO_3^- + aI^- + bH^+ \longrightarrow cH_2O + dI_2$$

a, b, c and d respectively corresponds to
(a) 5, 6, 3, 3 (b) 5, 3, 6, 3
(c) 3, 5, 3, 6 (d) 5, 6, 5, 5

8. What could be the X^- in the system, Where X signifies halogen ; formation of shown below X_2 takes place, when F_2 is purge into aqueous solution of X^-?



(a) Br^- (b) Cl^-
(c) I^- (d) All of these

9

Hydrogen

Fill in the Blanks :

1. _______ is not an isotope of hydrogen .
2. Number of neutrons in three isotopes of hydrogen, protium, deuterium and tritium respectively is _______ , _______ .
3. The property of hydrogen which distinguishes it from alkali metals is its _______ .
4. _______ and _______ are formed when zinc reacts with sodium hydroxide.
5. _______ is evolved by the action of cold dil. HNO_3 on Mn
6. Hydrogen is not obtained when zinc reacts with _______ .
7. In gas phase water is _______ molecule with a bond angle of _______ and O–H bond length of _______ .
8. _______ reacts with H_2O at room temperature.
9. _______ of water is due to the presence of chlorides and sulphates of calcium and magnesium
10. HCl on addition with MnO_2 give _______ .
11. The volume strength of 1.5 N H_2O_2 solution is _______ .
12. The decomposition of H_2O_2 is accelerated by _______ .

True/ False :

1. The H–H bond dissociation enthalpy is highest for a single bond between two atoms of any element
2. Hydrogen combines with almost all the elements due to its incomplete orbital
3. The atomic hydrogen is produced at high temperature in an electric arc or under UV radiations.
4. Dihydrogen reduces copper (II) oxide to copper
5. Hydroformylation of olefins yields aldehydes which further undergo reduction to give alcohols.
6. Hydrogenation of vegetable oils using iron as catalyst gives edible fats.
7. At atmospheric pressure ice crystallises in the hexagonal form, but at very low temperatures it condenses to cubic form.
8. Density of ice is less than that of water. Therefore, an ice cube floats on water.
9. In winter season ice formed on the surface of a lake makes survival of the aquatic life difficult.
10. Hydrogen bonding gives ice a open type structure with wide holes.
11. Hydrogen peroxide is industrially prepared by the auto-oxidation of 2-alkylanthraquinols
12. One millilitre of 30% H_2O_2 means that solution will give 100 V of oxygen at STP
13. Dihedral angle of H_2O_2 in gas phase is 90.2° and in solid phase dihedral angle is 111.5°
14. Heavy water is more associated than ordinary water.

Conceptual MCQs

1. Hydrogen resembles halogens in many respects for which several factors are responsible. Of the following factors which one is most important in this respect?
   (a) Its tendency to lose an electron to form a cation.
   (b) Its tendency to gain a single electron in its valence shell to attain stable electronic configuration.

(c) Its low negative electron gain enthalpy value.
(d) Its small size.

2. Some statements about heavy water are given below:
(A) Heavy water is used as a moderator in nuclear reactors.
(B) Heavy water is more associated than ordinary water.
(C) Heavy water is more effective solvent than ordinary water.
Which of the above statements are correct?
(a) (A) and (C) (b) (A) and (B)
(c) (A), (B) and (C) (d) (B) and (C)

3. Which of the following reactions increases production of dihydrogen from synthesis gas?

(a) $CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270K} CO(g) + 3H_2(g)$

(b) $C(s) + H_2O(g) \xrightarrow{1270K} CO(g) + H_2(g)$

(c) $CO(g) + H_2O(g) \xrightarrow[Catalyst]{673K} CO_2(g) + H_2(g)$

(d) $C_2H_6 + 2H_2O \xrightarrow[Ni]{1270K} 2CO + 5H_2$

4. Which of the following reactions is an example of use of water gas in the synthesis of other compounds?

(a) $CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270K} CO(g) + H_2(g)$

(b) $CO(g) + H_2O(g) \xrightarrow[Catalyst]{673K} CO_2(g) + H_2(g)$

(c) $C_nH_{2n+2} + nH_2O(g) \xrightarrow[Ni]{1270K} nCO + (2n+1)H_2$

(d) $CO(g) + 2H_2(g) \xrightarrow[Catalyst]{Cobalt} CH_3OH(l)$

5. Consider the following statements :
1. Atomic hydrogen is obtained by passing hydrogen through an electric arc.
2. Hydrogen gas will not reduce heated aluminium oxide.
3. Finely divided palladium absorbs large volume of hydrogen gas.
4. Pure nascent hydrogen is best obtained by reacting Na with C_2H_5OH.

Which of the above statements is/are correct ?
(a) 1 alone (b) 2 alone
(c) 1, 2 and 3 (d) 2, 3 and 4

6. Which of the following statements is correct ?
(a) Hydrogen has same IP as alkali metals
(b) Hydrogen has same electronegativity as halogens
(c) It has oxidation number of –1 and +1
(d) It will not be liberated at anode.

7. Which of the following can produce hydrogen from water ?
(a) Heated stannic oxide
(b) Heated iron
(c) Heated aluminium oxide
(d) Heated copper oxide

8. Elements of which of the following group(s) of periodic table do not form hydrides.
(a) Groups 7, 8, 9 (b) Group 13
(c) Groups 15, 16, 17 (d) Group 14

9. Calculate the normality of 10 volume H_2O_2 ?
(a) 1.7 N (b) 12 N
(c) 30.3 N (d) 0.0303 N

10. Water contracts on heating
(a) to 100 °C (b) from 0°C to 4°C
(c) to 273 K (d) from 10°C to 20°C

11. The m.p. of most of the solid substances increase with an increase of pressure . However ice melts at a temperature lower than its usual melting point when pressure is increased . This is because
(a) ice is less denser than H_2O
(b) pressure generates heat
(c) the chemical bonds break under pressure
(d) ice is not a true solid

12. Match list I with list II and select the correct answer using the codes given below the lists :

	List I		List II
1.	Heavy water	A.	Bicarbonates of Mg and Ca in water
2.	Temporary hard water	B.	No foreign ions in water
3.	Soft water	C.	D_2O
4.	Permanent hard water	D.	Sulphates & chlorides of Mg & Ca in water

Codes
(a) 1–C, 2–D, 3–B, 4–A
(b) 1–B, 2–A, 3–C, 4–D
(c) 1–B, 2–D, 3–C, 4–A
(d) 1–C, 2–A, 3–B, 4–D

13. H_2 will not reduce which of following oxide ?
(a) Aluminium oxide
(b) Calcium oxide
(c) Ferrous oxide
(d) None of the above

14. Consider the reactions
(A) $H_2O_2 + 2HI \rightarrow I_2 + 2H_2O$
(B) $HOCl + H_2O_2 \rightarrow H_3O^+ + Cl^- + O_2$
Which of the following statements is correct about H_2O_2 with reference to these reactions? Hydrogen peroxide is ______ .
(a) an oxidising agent in both (A) and (B)
(b) an oxidising agent in (A) and reducing agent in (B)
(c) a reducing agent in (A) and oxidising agent in (B)
(d) a reducing agent in both (A) and (B)

15. Heavy water is
(a) $CaSO_4$
(b) water contains $CaSO_4$, $MgSO_4$
(c) D_2O
(d) water contain $CaCO_3$

16. Which of the following equations depict the oxidising nature of H_2O_2?
(a) $2MnO_4^- + 6H^+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$
(b) $2Fe^{3+} + 2H^+ + H_2O_2 \rightarrow 2Fe^{2+} + 2H_2O + O_2$
(c) $2I^- + 2H^+ + H_2O_2 \rightarrow I_2 + 2H_2O$
(d) $KIO_4 + H_2O_2 \rightarrow KIO_3 + H_2O + O_2$

17. Which of the following equation depicts reducing nature of H_2O_2?
(a) $2[Fe(CN)_6]^{4-} + 2H^+ + H_2O_2 \rightarrow 2[Fe(CN)_6]^{3-} + 2\,H_2O$
(b) $I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$
(c) $Mn^{2+} + H_2O_2 \rightarrow Mn^{4+} + 2OH^-$
(d) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

18. Decomposition of H_2O_2 is retarded by :
(a) H_3PO_4 (b) Alcohol
(c) Acetanilide (d) All

19. D_2O is used in
(a) industry (b) nuclear reactor
(c) medicine (d) insecticide

20. Why does H^+ ion always get associated with other atoms or molecules?
(a) Ionisation enthalpy of hydrogen resembles that of alkali metals.
(b) Its reactivity is similar to halogens.
(c) It resembles both alkali metals and halogens.
(d) Loss of an electron from hydrogen atom results in a nucleus of very small size as compared to other atoms or ions. Due to small size it cannot exist free.

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*
(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** H^+ does not exist freely and is always associated with other atoms or molecules.
Reason : Loss of the electron from hydrogen atom
results in nucleus (H^+) of ~ 1.5×10^{-3} pm size. This is extremely small as compared to normal atomic and ionic sizes of 50 to 200 pm.

2. **Assertion :** Hydrogen combines with other elements by losing, gaining or sharing of electrons.
Reason : Hydrogen forms electrovalent and covalent bonds with other elements.

3. **Assertion :** Temporary hardness can be removed by boiling.
Reason : On boiling the soluble bicarbonates change to carbonates which being insoluble, get precipitated.

4. **Assertion :** Calgon is used for removing permanent hardness of water.
Reason : Calgon forms precipitates with Ca^{2+} and Mg^{2+}.

5. **Assertion :** Hard water is not suitable for laundary.
Reason : Soap containing sodium stearate reacts with hard water to precipitate out as calcium or magnesium stearate.

6. **Assertion :** Decomposition of H_2O_2 is a disproportionation reaction.
Reason : H_2O_2 molecule simultaneously undergoes oxidation and reduction.

7. **Assertion :** H_2O_2 is not stored in glass bottles.
Reason : Alkali oxides present in glass catalyse the decomposition of H_2O_2

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I	**Column-II**
(A) Ionic hydrides	(1) $NiH_{0.6\text{-}0.7}$
(B) Molecular hydrides	(2) LiH
(C) Metallic hydrides	(3) HF

(a) A – (2), B – (3), C – (1)
(b) A – (3), B – (2), C – (1)
(c) A – (2), B – (1), C – (3)
(d) A – (3), B – (1), C – (2)

2. Match the columns

Column - I (Chemical property of water)	**Column - II (Chemical equation)**
(A) Basic nature	(1) $2H_2O(l) + 2Na(s) \longrightarrow 2NaOH(aq) + H_2(g)$
(B) Auto-protolysis	(2) $H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$
(C) Oxidising nature	(3) $2F_2(g) + 2H_2O(l) \longrightarrow 4H^+(aq) + 4F^-(aq) + O_2(g)$
(D) Reducing nature	(4) $H_2O(l) + H_2S(aq) \rightleftharpoons H_3O^+(aq) + HS^-(aq)$

(a) A – (4), B – (2), C – (3), D – (1)
(b) A – (4), B – (2), C – (1), D – (3)
(c) A – (3), B – (2), C – (4), D – (1)S
(d) A – (1), B – (2), C – (4), D – (3)

3. Match the columns

Column-I	**Column-II**
(A) Clark's method	(1) $Mg(HCO_3)_2 + 2Ca(OH)_2 \rightarrow 2CaCO_3\downarrow + Mg(OH)_2\downarrow + 2H_2O$
(B) Calgon's method	(2) $2NaZ(s) + M^{2+}(aq) \rightarrow MZ_2(s) + 2Na^+(aq)$
(C) Boiling	(3) $Ca(HCO_3)_2 \rightarrow CaCO_3\downarrow + H_2O + CO_2\uparrow$
(D) Ion exchange method	(4) $M^{2+} + Na_4P_6O_{18}^{2-} \rightarrow [Na_2MP_6O_{18}]^{2-} + 2Na^+$

(a) A – (4), B – (2), C – (3), D – (1)
(b) A – (2), B – (1), C – (3), D – (4)
(c) A – (1), B – (4), C – (3), D – (2)
(d) A – (3), B – (2), C – (1), D – (4)

4. Match the columns

Column-I	**Column-II**
(A) Coordinated water	(1) $[Cu(H_2O)_4]^{4+}SO_4^{2-}.H_2O$
(B) Interstitial water	(2) $C_{17}H_{35}COONa$
(C) Hydrogen-bonded water	(3) $BaCl_2.2H_2O$
	(4) $[Cr(H_2O)_6]^{3+}3Cl^-$

(a) A – (3), B – (4), C – (2)
(b) A – (2), B – (3), C – (4)
(c) A – (3), B – (2), C – (1)
(d) A – (4), B – (3), C – (1)

5. Match the columns

Column-I	**Column-II**
(A) Heavy water	(1) Bicarbonates of Mg and Ca in water
(B) Temporary hard water	(2) No foreign ions in water

(C) Soft water (3) D_2O
(D) Permanent hard water (4) Sulphates & chlorides of Mg & Ca in water

(a) A – (3), B – (4), C – (2), D – (1)
(b) A – (2), B – (3), C – (4), D – (4)
(c) A – (2), B – (4), C – (3), D – (1)
(d) A – (3), B – (1), C – (2), D – (4)

6. Match the Column-I with Column-II and mark the appropriate choice.

Column-I	Column-II
(A) Syngas	(1) $Na_6P_6O_{18}$
(B) Calgon	(2) $NaAlSiO_4$
(C) Permutit	(3) $CO + H_2$
(D) Producer gas	(4) $CO + N_2$

(a) (A) – (1), (B) – (2), (C) – (3), (D) – (4)
(b) (A) – (3), (B) – (1), (C) – (2), (D) – (4)
(c) (A) – (3), (B) – (2), (C) – (4), (D) – (1)
(d) (A) – (3), (B) – (2), (C) – (1), (D) – (4)

Critical Thinking Type Questions :

1. Which of the following terms is not correct for hydrogen ?
(a) Its molecule is diatomic
(b) It exists both as H^+ and H^- in different chemical compounds
(c) It is the only species which has no neutrons in the nucleus
(d) Heavy water is unstable because hydrogen is substituted by its isotope deuterium

2. The hydride ion, H^-, is a stronger base than the hydroxide ion, OH^-. Which one of the following reactions will occur if sodium hydride (NaH) is dissolved in water?
(a) $H^-(aq) + H_2O(l) \rightarrow H_3O^-(aq)$
(b) $H^-(aq) + H_2O(l) \rightarrow OH^-(aq) + H_2(g)$
(c) $H^-(aq) + H_2O(l) \rightarrow OH^-(aq) + 2H^+(aq) + 2e$
(d) $H^-(aq) + H_2O(l) \rightarrow$ No reaction

3. Which of the following is not true?
(a) D_2O freezes at lower temperature than H_2O
(b) Reaction between H_2 and Cl_2 is much faster than D_2 and Cl_2
(c) Ordinary water gets electrolysed more rapidly than D_2O
(d) Bond dissociation energy of D_2 is greater than H_2

4. Heavy water reacts respectively with CO_2, SO_3, P_2O_5 and N_2O_5 to give the compounds :
(a) $D_2CO_3, D_2SO_4, D_3PO_2, DNO_2$
(b) $D_2CO_3, D_2SO_4, D_3PO_4, DNO_2$
(c) $D_2CO_3, D_2SO_3, D_3PO_4, DNO_2$
(d) $D_2CO_3, D_2SO_4, D_3PO_4, DNO_3$

5. Identify x and y in following reaction:

$$2HSO_4^-(aq) \xrightarrow{\text{electrolysis}} x \xrightarrow{\text{hydrolysis}} y + 2H^+(aq) + H_2O_2(aq)$$

(a) $x = H_2SO_4$ (aq), $y = 2HSO_4^-(aq)$
(b) $x = HO_3SOOSO_3H(aq)$, $y = 2HSO_4^-(aq)$
(c) $x = HO_3SOOSO_3H$ (aq), $y = H_2SO_4(aq)$
(d) $x = H_2SO_4(aq)$, $y = HO_3SOOSO_3H(aq)$

6. Following are some properties of hydrogen which of the following properties resemble with alkali metals and which with halogens
(i) Hydrogen lose one electron to form unipositive ions
(ii) Hydrogen gain one electron to form uninegative ions
(iii) Hydrogen forms oxides, halides and sulphides
(iv) Hydrogen has a very high ionization enthalpy
(v) Hydrogen forms a diatomic molecule, combines with elements to form hydrides and covalent compounds.

(a) Alkali metals resemble (i), (iii) and (iv)
Halogens resemble (ii) and (v)
(b) Alkali metals resemble (i) and (iii)
Halogens resemble (ii), (iii) and (v)
(c) Alkali metals resemble (i) and (iii)
Halogens resemble (ii), (iv) and (v)
(d) Alkali metals resemble (i) only
Halogens resemble (iv) and (v)\

10 THE S-BLOCK ELEMENTS

Fill in the Blanks :

1. Anhydrous $MgCl_2$ is obtained by heating hydrated salt with _______ .
2. Sodium dissolved in liquid ammonia conducts electricity because _______ .
3. Ca^{2+} has a smaller ionic radius than K^+ because it has _______ .
4. The element which on burning in air gives peroxide is _______ .
5. The metal that produces red-violet colour in the non-luminous flame is _______ .
6. The alkali metals dissolve in liquid ammonia giving deep blue solution. The solution is _______. In concentrated solution, the blue colour changes to _______ and becomes _______ .
7. On heating anhydrous Na_2CO_3, _______ is evolved.
8. Among LiI, NaI, KI, the one which is more ionic and more soluble in water is _______ .
9. The most electropositive amongst the alkaline earth metals is _______ .
10. Alkaline earth metals are not found free in nature because of their _______ .

True/ False :

1. $MgCl_2.6H_2O$ on heating give anhydrous $MgCl_2$.
2. The softness of group I-A metals increases down the group with increasing atomic number.
3. Sodium when burnt in excess of oxygen gives sodium oxide.
4. Cs^+ is more highly hydrated than the other alkali metal ions
5. Among the alkali metals only lithium forms a stable nitride by direct combination with nitrogen
6. Alkali metal hydrides are ionic solids with high melting point.
7. Li is the least powerful reducing agent and Na is the most powerful reducing agent.
8. The alkali metal hydroxides are the strongest of all bases.
9. The stability of the carbonates and hydrogen carbonates of alkali metals decrease with increase in electropositive character down the group.
10. Only $LiHCO_3$ exist as solid.
11. Second ionisation enthalpies of the alkaline earth metals are smaller than those of the corresponding alkali metals.
12. Compounds of alkaline earth metals are more extensively hydrated than those of alkali metals
13. Metallic beryllium is used for making window X-ray tubes.
14. Barium is used in treatment of cancer.
15. The hydrated chlorides, bromides and iodies of Ca, Sr and Ba on heating undergoes hydrolysis while corresponding hydrated halides of Be and Mg on heating undergo dehydration.
16. Nitrates of alkaline earth metals decompose on heating as below

$$2M(NO_3)_2 \rightarrow 2MO + 4NO_2 + O_2$$

Conceptual MCQs

1. The alkali metals have low melting point. Which of the following alkali metal is expected to melt if the room temperature rises to 30°C?

(a) Na (b) K
(c) Rb (d) Cs

2. Lithium is strongest reducing agent among alkali metals due to which of the following factor?
(a) Ionization energy
(b) Electron affinity
(c) Hydration energy
(d) Lattice energy

3. The solubility of metal halides depends on their nature, lattice enthalpy and hydration enthalpy of the individual ions. Amongst fluorides of alkali metals, the lowest solubility of LiF in water is due to
(a) Ionic nature of lithium fluoride
(b) High lattice enthalpy
(c) High hydration enthalpy for lithium ion.
(d) Low ionisation enthalpy of lithium atom

4. Match List – I with List –II for the compositions of substances and select the correct answer using the code given below the lists :

List - I Substances		**List - II** Composition	
(A)	Plaster of paris	(i)	$CaSO_4.2H_2O$
(B)	Epsomite	(ii)	$CaSO_4.\frac{1}{2}H_2O$
(C)	Kieserite	(iii)	$MgSO_4.7H_2O$
(D)	Gypsum	(iv)	$MgSO_4.H_2O$
		(v)	$CaSO_4$

Code :

	(A)	(B)	(C)	(D)
(a)	(iii)	(iv)	(i)	(ii)
(b)	(ii)	(iii)	(iv)	(i)
(c)	(i)	(ii)	(iii)	(v)
(d)	(iv)	(iii)	(ii)	(i)

5. Which statement is false for alkali metals
(a) Lithium is the strongest reducing agent
(b) Sodium is amphoteric in nature
(c) Li^+ is exceptionally small
(d) All alkali metals give blue solution in liquid ammonia

6. In the replacement reaction

$$\gt CI + MF \longrightarrow \gt CF + MI$$

The reaction will be most favourable if M happens to be :
(a) Na (b) K
(c) Rb (d) Li

7. On heating sodium metal in a current of dry ammonia gas the compound formed is
(a) Sodium nitrate (b) Sodium hydride
(c) Sodium amide (d) Sodium azide

8. In the synthesis of sodium carbonate, the recovery of ammonia is done by treating NH_4Cl with $Ca(OH)_2$. The by-product obtained in this process is
(a) $CaCl_2$ (b) NaCl
(c) NaOH (d) $NaHCO_3$

9. The formula of soda ash is
(a) $Na_2CO_3, 10H_2O$ (b) $Na_2CO_3, 2H_2O$
(c) $Na_2CO_3. H_2O$ (d) Na_2CO_3

10. Sodium cannot be extracted by the electrolysis of brine solution because :
(a) Electrolysis cannot take place with brine solution.
(b) Sodium reacts with water to produce NaOH + H_2
(c) Sodium being more electropositive than hydrogen, H_2 is liberated at cathode not sodium.
(d) None.

11. The first ionization energies of alkaline earth metals are higher than those of the alkali metals. This is because
(a) There is an increase in the nuclear charge of the alkaline earth metals
(b) There is a decrease in the nuclear charge of the alkaline earth metals
(c) There is no change in the nuclear charge
(d) None of the above

12. The order of solubility of lithium halides in non polar solvents follows the order:
(a) LiI > LiBr > LiCl > LiF
(b) LiF > LiI > LiBr > LiCl
(c) LiCl > LiF > LiI > LiBr
(d) LiBr > LiCl > LiF > LiI

13. Some of the Group 2 metal halides are covalent and soluble in organic solvents. Among the following metal halides, the one which is soluble in ethanol is

(a) $BeCl_2$ (b) $MgCl_2$
(c) $CaCl_2$ (d) $SrCl_2$

14. Which of the following has correct increasing basic strength?
(a) $MgO < BeO < CaO < BaO$
(b) $BeO < MgO < CaO < BaO$
(c) $BaO < CaO < MgO < BeO$
(d) $CaO < BaO < BeO < MgO$

15. Chemical A is used for water softening to remove temporary hardness. A reacts with Na_2CO_3 to generate caustic soda. When CO_2 is bubbled through A, it turns cloudy. What is the chemical formula of A
(a) $CaCO_3$ (b) CaO
(c) $Ca(OH)_2$ (d) $Ca(HCO_3)_2$

16. The following compounds have been arranged in order of their increasing thermal stabilities. Identify the correct order.
K_2CO_3 (I) $MgCO_3$ (II)
$CaCO_3$ (III) $BeCO_3$ (IV)
(a) I < II < III < IV (b) IV < II < III < I
(c) IV < II < I < III (d) II < IV < III < I

17. Dehydration of hydrates of halides of calcium, barium and strontium i.e., $CaCl_2.6H_2O$, $BaCl_2.\ 2H_2O$, $SrCl_2\ .\ 2H_2O$, can be achieved by heating. These become wet on keeping in air. Which of the following statements is correct about these halides?
(a) act as dehydrating agent
(b) can absorb moisture from air
(c) Tendency to form hydrate decreases from calcium to barium
(d) All of the above

18. Which of the following statements is true about $Ca(OH)_2$?
(a) It is used in the preparation of bleaching powder
(b) It is a light blue solid
(c) It does not possess disinfectant property.
(d) It is used in the manufacture of cement.

19. The best explanation for not placing hydrogen with the group of alkali metals or halogens is.
(a) Hydrogen can form compounds with all other elements
(b) Hydrogen is much lighter element than the alkali metals or the halogens
(c) The IE of hydrogen is too high for group of alkali metals but too low for halogen group
(d) None of these

20. Dead burnt plaster is
(a) $CaSO_4$ (b) $CaSO_4.\ \frac{1}{2}H_2O$
(c) $CaSO_4.\ H_2O$ (d) $CaSO_4.\ 2H_2O$

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*
(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion:** Lithium salts are mostly hydrated.
Reason : The hydration enthalpy of alkali metal ions decreases with increase in ionic sizes.

2. **Assertion :** Lithium carbonate is not so stable to heat.
Reason : Lithium being very small in size polarizes large CO_3^{2-} ion leading to the formation of more stable Li_2O and CO_2

3. **Assertion :** Compounds of beryllium is largely covalent and get hydrolysed easily.
Reason : This is due to high value of ionisation potential and small size of Be.

4. **Assertion :** Radium is most abundant *s*-block element.

Reason : *s*-block elements are non-radioactive in nature.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I (Alkali metal)	**Column-II (Colour imparted to an oxidizing flame)**
(A) Cs	(1) Yellow
(B) Rb	(2) Blue
(C) K	(3) Violet
(D) Na	(4) Red violet
(E) Li	(5) Crimson red

(a) A – (2), B – (4), C – (3), D – (1), E – (5)
(b) A – (4), B – (2), C – (3), D – (1), E – (5)
(c) A – (5), B – (3), C – (4), D – (1), E – (2)
(d) A – (2), B – (1), C – (3), D – (1), E – (5)

2. Match the columns

Column-I (Metal)	**Column-II (Oxide formed on burning)**
(A) Caesium	(1) Superoxide
(B) Lithium	(2) Peroxide
(C) Sodium	(3) Monoxide

(a) A – (2), B – (1), C – (3)
(b) A – (3), B – (2), C – (1)
(c) A – (1), B – (3), C – (2)
(d) A – (2), B – (3), C – (1)

3. Match the columns. Here Column-I shows the names of the metals used with lithium to make useful alloys and Column-II shows the uses of these alloys

Column-I	**Column-II**
(A) Aluminium	(1) Armour plates
(B) Magnesium	(2) Aircraft parts
(C) Lead	(3) Bearings for motor engines.

(a) A – (2), B – (1), C – (3)
(b) A – (2), B – (3), C – (1)
(c) A – (1), B – (2), C – (3)
(d) A – (1), B – (3), C – (2)

4. Match the columns.

Column-I (Sodium compound)	**Column-II (Uses)**
(A) Sodium carbonate	(1) In fire extinguisher
(B) Sodium chloride	(2) In manufacture of glass, soap, borax and caustic soda.
(C) Sodium hydroxide	(3) In preparation of Na_2O_2, NaOH and Na_2CO_3
(D) Sodium hydrogen	(4) In petroleum refining carbonate

(a) A – (2), B – (3), C – (4), D – (1)
(b) A – (4), B – (2), C – (3), D – (1)
(c) A – (1), B – (4), C – (3), D – (2)
(d) A – (4), B – (3), C – (1), D – (2)

5. Match the columns

Column-I	**Column-II**
(A) Quick lime	(1) $Ca(OH)_2$

(B) Slaked lime (2) CaO
(C) Bleaching powder (3) $Ca(OCl)_2$
(D) Plaster of Paris (4) $CaSO_4 . H_2O$
(a) A – (1), B – (2), C – (3), D – (4)
(b) A – (4), B – (3), C – (2), D – (1)
(c) A – (2), B – (1), C – (3), D – (4)
(d) A – (2), B – (1), C – (4), D – (3)

6. Match the columns

(A) Quick lime	(1) Setting fractured bones
(B) Plaster of Paris	(2) A constituent of chewing gum
(C) Slaked lime	(3) Manufacture of bleaching powder
(D) Limestone	(4) Manufacture of dyestuffs

(a) A – (1), B – (4), C – (2), D – (3)
(b) A – (4), B – (1), C – (3), D – (2)
(c) A – (2), B – (3), C – (1), D – (4)
(d) A – (3), B – (2), C – (4), D – (1)

Critical Thinking Type Questions :

1. The melting point of lithium (181°C) is just double the melting point of sodium (98°C) because
(a) down the group, the hydration energy decreases
(b) down the group, the ionization energy decreases
(c) down the group the cohesive energy decreases
(d) None of these

2. Which of the following statements is incorrect?
(a) Alkali metal hydroxide are hygroscopic
(b) Dissolution of alkali metal hydroxide is endothermic
(c) Aqueous solution of alkali metal hydroxides are strongly basic
(d) Alkali metal hydroxides form ionic crystals

3. Suppose an element is kept in air chamber, than air content was evaluated after sometime , oxygen and nitrogen content was found to be low comparitively. The given element will be
(a) Li (b) Rb
(c) Na (d) K

4. Suppose metal react with the oxygen to form oxide, than aqueous solution of this oxide when added to a solution of HI, solution turn yellowish brown in colour. This compound is
(a) Na_2O (b) Li_2O
(c) NaOH (d) Na_2O_2

5. Li has the maximum value of ionisation potential among alkali metals i.e. lithium has the minimum tendency to ionise to give LI^+ ion. Thus, in aq. solution lithium is
(a) strongest reducing agent
(b) poorest reducing agent
(c) strongest oxidising agent
(d) poorest oxidising agent

6. The raw materials in Solvay Process are
(a) $Na_2CO_3, CaCO_3$ and NH_3
(b) $Na_2SO_4, CaCO_3$ and NH_3
(c) NaCl, NH_3 and $CaCO_3$.
(d) NaOH, CaO and NH_3 .

7. Arrange the following in increasing order of their solubility?
$MgCO_3$(A), $CaCO_3$(B), $SrCO_3$(C), Na_2CO_3(D)
(a) $A < B < C < D$ (b) $A < C < B < D$
(c) $C < A < B < D$ (d) $C < B < A < D$

8. Compared with the alkaline earth metals, the alkali metals exhibit
(a) smaller ionic radii
(b) highest boiling points
(c) greater hardness
(d) lower ionization energies.

9. Aqueous solution of group 2 is precipitated by adding Na_2CO_3, then this precipitate is tested on flame, no light in visible region is observed , this element can be
(a) Ba (b) Mg
(c) Ca (d) Sr

10. Which of the following statement is false ?
(a) Strontium decomposes water readily than beryllium
(b) Barium carbonate melts at a higher temperature than calcium carbonate

11 The P-Block Elements (Group 13 and 14)

Fill in the Blanks :

1. Hydrogen gas is liberated by the action of aluminium with concentrated solution of _______ .
2. The hydrolysis of alkyl substituted chlorosilanes gives _______ .
3. The lead chamber process involves oxidation of SO_2 by atomic oxygen under the influence of _______ as catalyst.
4. The hydrolysis of trialkylchlorosilane R_3SiCl, yields _______ .
5. One recently discovered allotrope of carbon (e.g., C_{60}) is commonly known as _______ .
6. Compounds that formally contain Pb^{4+} are easily reduced to Pb^{2+}. The stability of the lower oxidation state is due to _______ .
7. The non-metal oxides are _______ whereas metal oxides are _______ in nature.
8. The element which shows least metallic character is _______ .
9. H_3BO_3 on heating up to _______ yields metaboric acid.
10. The bonds present in borazole or inorganic benzene are _______ and 3π.
11. _______ does not react with aqueous NaOH.
12. _______ helps to maintain pH of blood between 7.26 to 7.42

True/ False :

1. When PbO_2 reacts with a dilute acid, it gives hydrogen peroxide.
2. Diamond is harder than graphite.
3. The tendency for catenation is much higher for C than for Si.
4. For heavier elements in each group oxidation state two unit less than the group oxidation state becomes more stable due to inert pair effect
5. Aluminium forms $[AlF_6]^{3-}$ ion while boron forms only $[BF_4]^-$ ion due to presence of *d*-orbitals in aluminium.
6. The first member of a group differs from the heavier members in its ability to form $p\pi$-$p\pi$ multiple bonds to itself and to other second row elements. While heavier member forms $d\pi$-$p\pi$ bonds.
7. Trichlorides on hydrolysis in water form tetrahedral $[M(OH)_4]^-$ species.
8. Aluminium chloride in acidified aqueous solution forms $[Al(OH)_4]^-$ ion.
9. Boranes undergoes cleavage reactions with Lewis bases to give borane adducts.
10. The tendency to show +2 oxidation state increase in the sequence Ge < Sn < Pb.
11. Lead compounds in +2 state are strong oxidising agents.
12. In laboratory CO_2 is prepared by the action of dilute HCl on calcium carbonate
13. Increase in carbon dioxide content in atmosphere lead to increase in green house effect.
14. CO_2 as dry ice is used as a refrigerant for ice cream and frozen food.
15. Silica does not react with halogens, dihydrogen and most of the acids and metals even at elevated temperature.

Conceptual MCQs

1. The element which exists in liquid state for a wide range of temperature and can be used for measuring high temperature is
(a) B (b) Al
(c) Ga (d) In

2. Syngas is a mixture of
(a) $CO_2 + H_2$ (b) $CO + H_2$
(c) $CO + CO_2$ (d) $CO + N_2$
(e) $CO + O_2$

3. Identify the statement that is not correct as far as structure of diborane is concerned
(a) There are two bridging hydrogen atoms and four terminal hydrogen atoms in diborane
(b) Each boron atom forms four bonds in diborane
(c) The hydrogen atoms are not in the same plane in diborane
(d) All, B – H bonds in diborane are similar

4. Aluminium vessels should not be washed with materials containing washing soda because
(a) washing soda is expensive
(b) washing soda is easily decomposed
(c) washing soda reacts with aluminium to form soluble aluminate
(d) washing soda reacts with aluminium to form insoluble aluminium oxide

5. Which is false in case of boric acid (H_3BO_3)?
(a) It acts as a tribasic acid.
(b) It has a planar structure.
(c) It acts as a monobasic acid.
(d) It is soluble in hot water.

6. Aluminium chloride is a/an
(a) Bronsted - Lowery acid
(b) Arhenius acid
(c) Lewis acid
(d) Lewis base

7. Aluminium is extracted from alumina (Al_2O_3) by electrolysis of a molten mixture of :
(a) $Al_2O_3 + HF + NaAlF_4$
(b) $Al_2O_3 + CaF_2 + NaAlF_4$
(c) $Al_2O_3 + Na_3AlF_6 + CaF_2$
(d) $Al_2O_3 + KF + Na_3AlF_6$

8. $AlCl_3$ on hydrolysis gives
(a) $Al_2O_3.\ H_2O$ (b) $Al(OH)_3$
(c) Al_2O_3 (d) $AlCl_3.6H_2O$

9. The basic structural unit of silicates is :
(a) SiO_4^{4-} (b) SiO_3^{2-}
(c) SiO_4^{2-} (d) SiO

10. Ionisation enthalpy ($\Delta_i H_1$ kJ mol^{-1}) for the elements of Group 13 follows the order.
(a) $B > Al > Ga > In > Tl$
(b) $B < Al < Ga < In < Tl$
(c) $B < Al > Ga < In > Tl$
(d) $B > Al < Ga > In < Tl$

11. Which of the following is most stable?
(a) Sn^{2+} (b) Ge^{2+}
(c) Si^{2+} (d) Pb^{2+}

12. Cement, the important building material is a mixture of oxides of several elements. Besides calcium, iron and sulphur, oxides of elements of which of the group (s) are present in the mixture?
(a) Group 2
(b) Groups 2, 13 and 14
(c) Groups 2 and 13
(d) Groups 2 and 14

13. The most commonly used reducing agent is
(a) $AlCl_3$ (b) $PbCl_2$
(c) $SnCl_4$ (d) $SnCl_2$

14. The hybridisation state of carbon in fullerene is
(a) sp (b) sp^2
(c) sp^3 (d) sp^3d

15. Catenation i.e., linking of similar atoms depends on size and electronic configuration of atoms. The tendency of catenation in Group 14 elements follows the order :
(a) $C > Si > Ge > Sn$ (b) $C >> Si > Ge \approx Sn$
(c) $Si > C > Sn > Ge$ (d) $Ge > Sn > Si > C$

16. Graphite is a soft solid lubricant extremely difficult to melt. The reason for this anomalous behaviour is that graphite
(a) is an allotropic form of diamond
(b) has molecules of variable molecular masses like polymers
(c) has carbon atoms arranged in large plates of rings of strongly bound carbon atoms with weak inter plate bonds
(d) is a non-crystalline substance

17. Which statement is false
(a) Water gas is a mixture of hydrogen and carbon dioxide.

(b) Producer gas is a mixture of CO and nitrogen
(c) Water gas is a mixture of water vapour and hydrogen.
(d) Natural gas consists of methane, ethane and gaseous hydrocarbons.

18. Silicon has a strong tendency to form polymers like silicones. The chain length of silicone polymer can be controlled by adding
(a) $MeSiCl_3$ (b) Me_2SiCl_2
(c) Me_3SiCl (d) Me_4Si

19. Dry ice is
(a) solid NH_3 (b) solid SO_2
(c) solid CO_2 (d) solid N_2

20. Ge(II)compounds are powerful reducing agents whereas Pb(IV)compounds are strong oxidants. It can be due to
(a) Pb is more electropositive than Ge
(b) Ionization potential of lead is less than that of Ge
(c) Ionic radii of Pb^{2+} and Pb^{4+} are larger than those of Ge^{2+} and Ge^{4+}
(d) More pronounced inert pair effect in lead than in Ge

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Atomic radius of gallium is higher than that of aluminium
Reason : The presence of additional *d*-electron offer poor screening effect for the outer electrons from increased nuclear charge.

2. **Assertion :** Boron is metalloid.
Reason : Boron shows metallic nature.

3. **Assertion :** The use of aluminium and its compounds for domestic purposes is now reduced considerably.
Reason : The highly toxic nature of aluminium is the responsible factor.

4. **Assertion :** Pb^{4+} compounds are stronger oxidizing agents than Sn^{4+} compounds.
Reason : The higher oxidation states for the group 14 elements are more stable for the heavier members of the group due to 'inert pair effect'.

5. **Assertion :** PbI_4 of lead does not exist.
Reason : Pb–I bond initially formed during the reaction does not release enough energy to unpair $6s^2$ electrons.

6. **Assertion :** Graphite is thermodynamically most stable allotrope of carbon.
Reason : $\Delta_f H^{\ominus}$ of graphite is taken as zero.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I	Column-II
(A) Borax-bead	(1) Alum
(B) Inorganic benzene	(2) Diborane
(C) Antiseptic	(3) Metaborate
(D) Bridged hydrogens	(4) Borazole

(a) A – (1), B – (3), C – (2), D – (4) (b) A – (3), B – (4), C – (1), D – (2)
(c) A – (4), B – (3), C – (1), D – (2) (d) A – (2), B – (3), C – (4), D – (1)

2. Identify (i) to (v) in reactions (1) and (2) on the basis of your identification choose the correct code for matching Column-I with Column-II.

1. $Na_2B_4O_7.10H_2O \xrightarrow{\Delta} (i) \xrightarrow{\Delta} (ii) + (iii)$
2. $Na_2B_4O_7.7H_2O \longrightarrow (iv) + (v)$

Column-I	**Column-II**
(A) (i)	(1) H_3BO_3
(B) (ii)	(2) B_2O_3
(C) (iii)	(3) $NaBO_2$
(D) (iv)	(4) NaOH
(E) (v)	(5) $Na_2B_4O_7$

(a) A – (5), B – (4), C – (1), D – (2), E – (3)
(b) A – (3), B – (2), C – (4), D – (1), E – (5)
(c) A – (5), B – (3), C – (2), D – (1), E – (4)
(d) A – (5), B – (3), C – (4), D – (2), E – (1)

3. Match Column-I (Compound of boron) with Column-II (Use) and choose the correct option.

Column-I	**Column-II**
(A) Metal borides	(1) Flux for soldering metals
(B) Boron fibres	(2) Bullet-proof vest
(C) Borax	(3) As a mild antiseptic
(D) Boric acid	(4) As control rods in nuclear industry

(a) A – (2), B – (4), C – (3), D – (1)
(b) A – (2), B – (4), C – (1), D – (3)
(c) A – (4), B – (2), C – (3), D – (1)
(d) A – (4), B – (2), C – (1), D – (3)

4. Match the columns

Column-I	**Column-II**
(A) Carbon	(1) Metal
(B) Silicon	(2) Non-metal
(C) Germanium	(3) Metalloid
(D) Tin	
(E) Lead	

(a) A – (1), B – (2), C – (3), D – (1), E – (1)
(b) A – (2), B – (3), C – (3), D – (1), E – (1)
(c) A – (2), B – (3), C – (3), D – (1), E – (2)
(d) A – (2), B – (2), C – (2), D – (3), E – (1)

5. Match columns

Column-I	**Column-II**
(A) Graphite fibres	(1) Abrasive for sharpening hard tools
(B) Carbon black	(2) Formation of light weight composites.
(C) Charcoal	(3) Used in water filters to remove organic contaminators
(D) Diamond	(4) As filler in automobile tyres

(a) A – (4), B – (2), C – (3), D – (1)
(b) A – (2), B – (4), C – (3), D – (1)
(c) A – (2), B – (3), C – (4), D – (1)
(d) A – (1), B – (3), C – (4), D – (2)

6. Match the columns

Column-I	Column-II
(A) Borazole	(1) $CaSO_4 \cdot \frac{1}{2} H_2O$
(B) Plaster of Paris	(2) C_{60}
(C) Boric acid	(3) SiO_2
(D) Quartz	(4) $B_3N_3H_6$
(E) Buckminsterfullerene	(5) H_3BO_3

(a) A – (3); B – (1); C – (2); D – (5); E – (4)
(b) A – (1); B – (5); C – (3); D – (4); E – (2)
(c) A – (5); B – (2); C – (1); D – (3); E – (4)
(d) A – (4); B – (1); C – (5); D – (3); E – (2)

Critical Thinking Type Questions :

1. Which one of the following is the correct statement?
   (a) Boric acid is a protonic acid
   (b) Beryllium exhibits coordination number of six
   (c) Chlorides of both beryllium and aluminium have bridged structures in solid phase
   (d) $B_2H_6.2NH_3$ is known as 'inorganic benzene'
2. Which is not correct?
   (a) Al acts as a reducing agent
   (b) Al does not react with steam even at higher temperature
   (c) Al forms a number of alloys with other metals
   (d) Al is ionic in all its compounds
3. A compound X, of boron reacts with NH_3 on heating to give another compound Y which is called inorganic benzene. The compound X can be prepared by treating BF_3 with lithium aluminium hydride. The compounds X and Y are represented by the formulas.
   (a) $B_2H_6, B_3N_3H_6$ (b) $B_2O_3, B_3N_3H_6$
   (c) $BF_3, B_3N_3H_6$ (d) $B_3N_3H_6, B_2H_6$
4. Which of the following statements is not correct ?
   (a) Fullerene is formed by condensation of vapourised C^n small molecules consists of mainly C_{60}.
   (b) In fullerene a six membered ring can only fuse with five membered ring and a five membered ring can only fuse with six membered rings.
   (c) All carbon atoms are sp^2 hybridised in fullerene
   (d) All the above are correct.
5. A group 14 element is oxidised to form corresponding oxide which is gaseous in nature, when dissolved in water pH of the water decreases further addition of group 2 hydroxides leads to precipitation. This oxide can be
   (a) GeO_2 (b) CO
   (c) CO_2 (d) SnO_2
6. Which one of the following statements about the zeolites is false ?
   (a) They are used as cation exchangers
   (b) They have open structure which enables them to take up small molecules
   (c) Zeolites are aluminosilicates having three dimensional network
   (d) None of the above

12 Organic Chemistry-Some Basic Principles and Techniques

Fill in the Blanks :

1. Among the given cations, _______ is most stable.
(*sec*-butyl carbonium ion; *tert*-butyl carbonium ion; *n*-butyl carbonium ion)
2. The compound having both *sp* and sp^2 hybridized carbon atoms is _______ .
(propene, propane, propadiene)
3. _______ ring is most strained.
(Cyclopropane, Cyclobutane, Cyclopentane)
4. The terminal carbon atom in butane is _______ hybridised.
5. A _______ diol has two hydroxyl groups on _______ carbon atoms.
6. Isomers which are _______ mirror images are known as _______ .
(superimposable, non-superimposable, enantiomers, diastereomers, epimers)
7. The valence atomic orbitals on carbon in silver acetylide is _______ hybridized.
8. The kind of delocalization involving sigma bond orbitals is called _______ .
9. The IUPAC name of succinic acid is _______ .
10. The organic reaction which proceed through heterolytic bond cleavage are called _______ or _______ .
11. In quantitative analysis of carbon and hydrogen, the mass of water produced is determined by passing the mixture through a weighed U – tube containing _______ and carbon dioxide is absorbed in concentrated solution of ______ .
12. In estimation of percentage of oxygen. The mixture of gaseous products containing oxygen is passed over red hot coke. All oxygen is converted to _______ . This mixture is passed through _______ when _______ is converted to _______ .

True/ False :

1. Iodide is a better nucleophile than bromide.
2. An electron donating substituent in benzene orients the incoming electrophilic group to the meta position.
3. 2, 3, 4-Trichloropentane has three asymmetric carbon atoms.
4. A carbon atom having an *sp* hybrid orbital is less electronegative than carbon atoms possessing sp^2 or sp^3 hybridised orbitals.
5. The number of σ and π bonds in compound $CH_2=C=CHCH_3$ are 7 and 2 respectively.
6. In homolytic cleavage, one of the electrons of the shared pair in a covalent bond goes with each of the bonded atoms.
7. In inductive effect polarisation of sigma bond is caused by the adjacent σ bond.
8. The resonance structures have different positions of nuclei but same number of unpaired electrons
9. Fractional distillation method is used if the two liquids have sufficiently large difference in their boiling points.
10. A fractionating column provides many surfaces for heat exchange between the ascending vapours and the descending condensed liquid.

11. In TLC the spots of colourless compounds can be detected by ultraviolet light.

12. The relative adsorption of each component of mixture is expressed in terms of its retardation factor (R_F)

Conceptual MCQs

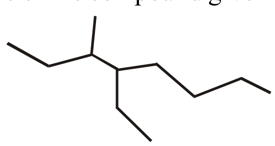
1. Electronegativity of carbon atoms depends upon their state of hybridisation. In which of the following compounds, the carbon marked with asterisk is most electronegative?
   (a) $CH_3-CH_2-{}^*CH_2-CH_3$
   (b) $CH_3-{}^*CH=CH-CH_3$
   (c) $CH_3-CH_2-C\equiv{}^*CH$
   (d) $CH_3-CH_2-CH={}^*CH_2$

2. Correct IUPAC name of

$$\begin{array}{l} H_3C-\underset{|\atop C_2H_5}{CH}-\underset{|\atop C_2H_5}{CH}-CH_3 \text{ is } \underline{\qquad\qquad}. \end{array}$$

   (a) 2 –ethyl-3-methylpentane
   (b) 3,4-dimethylhexane
   (c) 2-sec-butylbutane
   (d) 2, 3-dimethylbutane

3. Name of the compound given below is



   (a) 3- methyl -4- ethyloctane
   (b) 2, 3- diethylheptane
   (c) 5- ethyl - 6- methyloctane
   (d) 4- ethyl- 3- methyloctane

4. The IUPAC name for

$$CH_3-\overset{O}{\overset{\|}{C}}-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-OH$$

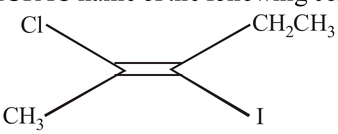
   is ___.
   (a) 1-hydroxypentane-1, 4-dione
   (b) 1,4-dioxopentanol
   (c) 1-carboxybutan-3-one
   (d) 4-oxopentanoic acid

5. The correct order of increasing bond length of $C-H$, $C-O$, $C-C$ and $C=C$ is :
   (a) $C-H<C=C<C-O<C-C$
   (b) $C-C<C=C<C-O<C-H$
   (c) $C-O<C-H<C-C<C=C$
   (d) $C-H<C-O<C-C<C=C$

6. In which of the following, functional group isomerism is not possible?
   (a) Alcohols (b) Aldehydes
   (c) Alkyl halides (d) Cyanides

7. Which of the following compounds will show metamerism?
   (a) CH_3–CO–C_2H_5 (b) C_2H_5–S–C_2H_5
   (c) CH_3–O–CH_3 (d) CH_3–O–C_2H_5

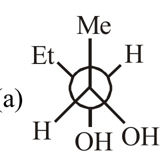
8. The IUPAC name of the following compound is

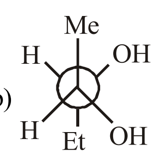


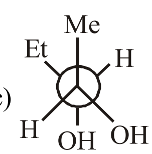
   (a) trans-2-chloro-3-iodo-2-pentene
   (b) cis-3-iodo-4-chloro-3-pentene
   (c) trans-3-iodo-4-chloro-3-pentene
   (d) cis-2-chloro-3-iodo-2-pentene

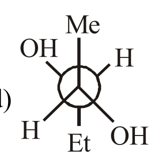
9. Which are isomers ?
   (a) ethyl alcohol and dimethyl ether
   (b) acetone and acetaldehyde
   (c) propionic acid and propanone
   (d) methyl alcohol and dimethyl ether

10. Out of the following which is relatively the most stable conformer of erythro-2, 3-pentandiol

(a) 

(b) 

(c) 

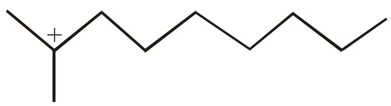
(d) 

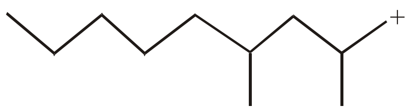
11. Which of the following compounds exhibits stereoisomerism ?
   (a) 2-methylbutene-1
   (b) 3-methylbutyne-1
   (c) 3-methylbutanoic acid
   (d) 2-methylbutanoic acid

12. The principle involved in paper chromatography is
   (a) Adsorption (b) Partition
   (c) Solubility (d) Volatility

13. Select the most stable carbocation from amongst the following

(a) 

(b) 

(c) 

(d) 

14. What is the correct order of decreasing stability of the following cations.

I. $CH_3-\overset{\oplus}{C}H-CH_3$

II. $CH_3-\overset{\oplus}{C}H-OCH_3$

III. $CH_3-\overset{\oplus}{C}H-CH_2-OCH_3$

(a) II > I > III (b) II > III > I
(c) III > I > II (d) I > II > III

15. The order of decreasing stability of the carbanions

$(CH_3)_3C^-(I);(CH_3)_2CH^-(II);CH_3CH_2^-(III);$

$C_6H_5CH_2^-(IV)$ is

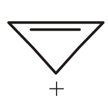
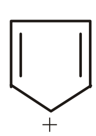
(a) I > II > III > IV (b) IV > III > II > I
(c) IV > I > II > III (d) I > II > IV > III

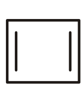
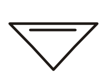
16. The most stable free radical among the following is

(a) $C_6H_5CH_2\dot{C}H_2$ (b) $C_6H_5\dot{C}HCH_3$

(c) $CH_3\dot{C}H_2$ (d) $CH_3\dot{C}HCH_3$

17. Among the following the aromatic compound is

(a)  (b) 

(c)  (d) 

18. The kind of delocalization involving sigma bond orbitals is called
(a) Inductive effect
(b) Hyperconjugation effect
(c) Electromeric effect
(d) Mesomeric effect

19. The fragrance of flowers is due to the presence of some steam volatile organic compounds called essential oils. These are generally insoluble in water at room temperature but are miscible with water vapour in vapour phase. A suitable method for the extraction of these oils from the flowers is:
(a) Distillation
(b) Crystallisation
(c) Distillation under reduced pressure
(d) Steam distillation

20. During hearing of a court case, the judge suspected that some changes in the documents had been carried out. He asked the forensic department to check the ink used at two different places. According to you which technique can give the best results?
(a) Column chromatography
(b) Solvent extraction
(c) Distillation
(d) Thin layer chromatography

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** A primary suffix indicates the type of linkage in the carbon atom.
Reason : CN is a Primary suffix

2. **Assertion :** The general formula for a dihydric alcohol is $C_nH_{2n}(OH)_2$
Reason : Ethylene glycol is a dihydric alcohol.

3. **Assertion :** IUPAC name of the following organic compound is 3, 4, 7 – trimethyloctane

$$CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_2-\underset{\underset{CH_3}{|}}{CH}-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_3$$

Reason : The numbering is done in such a way that the branched carbon atoms get the lowest possible numbers.

4. **Assertion :** Chain isomerism is observed in compounds containining four or more than four carbon atoms

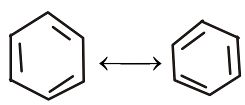
Reason : Only alkanes show chain isomerism

5. **Assertion :** But-1-ene and 2-methylprop-1-ene are position isomers.

Reason : Position isomers have same molecular formula but differ in position of functional group or C = C.

6. **Assertion :** Benzene exhibit two different bond lengths, due to C – C single and C = C double bonds.

Reason : Actual structure of benzene is a hybrid of following two structures.



7. **Assertion :** Aniline is better nucleophile than anilium ion.

Reason : Anilium ion have +ve charge.

8. **Assertion :** Different number of electron pairs are present in resonance structures.

Reason : Resonance structures differ in the location of electrons around the constituent atoms.

9. **Assertion :** Energy of resonance hybrid is equal to the average of energies of all canonical forms.

Reason : Resonance hybrid cannot be presented by a single structure.

10. **Assertion :** Simple distillation can help in separating a mixture of propan-1-ol (boiling point 97°C) and propanone (boiling point 56°C).

Reason : Liquids with a difference of more thatn 20°C in their boiling points can be separated by simple distillation.

11. **Assertion :** Components of a mixture of red and blue inks can be separated by distributing the components between stationary and mobile phases in paper chromatography.

Reason : The coloured components of inks migrate at different rates because paper selectively retains different components according to the difference in their partition between the two phases.

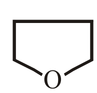
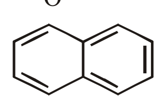
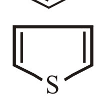
12. **Assertion :** Sulphur present in an organic compound can be estimated quantitatively by Carius method.

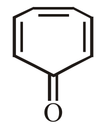
Reason : Sulphur is separated easily from other atoms in the molecule and gets precipitated as light yellow solid.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I	Column-II
(A) Non – benzenoid compound	(1) 
(B) Alicyclic compound	(2) 
(C) Benzenoid compound	(3) 

(D) Heterocyclic aromatic compound (4) 

(a) A – (3), B – (1), C – (4), D – (2) (b) A – (4), B – (1), C – (2), D – (3)
(c) A – (1), B – (3), C – (1), D – (3) (d) A – (3), B – (1), C – (2), D – (3)

2. Match Column-I (organic compound) with Column-II (common name of the compound) and choose the correct option.

Column-I (Organic compound)	Column-II (Common name of compound)
(A) $C_6H_5OCH_3$	(1) Neopentane
(B) $H_3CCH_2CH_2OH$	(2) Anisole
(C) $(H_3C)_4C$	(3) Acetophenone
(D) $C_6H_5COCH_3$	(4) n – propyl alcohol.

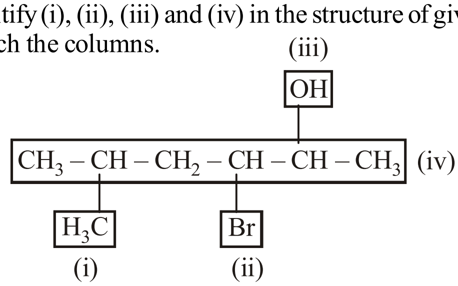
(a) A – (3), B – (4), C – (1), D – (2) (b) A – (3), B – (1), C – (4), D – (2)
(c) A – (2), B – (4), C – (1), D – (3) (d) A – (2), B – (4), C – (3), D – (1)

3. Match the columns

Column-I	Column-II
(A) Aldehyde	(1) Chloro
(B) Ketone	(2) ol
(C) Alcohol	(3) one
(D) Halogen	(4) al

(a) A – (4), B – (3), C – (2), D – (1) (b) A – (4), B – (2), C – (1), D – (3)
(c) A – (1), B – (2), C – (3), D – (4) (d) A – (3), B – (4), C – (2), D – (1)

4. Identify (i), (ii), (iii) and (iv) in the structure of given organic compound. On the basis of your identification match the columns.



Column-I	Column-II
A (i)	(1) Functional group
B (ii)	(2) Branch chain
C (iii)	(3) Parent chain
D (iv)	(4) Homologues unit

(a) A – (2), B – (1), C – (4), D – (3) (b) A – (1), B – (4), C – (2), D – (3)
(c) A – (2), B – (1), C – (3), D – (4) (d) A – (2), B – (1), C – (4), D – (3)

5. Match the columns.

Column-I	**Column–II**
(A) $\begin{array}{ccc} & CH_3 & \\ & \vert & \\ CH_3 - & C & - CH_2 - \\ & \vert & \\ & CH_3 & \end{array}$	(1) Isobutyl
(B) $\begin{array}{ccc} CH_3 - CH_2 - & CH & - \\ & \vert & \\ & CH_3 & \end{array}$	(2) sec – Butyl
(C) $\begin{array}{ccc} CH_3 - & CH & - CH_2 - \\ & \vert & \\ & CH_3 & \end{array}$	(3) Neopentyl
(D) $\begin{array}{ccc} & CH_3 & \\ & \vert & \\ CH_3 - & C & - \\ & \vert & \\ & CH_3 & \end{array}$	(4) tert – Butyl

(a) A – (3), B – (2), C – (1), D –(4)
(b) A – (4), B – (1), C – (3), D –(2)
(c) A – (4), B – (1), C – (2), D –(3)
(d) A – (4), B – (2), C – (1), D –(3)

6. Column-II give formula for compounds given in Column-I, match them correctly.

Column-I	**Column-II**
(A) Propane	(1) C_2H_5OH
(B) ethyl alcohol	(2) C_3H_8
(C) carboxylic acid	(3) CH_3COOH
(D) ethyl ethanoate	(4) $CH_3COOC_2H_5$

(a) A – (2), B – (1), C – (3), D – (4)
(b) A – (1), B – (2), C – (4), D – (3)
(c) A – (2), B – (4), C – (1), D – (3)
(d) A – (2), B – (1), C – (4), D – (3)

7. Match the columns

Column-I (Organic compounds)	**Column-II (Type of isomerism)**
(A) $CH_3CH_2CH_2CH_2CH_3$ & $\begin{array}{ccc} & CH_3 & \\ & \vert & \\ CH_3 - & CH & - CH_2CH_3 \end{array}$	(1) Functional group isomerism
(B) $CH_3CH_2CH_2OH$ & $\begin{array}{ccc} & OH & \\ & \vert & \\ CH_3 - & CH & - CH_3 \end{array}$	(2) Chain isomerism
(C) $\begin{array}{ccc} & O & \\ & \Vert & \\ CH_3 - & C & - CH_3 \end{array}$ & $\begin{array}{cc} & H \\ & \vert \\ CH_3 - CH_2 - & C = O \end{array}$	(3) Metamerism

(D) $CH_3OC_3H_7$ & $C_2H_5OC_2H_5$ | (4) Position isomerism

(a) A – (4), B – (2), C – (3), D – (1)
(b) A – (4), B – (2), C – (1), D – (3)
(c) A – (2), B – (4), C – (3), D – (1)
(d) A – (2), B – (4), C – (1), D – (3)

8. Match the columns

Column-I	**Column-II**
(A) CH_3COOH & $HCOOCH_3$	(1) Functional isomers
(B) 1 butene & 2-butene	(2) Metamers
(C) diethyl ether & methyl propyl ether	(3) Position isomers
(D) dimethyl ether and ethanol	(4) Chain isomers and ethanol

(a) A – (1), B – (3), C – (2), D – (4)
(b) A – (2), B – (3), C – (4), D – (1)
(c) A – (2), B – (4), C – (1), D – (3)
(d) A – (2), B – (1), C – (4), D – (3)

9. Match the columns

Column-I	**Column-II**
(A) Free radical	(1) Trigonal planar
(B) Carbocation	(2) Pyramidal
(C) Carbanion	(3) Linear

(a) A – (1), B – (2), C – (3)
(b) A – (1), B – (1), C – (2)
(c) A – (3), B – (1), C – (2)
(d) A – (1), B – (1), C – (3)

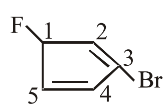
10. Match the columns

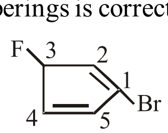
Column - I	**Column - II**
(A) Separation of sublimable compounds from non sublimable	(1) Steam distillation
(B) Method based on the difference in the solubilities of the compound and the impurities in a suitable solvent	(2) Sublimation
(C) Separation of liquids having sufficient difference in their boiling points.	(3) Distillation
(D) Separation of substances which are steam volatile and are immiscible with water.	(4) Crystallisation

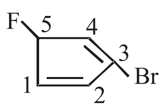
(a) A – (2), B – (4), C – (3), D – (1)
(b) A – (2), B – (3), C – (1), D – (4)
(c) A – (4), B – (2), C – (3), D – (1)
(d) A – (2), B – (4), C – (1), D – (3)

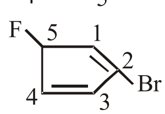
Critical Thinking Type Questions :

1. Which of the following numberings is correct ?

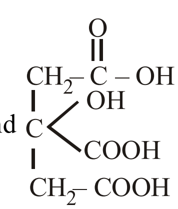
A. 

B. 

C. 

D. 

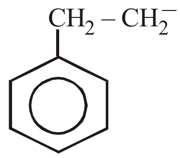
(a) A
(b) B
(c) C
(d) D

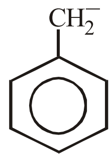
2. The IUPAC name of compound 

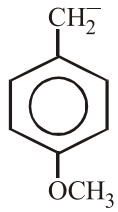
is:

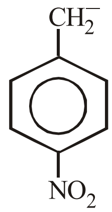
(a) 1, 2, 3 - tricarboxy - 2, 1 - propane
(b) 3 - carboxy - 3 hydroxy - 1 , 5 - pentanedioic acid
(c) 3 - hydroxy - 3 - carboxy - 1, 5 - pentanedioic acid
(d) 2 - hydroxy propane -1, 2, 3 - tricarboxylic acid.

3. The most stable carbanion among the following is

(a) 

(b) 

(c) 

(d) 

4. Which of the following does not represent formation of reactive intermediate correctly ?

(i) $CH_3-CN \rightarrow \overset{+}{C}H_3 + CN^-$

(ii) $CH_3-Cu \rightarrow \overset{-}{C}H_3 + \overset{+}{C}u$

(iii) $CH_3-Br \rightarrow {}^+CH_3 + Br^-$

(iv) $CH_3-Cl \rightarrow {}^+CH_3 + Cl^-$

(a) (ii) only (b) (ii) and (iii)

(c) (ii) and (iv) (d) (iii) and (iv)

13 Hydrocarbons

Fill in the Blanks :

1. _______ is most acidic.
(Ethane, Ethene, Ethyne)
2. Acetylene is treated with excess sodium in liquid ammonia. The product is reacted with excess methyl iodide. The final product is _______ .
3. The starting material for the manufacture of polyvinyl chloride is obtained by reacting HCl with _______ .
4. Kolbe electrolysis of potassium succinate gives CO_2 and _______ .
5. Addition of water to acetylenic compounds is catalyzed by _______ and _______ .
6. The number of 4° carbon atoms in 2,2,4,4-tetramethyl pentane is _______ .
7. The number of primary, secondary and tertiary carbons in 3, 4-dimethylheptane are _______, _______ and _______ respectively
8. Sodium salts of carboxylic acids on heating with soda lime give alkanes containing _______ than the carboxylic acid.
9. Number of alkynes for formula C_5H_8 is _______.
10. The total number of isomers for C_4H_8 is _______ .

True/ False :

1. LNG is obtained by liquefaction of natural gas.
2. CNG is found in upper strata during drilling of oil wells.
3. Saturated hydrocarbons contain both carbon-carbon and carbon-hydrogen single bond.
4. Unsaturated hydrocarbons contain carbon-carbon double and triple bonds both.
5. Rate of replacement of hydrogens of alkanes is $3° > 2° > 1°$
6. Iodination of alkanes is too violent to be controlled.
7. Pyrolysis and cracking are different processes.
8. Pyrolysis follow free radical mechanism.
9. Alkanes can have infinite number of conformations by rotation around a C – C single bonds.
10. Stability of conformation is affected due to torsional strain.
11. Staggered form has maximum torsional strain.
12. Bond length of C–C double bond in alkene is shorter than C–C single bond in alkane.
13. Alkynes on reduction with palladised charcoal form trans alkenes.
14. Propyne on reduction with palladised charcoal form a mixture of cis and trans propene.
15. Polynuclear hydrocarbons are formed on incomplete combustion of organic materials like tobacco, coal and petroleum.

Conceptual MCQs

1. In the following reaction, $C_6H_5CH_2Br \xrightarrow[2.H_3O^+]{1.Mg, Ether}$ X, the product 'X' is
(a) $C_6H_5CH_2CH_2C_6H_5$
(b) $C_6H_5CH_2OCH_2C_6H_5$
(c) $C_6H_5CH_2OH$
(d) $C_6H_5CH_3$
2. Pure methane can be produced by
(a) Wurtz reaction
(b) Kolbe's electrolytic method
(c) Soda-lime decarboxylation
(d) Reduction with H_2

3. Arrange the following in decreasing order of their boiling points.

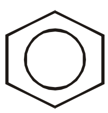
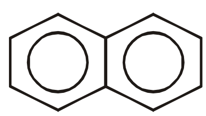
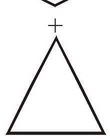
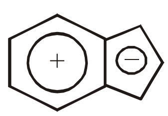
(A) n–butane
(B) 2-methylbutane
(C) n-pentane
(D) 2, 2–dimethylpropane

(a) A > B > C > D
(b) B > C > D > A
(c) D > C > B > A
(d) C > B > D > A

4. Arrange the halogens F_2, Cl_2, Br_2, I_2, in order of their increasing reactivity with alkanes.

(a) $I_2 < Br_2 < Cl_2 < F_2$
(b) $Br_2 < Cl_2 < F_2 < I_2$
(c) $F_2 < Cl_2 < Br_2 < I_2$
(d) $F_2 < I_2 < Cl_2 < F_2$

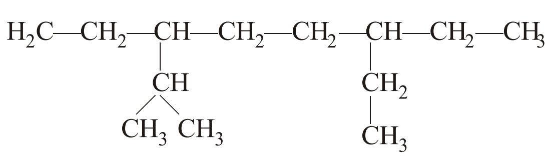
5. The chemical system that is non-aromatic is

(a) 
(b) 
(c) 
(d) 

6. Which of the following reactions of methane is incomplete combustion ?

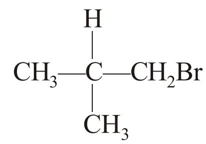
(a) $2CH_4 + O_2 \xrightarrow{Cu/523\,K/100\,atm} 2CH_3OH$
(b) $CH_4 + O_2 \xrightarrow{Mo_2O_3} HCHO + H_2O$
(c) $CH_4 + O_2 \rightarrow C(s) + 2H_2O(l)$
(d) $CH_4 + 2O_2 \rightarrow CO_2\,(g) + 2H_2O(l)$

7. The correct IUPAC name of following alkane is



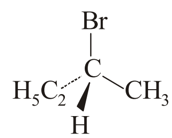
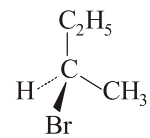
(a) 3,6 – Diethyl – 2 – methyloctane
(b) 5 – Isopropyl – 3 – ethyloctane
(c) 3 – Ethyl – 5 – isopropyloctane
(d) 3 – Isopropyl – 6 – ethyloctane

8. Arrange the following alkyl halides in decreasing order of the rate of β–elimination reaction with alcoholic KOH.

(A) 
(B) $CH_3—CH_2—Br$
(C) $CH_3—CH_2—CH_2—Br$

(a) A > B > C (b) C > B > A
(c) B > C > A (d) A > C > B

9. The addition of HBr to 1-butene gives a mixture of products A, B and C

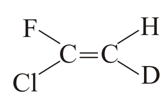
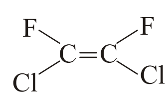
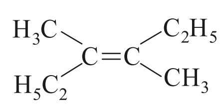
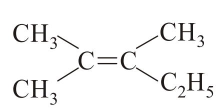
(A)  (B) 

(C) $CH_3—CH_2—CH_2—CH_2—Br$

The mixture consists of

(a) A and B as major and C as minor products
(b) B as major, A and C as minor products
(c) B as minor, A and C as major products
(d) A and B as minor and C as major products

10. Which of the following will not show geometrical isomerism?

(a) 
(b) 
(c) 
(d) 

11. Consider the following statements : A hydrocarbon of molecular formula C_5H_{10} is a

I. monosubstituted alkene
II. disubstituted alkene
III. trisubstituted alkene

Which of the following statement(s) is(are) correct?

(a) I, II and III (b) I and II
(c) II and III (d) I and III

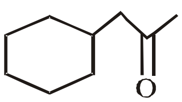
12. When $CH_3CH_2CHCl_2$ is treated with $NaNH_2$, the product formed is

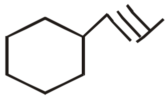
(a) $CH_3-CH=CH_2$

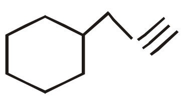
(b) $CH_3-C\equiv CH$

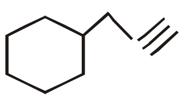
(c) $CH_3CH_2CH\begin{cases}NH_2\\NH_2\end{cases}$

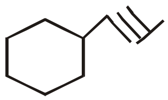
(d) $CH_3CH_2CH\begin{cases}Cl\\NH_2\end{cases}$

13. Choose the correct alkyne and reagents for the preparation of 

(a)  , $HgSO_4,\ H_2SO_4,\ H_2O$

(b)  , $HgSO_4,\ H_2SO_4,\ H_2O$

(c)  , $BH_3,\ H_2O_2$, NaOH

(d)  , $BH_3,\ H_2O_2$, NaOH

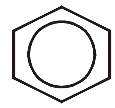
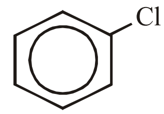
14. 3-Hexyne reacts with Na/liq. NH_3 to produce

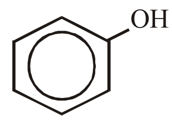
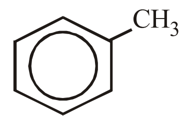
(a) cis-3-Hexene (b) trans-3-Hexene
(c) 3-Hexylamine (d) 2-Hexylamine

15. Select the true statement about benzene from amongst the following

(a) Because of unsaturation benzene easily undergoes addition
(b) There are two types of C—C bonds in benzene molecule
(c) There is cyclic delocalisation of pi-electrons in benzene
(d) Monosubstitution of benzene gives three isomeric products

16. Which of the following will be most easily attacked by an electrophile?

(a)  (b) 

(c)  (d) 

17. Which of the following has the lowest dipole moment ?

(a) $\begin{matrix}CH_3\\H\end{matrix}\!\!>C=C<\!\!\begin{matrix}CH_3\\H\end{matrix}$

(b) $CH_3C\equiv CCH_3$

(c) $CH_3CH_2C\equiv CH$

(d) $CH_2=CH-C\equiv CH$

18. In the given reaction

$$CH_3CH_2CH=CHCH_3 \xrightarrow{X} CH_3CH_2COOH + CH_3COOH$$

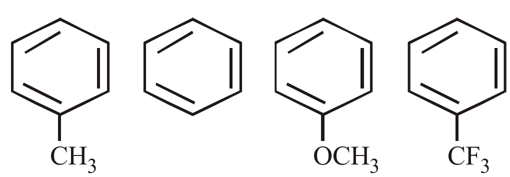
The X is

(a) C_2H_5ONa
(b) Conc. HCl + Anhy.$ZnCl_2$
(c) Anh. $AlCl_3$
(d) $KMnO_4/OH^-$

19. The order of activity of the various o- and p-director is

(a) $-O^- > -OH > -OCOCH_3 > -COCH_3$
(b) $-OH > -O^- > -OCOCH_3 > -COCH_3$
(c) $-OH > -O^- > -COCH_3 > -OCOCH_3$
(d) $-O^- > -COCH_3 > -OCOCH_3 > -OH$

20. Among the following compounds, the decreasing order of reactivity towards electrophilic substitution is



I II III IV

(a) III > I > II > IV (b) IV > I > II > III
(c) I > II > III > IV (d) II > I > III > IV

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.

(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion

(c) Assertion is correct, reason is incorrect

(d) Assertion is incorrect, reason is correct.

1. **Assertion:** 1-Butene on reaction with HBr in the presence of a peroxide produces 1-bromobutane.

Reason : It involves the free radical mechanism.

2. **Assertion :** CH_4 does not react with Cl_2 in dark.

Reason: Chlorination of CH_4 takes place in sunlight.

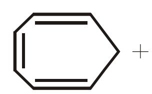
3. **Assertion:** Iodination of alkanes is reversible.

Reason : Iodination is carried out in presence of iodic acid.

4. **Assertion:** All the hydrogen atoms in $CH_2 = C = CH_2$ lie in one plane.

Reason: Carbon atoms are sp^2 and sp hybridized.

5. **Assertion :** Tropylium cation is aromatic in nature

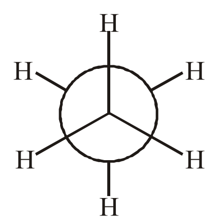
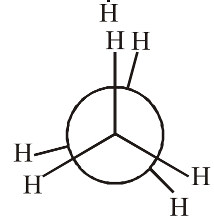
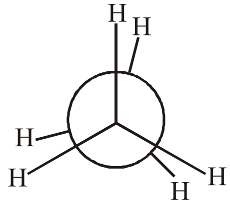


Reason : The only property that determines its aromatic behaviour is its planar structure.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I	Column-II
(A) Eclipsed	(1) 
(B) Staggered	(2) 
(C) Skew	(3) 

(a) A – (3), B – (1), C – (2)

(b) A – (3), B – (2), C – (1)

(c) A – (1), B – (2), C – (3)

(d) A – (2), B – (1), C – (3)

2. Match the columns

Column-I	Column-II
(A) $CH_2=CH_2 \rightarrow CH_3-CH_3$	(1) H_2, Zn, H^+
(B) $CH_3Cl \rightarrow CH_4$	(2) NaOH, CaO
(C) $CH_3Br \rightarrow CH_3CH_3$	(3) H_2, Pt/Pd
(D) $CH_3COONa \rightarrow CH_4$	(4) Na, dry ether

(a) A – (3), B – (1), C – (4), D – (2)
(b) A – (1), B – (4), C – (3), D – (2)
(c) A – (4), B – (2), C – (1), D – (3)
(d) A – (2), B – (1), C – (4), D – (3)

3. Match the columns

Column-I	Column-II
(A) $CH_4 + O_2 \xrightarrow{Cu/523K/100\ atm}$	(1) HCHO
(B) $CH_4 + O_2 \xrightarrow[\Delta]{Mo_2O_3}$	(2) $(CH_3)_3COH$
(C) $C_2H_6 + O_2 \xrightarrow[\Delta]{(CH_3COO)_2Mn}$	(3) CH_3OH
(D) $(CH_3)_3CH \xrightarrow[oxidation]{KMnO_4}$	(4) CH_3COOH

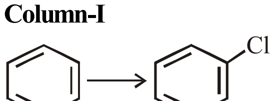
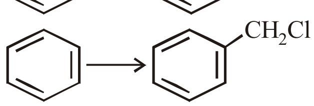
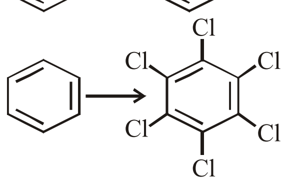
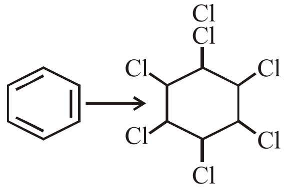
(a) A – (4), B – (1), C – (3), D – (4)
(b) A – (2), B – (1), C – (4), D – (3)
(c) A – (3), B – (1), C – (4), D – (2)
(d) A – (1), B – (2), C – (3), D – (4)

4. Match the columns

Column-I	Column-II
(A) $CH \equiv CH + H_2 \longrightarrow CH_2 = CH_2$	(1) Zn
(B) $CH_3CH_2Br \longrightarrow CH_2=CH_2$	(2) Conc. H_2SO_4
(C) $CH_2BrCH_2Br \longrightarrow CH_2=CH_2$	(3) Pd/C
(D) $CH_3CH_2OH \longrightarrow CH_2 = CH_2$	(4) Alc. KOH

(a) A – (3), B – (4), C – (1), D – (2)
(b) A – (4), B – (3), C – (2), D – (1)
(c) A – (2), B – (1), C – (4), D – (3)
(d) A – (3), B – (4), C – (2), D – (1)

5. Match the columns

Column-I	Column-II
(A) 	(1) Cl_2, uv, 500 K
(B) 	(2) anhy. $AlCl_3$
(C) 	(3) CH_2Cl_2, anhy. $AlCl_3$
(D) 	(4) Cl_2, anhy. $AlCl_3$,

(a) A – (4), B – (3), C – (2), D – (1)
(b) A – (2), B – (3), C – (4), D – (1)
(c) A – (3), B – (1), C – (2), D – (4)
(d) A – (2), B – (1), C – (4), D – (3)

6. Match the following reactants in Column I with the corresponding reaction products in Column II and choose the correct option from the codes given below.

Column - I	Column - II
(A) Benzene + $Cl_2 \xrightarrow{AlCl_3}$	(1) Benzoic acid
(B) Benzene + $CH_3Cl \xrightarrow{AlCl_3}$	(2) Methyl phenyl ketone
(C) Benzene + $CH_3COCl \xrightarrow{AlCl_3}$	(3) Toluene
(D) Toluene $\xrightarrow{KMnO_4/NaOH}$	(4) Chlorobenzene

(a) A – (4), B – (3), C – (2), D – (1)
(b) A – (4), B – (3), C – (1), D – (2)
(c) A – (3), B – (4), C – (1), D – (2)
(d) A – (3), B – (4), C – (2), D – (1)

7. Match the columns

Column - I	Column - II
(A) Alkyl + Acid halide in presence of dry ether	(1) Sulphonation
(B) Arene + Acid halide in presence of $AlCl_3$	(2) Wurtz reaction
(C) Arene + Fuming sulphuric in presence of $AlCl_3$	(3) Catalytic hydrogenation
(D) Arene + Hydrogen in presence of Ni	(4) Friedel-Crafts reaction

(a) A - (1), B - (3), C - (2); D - (4)
(b) A - (4), B - (2), C - (3); D - (1)
(c) A - (3), B - (1), C - (4); D - (2)
(d) A - (2), B - (4), C - (1); D - (3)

8. Match the columns

Column - I	Column - II
(A) Aromatic	(1) Planar
(B) Antiaromatic	(2) Non-planar
(C) Huckel rule	(3) $4n\pi$ localised electrons
(D) Cyclo-octatetraene	(4) $(4n+2)\pi$ delocalised electrons

(a) A - (1, 4), B - (1, 3), C - (4), D - (2, 3)
(b) A - (1, 3), B - (1, 4), C - (4), D - (2, 3)
(c) A - (1, 4), B - (4), C - (1, 3), D - (2, 3)
(d) A - (2, 3), B - (1, 3), C - (4), D - (1, 4)

9. Match the columns

Column - I (Reactants)	Column - II (No. of chlorinated products)
(A) Benzene $\xrightarrow{Cl_2,\ light}$	(1) Three compounds
(B) Toluene $\xrightarrow{Cl_2,\ light}$	(2) Four compounds
(C) Methane $\xrightarrow{Cl_2,\ light}$	(3) Single monochloro derivative
(D) Benzene $\xrightarrow{Cl_2,\ AlCl_3}$	(4) Six isomeric compounds

(a) A – (3), B – (1, 3), C – (2, 3), D – (4)
(b) A – (4), B – (1, 3), C – (2, 3), D – (3)
(c) A – (1, 3), B – (4), C – (2, 3), D – (3)
(d) A – (4), B – (1, 3), C – (3), D – (2, 3)

Critical Thinking Type Questions :

1. The number of primary, secondary, tertiary and quaternary carbons in neopentane are respectively

(a) 4, 3, 2 and 1 (b) 5, 0, 0 and 1
(c) 4, 0, 0 and 1 (d) 4, 0, 1 and 1

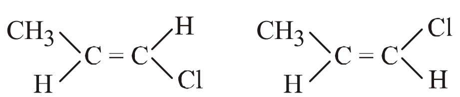
2. When neo-pentyl bromide is subjected to Wurtz reaction, the product formed is

(a) 2,2,4,4-tetramethylhexane
(b) 2,2,4,4-tetramethylpentane
(c) 2,2,5,5-tetramethylhexane
(d) 2,2,3,3-tetramethylhexane

3. A hydrocarbon A on chlorination gives B which on heating with alcoholic potassium hydroxide changes into another hydrocarbon C. The latter decolourises Baeyer's reagent and on ozonolysis forms formaldehyde only. A is

(a) Ethane (b) Butane
(c) Methane (d) Ethene

4. Which of the following is correct set of physical properties of the geometrical isomers –



I II

	Dipole moment	B.P.	M.P.	Stability
(a)	I > II	I > II	II > I	I > II
(b)	II > I	II > I	II > I	II > I
(c)	I > II	I > II	I > II	I > II
(d)	II > I	II > I	I > II	I > II

5. In the following reactions,

(i) $CH_3–CH(CH_3)–CH(OH)–CH_3 \xrightarrow{H^+/Heat} \underset{\text{(Major products)}}{A} + \underset{\text{(Minor products)}}{B}$

(ii) $A \xrightarrow[\text{in absence of peroxide}]{\text{HBr, dark}} \underset{\text{(Major product)}}{C} + \underset{\text{(Minor product)}}{D}$

the major products (A) and (C) are respectively :

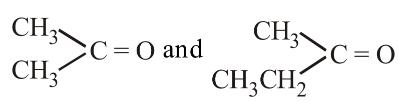
(a) $CH_2 = C(CH_3) – CH_2 – CH_3$ and $CH_2(Br) – CH(CH_3) – CH_2 – CH_3$

(b) $CH_3 – C(CH_3) = CH – CH_3$ and $CH_3 – C(CH_3)(Br) – CH_2 – CH_3$

(c) $CH_3 – C(CH_3) = CH – CH_3$ and $CH_3 – CH(CH_3) – CH(Br) – CH_3$

(d) $CH_2 = C(CH_3) – CH_2 – CH_3$ and $CH_3 – C(CH_3)(Br) – CH_2 – CH_3$

6. An alkene having molecular formula C_7H_{14} was subjected to ozonolysis in the presence of zinc dust. An equimolar amount of the following two compounds was obtained



The IUPAC name of the alkene is

(a) 3, 4-dimethyl-3-pentene
(b) 3, 4-dimethyl-2-pentene
(c) 2, 3-dimethyl-3-pentene
(d) 2, 3-dimethyl-2-pentene

14

Environmental Chemistry

Fill in the Blanks :

1. High concentration of _______ in atmosphere leads to stiffness of flower buds.
2. CO_2 is not regarded as a _______ .
3. _______ have the largest concentration in acid rain.
4. The secondary precursors of photochemical smog are O_3 and _______ .
5. Dust is a _______ particulate.
6. Minamata disease of Japan is due to pollution of ______ .
7. Brewery and sugar factory waste alters the quality of a water body by increasing _______ and _______ .
8. _______ metal is a water pollutant and causes sterility in human being.
9. The maximum prescribed concentration of cadmium in drinking water in ppm is _______ .
10. Limit of BOD prescribed by Central Pollution Control Board for the discharge of industrial and municipal waste waters into natural surface waters, is _______ .

True/ False :

1. Troposphere is the lowest region of atmosphere in which the human beings along with other organisms live.
2. Troposphere contains much little water vapour, dinitrogen, dioxygen and ozone
3. Stratosphere contains ozone, and cloud formation also takes place in this region.
4. Sulphuric acid, nitric acid as well as ammonium salts are components of acid rain.
5. Catalytic converters must be used in cars to reduce the harmful effect of exhaust.
6. Main component of catalytic converter is ceramic honey comb coated with metals like – Au, Ag, Pt etc.
7. Classical smog is a mixture of smoke, fog and sulphur dioxide.
8. Hydrocarbons, NO_2 and PAN are components of photochemical smog.
9. F^- ion concentration above 2ppm causes brown mottling in teeth.
10. Excessive lead in drinking water causes disease methemoglobinemia

Conceptual MCQs

1. Which one of the following statement is **not** true ?
   (a) pH of drinking water should be between 5.5 – 9.5.
   (b) Concentration of DO below 6 ppm is good for the growth of fish.
   (c) Clean water would have a BOD value of less than 5 ppm.
   (d) Oxides of sulphur, nitrogen and carbon are the most widespread air pollutant.
2. The pollutants which came directly in the air from sources are called primary pollutants. Primary pollutants are sometimes converted into secondary pollutants. Which of the following belongs to secondary air pollutants?
   (a) CO
   (b) Hydrocarbon
   (c) Peroxyacetyl nitrate
   (d) NO
3. Which of the following is not a consequence of greenhouse effect?

(a) Climatic conditions will be changed resulting in
(b) Plants in warmer climates with adequate rainfall would grow faster
(c) The incidence of infectious diseases is likely to increase
(d) Malaria will be controlled as the mosquitoes will not survive.

4. Which of the following gases is not a green house gas?
(a) CO (b) O_3
(c) CH_4 (d) H_2O vapour

5. The substance having the largest concentration in acid rain?
(a) H_2CO_3 (b) HNO_3
(c) HCl (d) H_2SO_4

6. Which one of the following statements regarding photochemical smog is not correct?
(a) Carbon monoxide does not play any role in photochemical smog formation.
(b) Photochemical smog is an oxidising agent in character.
(c) Photochemical smog is formed through photochemical reaction involving solar energy.
(d) Photochemical smog does not cause irritation in eyes and throat.

7. Which of the following statements is not true about classical smog?
(a) Its main components are produced by the action of sunlight on emissions of automobiles and factories.
(b) Produced in cold and humid climate.
(c) It contains compounds of reducing nature.
(d) It contains smoke fog and sulphur dioxide

8. Which of the following statements about photochemical smog is wrong?
(a) It has high concentration of oxidising agents
(b) It has low concentration of oxidising agent
(c) It can be controlled by controlling the release of NO_2, hydrocarbons ozone, etc.
(d) Plantation of some plants like pinus helps in controlling photochemical smog.

9. Which of the following statements is wrong?
(a) Ozone is not responsible for green house effect.
(b) Ozone can oxidise sulphur dioxide present in the atmosphere to sulphur trioxide.
(c) Ozone hole is thinning of ozone layer present in stratosphere.
(d) Ozone is produced in upper stratosphere by the action of UV rays on oxygen.

10. Roasting of sulphides gives the gas X as a by product. This is colorless gas with choking smell of burnt sulphur and caused great damage to respiratory organs as a result of acid rain. Its aqueous solution is acidic, acts as a reducing agent and its acid has never been isolated. The gas X is :
(a) SO_2 (b) CO_2
(c) SO_3 (d) H_2S

11. Biochemical Oxygen Demand, (BOD) is a measure of organic material present in water. BOD value less than 5 ppm indicates a water sample to be __________.
(a) rich in dissolved oxygen
(b) poor in dissolved oxygen
(c) highly polluted
(d) not suitable for aquatic life

12. Photochemical smog occurs in warm, dry and sunny climate. One of the following is not amongst the components of photochemical smog, identify it.
(a) NO_2
(b) O_3
(c) SO_2
(d) Unsaturated hydrocarbon

13. Phosphate pollution is caused by
(a) sewage and agricultural fertilizers
(b) weathering of phosphate rocks only
(c) agriculutral fertilizers only
(d) phosphate rocks and sewage

14. Photochemical smog is due to the presence of
(a) oxides of sulphur (b) oxides of nitrogen
(c) oxides of carbon (d) lead

15. Which among the following statements is *false*?
(a) Oil slick in sea water increases D.O. value.
(b) The main reason for river water pollution is industrial and domestic sewage discharge.
(c) Surface water contains a lot of organic matter mineral nutrients and radioactive materials.
(d) Oil spill in sea water causes heavy damage to fishery.

16. Sewage containing organic waste should not be disposed in water bodies because it causes major water pollution. Fishes in such a polluted water die because of
(a) large number of mosquitoes
(b) increase in the amount of dissolved oxygen
(c) decrease in the amount of dissolved oxygen in water
(d) clogging of gills by mud.

17. Which of the following practices will not come under green chemistry?
(a) If possible, making use of soap made of vegetable oils instead of using synthetic detergents.
(b) Using H_2O_2 for bleaching purpose instead of using chlorine based bleaching agents.
(c) Using bicycle for travelling small distances instead of using petrol/ diesel based vehicles.
(d) Using plastic cans for neatly storing substances.

18. Excess nitrate in drinking water can cause
(a) methemoglobinemia
(b) kidney damage
(c) liver damage
(d) laxative effect

19. Water is often treated with chlorine to
(a) remove hardness
(b) increase oxygen content
(c) kill germs
(d) remove suspended particles

20. Identify the wrong statement in the following:
(a) Chlorofluorocarbons are responsible for ozone layer depletion
(b) Greenhouse effect is responsible for global warming
(c) Acid rain is mostly because of oxides of nitrogen and sulphur
(d) Ozone layer does not permit infrared radiation from the sun to reach the earth

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Uncatalysed oxidation of sulphur dioxide is a slow process.
Reason : Particulate matter in polluted air catalyses the oxidation of sulphur dioxide.

2. **Assertion :** Dinitrogen and dioxygen do not react with each other at a normal temperature.
Reason : At high altitudes dinitrogen combines with dioxygen to form oxides of nitrogen

3. **Assertion :** CO_2 causes green house effect.
Reason : Other gases do not show such effect.

4. **Assertion :** Green house effect was observed in houses used to grow plants and these are made of green glass.
Reason : Green house name has been given because glass houses are made of green glass.

5. **Assertion :** The pH of acid rain is less than 5.6.
Reason : Carbon dioxide present in the atmosphere dissolves in rain water and forms carbonic acid.

6. **Assertion :** Photochemical smog is oxidising in nature.
Reason : Photochemical smog contains NO_2 and O_3, which are formed during the sequence of reactions.

7. **Assertion :** Suspended particulate matter (SPM) is an important pollutant released by diesel vehicles.
Reason : Catalytic converters greatly reduce pollution caused by automobiles.

8. **Assertion :** Carbon dioxide is one of the important greenhouse gases.
Reason : It is largely produced by respiratory function of animals and plants.

9. **Assertion :** Ozone is destroyed by solar radiation in upper stratosphere.
Reason : Thinning of the ozone layer allows excessive UV radiations to reach the surface of earth.

10. **Assertion :** Excessive use of chlorinated synthetic pesticides causes soil and water pollution.
Reason : Such pesticides are non-biodegradables.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column - I	**Column - II**
(A) Concentration of dissolved oxygen in cold water	(1) 6 ppm
(B) Concentration of dissolved oxygen below which growth of fish gets inhibited	(2) 17 ppm
(C) BOD value of clean water	(3) 5 ppm
(D) BOD value of polluted water.	(4) 10 ppm

(a) A – (4), B – (4), C – (2), D – (1)
(b) A – (1), B – (2), C – (3), D – (4)
(c) A – (4), B – (1), C – (3), D – (2)
(d) A – (1), B – (4), C – (2), D – (3)

2. Match the columns

Column I	**Column II**
(A) Acid rain	(1) $CHCl_2 - CHF_2$
(B) Photochemical smog	(2) CO
(C) Combination with haemoglobin	(3) CO_2
(D) Depletion of ozone layer	(4) SO_2
	(5) Unsaturated hydrocarbons

(a) A – (3, 4), B – (5, 4), C – (2), D – (1)
(b) A – (3), B – (4), C – (2), D – (1)
(c) A – (5, 4), B – (4), C – (2), D – (3)
(d) A – (3), B – (5), C – (2), D – (1)

3. Match the columns

Column-I	**Column-II**
(A) Oxides of sulphur	(1) Global warming
(B) Nitrogen dioxide	(2) Damage to kidney
(C) Carbon dioxide	(3) 'Blue baby' syndrome
(D) Nitrate in drinking water	(4) Respiratory diseases
(E) Lead	(5) Red haze in traffic and congested areas

(a) A – (5), B – (1), C – (3), D – (4), E – (2)
(b) A – (4), B – (5), C – (1), D – (3), E – (2)
(c) A – (4), B – (2), C – (1), D – (5), E – (3)
(d) A – (2), B – (4), C – (5), D – (3), E – (1)

4. Match the columns

Column-I	**Column-II**
(A) Nitrous oxide from car exhausts	(1) Secondary pollutant
(B) Chlorofluorocarbon (CFCs)	(2) Combustion of fossil fuels, wood, etc
(C) Methane	(3) Denitrification
(D) Ozone (O_3)	(4) Refrigerators, aerosol, sprays
(E) Carbon dioxide	(5) Cattle, rice fields, toilets.

(a) A – (3), B – (4), C – (5), D – (1), E – (2)
(B) A – (5), B – (1), C – (3), D – (4), E – (2)
(c) A – (4), B – (5), C – (1), D – (2), E – (3)
(d) A – (1), B – (3), C – (4), D – (5), E – (2)

5. Match the columns

Column-I	Column-II
(A) Releasing gases to the atmosphere after burning waste material containing sulphur	(1) Water pollution
(B) Using carbamates as pesticides	(2) Photochemical smog, damage to plant life, corrosion to building material, induce breathing problems, water pollution
(C) Using synthetic detergents for washing clothes	(3) Damaging ozone layer
(D) Releasing gases produced by automobiles and factories in the atmosphere.	(4) May cause nerve diseases in human
(E) Using chlorofluoro-carbon compounds water pollution, induce computer breathing problems, buildings,	(5) Classical smog, acid rain, for cleaning parts damage to corrosion of metals.

(a) A – (5), B – (4), C – (1), D – (2), E – (3)
(b) A – (4), B – (5), C – (2), D – (1), E – (3)
(c) A – (2), B – (5), C – (3), D – (1), E – (4)
(d) A – (3), B – (4), C – (1), D – (2), E – (5)

6. Match the columns

Column I	Column II
(A) Phosphate fertilisers in water	(1) BOD level of water increases
(B) Methane in air	(2) Acid rain
(C) Synthetic detergents in water	(3) Global warming
(D) Nitrogen oxides in air	(4) Eutrophication

(a) A – (1, 4), B – (3), C – (1), D – (2)
(b) A – (1), B – (4), C – (3), D – (2)
(c) A – (4), B – (3), C – (2), D – (1)
(d) A – (1), B – (2), C – (4), D – (3)

Critical Thinking Type Questions :

1. Dinitrogen and dioxygen are main constituents of air but these do not react with each other to form oxides of nitrogen because __________.

(a) the reaction is endothermic and requires very high temperature.
(b) the reaction can be initiated only in presence of a catalyst.
(c) oxides of nitrogen are unstable.
(d) N_2 and O_2 are unreactive

2. The beauty of Taj Mahal is endangered due to

(a) degradation of marble due to high temperature
(b) discharge of industrial waste in Yamuna river
(c) air pollutants released from oil refinery
(d) riparian erosion

3. Acid rain is caused by or recent reports of acid rain in some industrial cities are due to the effect of atmospheric pollution by

(a) excessive release of CO_2 by burning of fuels like wood and charcoal, cutting of forests and increased animal population
(b) excessive release of NO_2 and SO_2 in atmosphere by burning of fossil fuel
(c) excessive release of NH_3 by industrial plants and coal gas

(d) excessive release of CO in atmosphere by incomplete combustion of coke, charcoal and other carbonaceous fuel in paucity of oxygen.

4. Which of the following is the major cause of global warming?

(a) re-radiation of U.V. rays by CO_2 and H_2O

(b) re-radiation of I.R. rays by CO_2 and H_2O

(c) re-radiation of I.R. rays by O_2 and N_2

(d) re-radiation of U.V. rays by O_2 and N_2

5. Which of the following statements about polar stratosphere clouds (PSCs) is not correct?

(a) PSCs do not react with chlorine nitrate and HCl

(b) Type I clouds are formed at about –77ºC and contain solid $HNO_3 . 3H_2O$

(c) Type II clouds are formed at about –85ºC and contain some ice

(d) A tight whirlpool of wind called Polar Vortex is formed which surrounds Antarctica

6. Which one of the following statements is correct?

(a) Extensive use of chemical fertilizers may lead to eutrophication of nearby water bodies

(b) Both Azotobacter and Rhizobium fix atmospheric nitrogen in root nodules of plants

(c) Cyanobacteria such as Anabaena and Nostoc are important mobilizers of phosphates and potassium for plant nutrition in soil

(d) At present it is not possible to grow maize without chemical fertilizers

15

THE Solid STATE

Fill in the Blanks :

1. _______ is not a crystalline solid?
2. Iodine molecules are held in the crystals lattice by ______.
3. Graphite is a good conductor of electricity due to the presence of ______.
4. Graphite cannot be classified as ______.
5. The total number of tetrahedral voids in the face centred unit cell is ______.
6. In the _______, the unit cell has 8 tetrahedral voids within the unit cells.
7. Cations are present in the interstitial sites in ________.
8. Silicon doped with electron – rich impurity forms _______.
9. An element (atomic mass = 100 g / mol) having bcc structure has unit cell edge 400 pm. Then, density of the element is _______ .

True/ False :

1. Crystalline solids have definite characteristic geometrical shape.
2. Sodium chloride and quartz glass are examples of crystalline solids.
3. Crystalline solids are isotropic in nature.
4. Ionic solids are electrical insulators in the solid state but conduct electricity in molten state.
5. Only $1/8^{th}$ portion of an atom located at corner of a cubic unit cell is its neighbouring unit cell.
6. Total number of atoms per unit cell for a face centered cubic unit cell is 3 .
7. In 3D hexagonal close packed structure tetrahedral voids are fomed when the triangular voids in the second layer lie above the triangular voids in the first layer and the triangular shapes of these voids do not overlap.
8. In 3D hexagonal close packed structure all the triangular voids are not covered by the spheres of the second layer.
9. ZnS, AgCl, AgBr and AgI shows Frenkel defect.
10. Schottky defect results in decrease in density of the solid.
11. For NaCl there is one Schottky defect per 10^{16} ions.
12. LiCl crystals are pink due to metal excess defect due to presence of extra Li^+ ion at interstitial sites.
13. In FeO crystals some Fe^{2+} are missing and the loss of positive charge is made up by the presence of required number of Fe^{3+} ions.
14. In semiconductors the gap between filled valence band and conduction band is small.
15. Insulators have conductivities ranging between 10^{-6} to 10^4 $ohm^{-1}\ m^{-1}$.

Conceptual MCQs

1. Most crystals show good cleavage because their atoms, ions or molecules are
   (a) weakly bonded together
   (b) strongly bonded together
   (c) spherically symmetrical
   (d) arranged in planes.
2. The number of octahedral void(s) per atom present in a cubic close-packed structure is :
   (a) 1 (b) 3
   (c) 2 (d) 4
3. A compound formed by elements X and Y crystallizes in a cubic structure in which the X atoms are at the corners of a cube and the Y atoms are at the face centres. The formula of the compound is
   (a) XY_3 (b) X_3Y
   (c) XY (d) XY_2

4. Which of the following compounds is a good conductor of electricity in solution state?
(a) Covalent
(b) Molecular solid
(c) Metallic solid
(d) Ionic compounds

5. In stoichiometric defects, the types of compound exhibit Frenkel defects have/has
(a) Low co-ordination nos.
(b) High co-ordination
(c) Small difference in the size of cations and anions
(d) None of these

6. The intermetallic compound LiAg crystallizes in a cubic lattice in which both lithium and silver atoms have coordination number of eight. To what crystal class does the unit cell belong ?
(a) Simple cubic
(b) Face-centred cubic
(c) Body-centred cubic
(d) None

7. The appearance of colour in solid alkali metal halides is generally due to
(a) Schottky defect
(b) Frenkel defect
(c) Interstitial positions
(d) F-centres

8. CsBr crystallises in a body centered cubic lattice. The unit cell length is 436.6 pm. Given that the atomic mass of Cs = 133 and that of Br = 80 amu and Avogadro number being 6.02×10^{23} mol^{-1}, the density of CsBr is
(a) 0.425 g/cm^3 (b) 8.25 g/cm^3
(c) 4.25 g/cm^3 (d) 42.5 g/cm^3

9. What type of crystal defect is indicated in the diagram below ?

$Na^+Cl^-Na^+Cl^-Na^+Cl^-$
Cl^- □ Cl^-Na^+ □ Na^+
Na^+Cl^- □ $Cl^-Na^+Cl^-$
$Cl^-Na^+Cl^-Na^+$ □ Na^+

(a) Interstitial defect
(b) Schottky defect
(c) Frenkel defect
(d) Frenkel & Schottky defects

10. Pure silicon doped with phosphorus is a
(a) metallic conductor
(b) insulator
(c) *n*-type semiconductor
(d) *p*-type semiconductor

11. Which of the following is a correct statement ?
(a) Bonding in metallic crystals is directional
(b) Diamond has two dimensional crystal lattice
(c) Co-ordination number of bcc lattice is 12
(d) A ccp structure has 8 tetrahedral and 4 Octahedral interstices.

12. The number of atoms per unit cell of bcc structure is
(a) 1 (b) 2
(c) 4 (d) 6

13. To get *n*-type doped semiconductor, impurity to be added to silicon should have the following number of valence electrons
(a) 2 (b) 5
(c) 3 (d) 1

14. The r_+/r_- ratio of ZnS is 0.402. Pick out the false statements of the following
(a) ZnS is 4 : 4 coordination compound
(b) ZnS does not crystallize in rock salt type lattice because r_+/r_- is too small to avoid overlapping of S^{2-} ions.
(c) Zn^{2+} ion is too small to fit precisely into the octahedral voids of S^{2-} ions.
(d) Zn^{2+} ion is too large to fit into the octahedral voids of S^{2-} ions.

15. The unit cell dimensions of a cubic lattice (edges a, b, c and the angles between them, α, β and γ) are
(a) $a = b = c, \alpha = \beta = \gamma = 90^0$
(b) $a = b \neq c, \alpha = \beta = \gamma = 90^0$
(c) $a = b = c, \alpha = \gamma = 90^0, \beta \neq 90^0$
(d) $a \neq b \neq c, \alpha = \beta = 90^0, \gamma \neq 90^0$

16. The second order Bragg's diffraction of X-rays of wavelength 100 pm from a set of parallel lattice planes in a metal occurs at a grazing angle of 30º. The spacing between the successive scattering planes in the cystal is
(a) 50 pm (b) 100 pm
(c) 150 pm (d) 200 pm

17. A NaCl crystal is changed into CsCl type structure by:
(a) Increasing temperature and decreasing pressure.
(b) Increasing pressure and decreasing temperature.
(c) Increasing both temperature and pressure
(d) None of these.

18. Total volume of atoms present in a face centred cubic unit cell of a metal is (*r* is atomic radius)
(a) $\frac{16}{3}\pi r^3$ (b) $\frac{20}{3}\pi r^3$
(c) $\frac{24}{3}\pi r^3$ (d) $\frac{12}{3}\pi r^3$

19. M_2X has anti fluorite structure. In such structure
(a) X^{--} ions occupy all the 8 octahedral voids
(b) Each X^{--} is surrounded by 4 M^+ in tetrahedral arrangement
(c) Larger cations occupy the position of F^- ions and smaller anions that of C^{++} ions
(d) Smaller cations occupy the position of F^- ions and larger anions that of C^{++} ions

20. A metallic element exists as cubic lattice. Each edge of the unit cell is 2.88 Å. The density of the metal is 7.20 g cm^{-3}. How many unit cell will be present in 100 g of the metal-
(a) 6.85×10^2 (b) 5.82×10^{23}
(c) 4.37×10^5 (d) 2.12×10^6

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*
(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Crystalline solids have long range order.
Reason : Amorphous solids have short range order.

2. **Assertion:** Glass panes fixed to windows or panes of old buildings are found to be slightly thicker at the bottom.
Reason: Amorphous solids have a tendency to flow.

3. **Assertion :** In crystal lattice, the size of the tetrahedral hole is larger than an octahedral hole.
Reason : The cations occupy less space than anions in crystal packing.

4. **Assertion :** In close packing of spheres, a tetrahedral void is surrounded by four spheres whereas an octahedral void is surrounded by six spheres.
Reason : A tetrahedral void has a tetrahedral shape whereas an octahedral void has an octahedral shape.

5. **Assertion :** The packing efficiency is maximum for the *fcc* structure.
Reason : The cordination number is 12 in *fcc* structures.

6. **Assertion :** In any ionic solid (MX) with Schottky defects, the number of positive and negative ions are same.
Reason : Equal number of cation and anion vacancies are present.

7. **Assertion :** Electrical conductivity of semiconductors increases with increasing temperature.
Reason : With increase in temperature, large number of electrons from the valence band can jump to the conduction band.

8. **Assertion :** On heating ferromagnetic or ferrimagnetic substances, they become paramagnetic.
Reason : The electrons change their spin on heating.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I (Type of solid)	**Column-II (Example of solid)**
(A) Molecular solid	(1) Ag
(B) Ionic solid	(2) SiC
(C) Metallic solid	(3) CCl_4
(D) Covalent solid	(4) MgO

(a) A – (4), B – (3), C – (1), D – (2)
(b) A – (2), B – (4), C – (1), D – (3)
(c) A – (3), B – (2), C – (1), D – (4)
(d) A – (3), B – (4), C – (1), D – (2)

2. Match the columns

Column-I (Type of unit cell)	**Column-II (Characteristic feature)**
(A) Primitive cubic unit cell	(1) Each of the three perpendicular edges compulsorily have the different edge length i.e.; $a \neq b \neq c$.
(B) Body centered cubic unit cell	(2) Number of atoms per unit cell is one
(C) Face centered cubic unit cell	(3) Each of the three perpendicular edges compulsorily have the same edge length i.e.; a = b = c.
(D) End centered orthorhombic unit cell	(4) In addition to the contribution from the corner atoms the number of atoms present in a unit cell is one.
	(5) In addition to the contribution from the corner atoms the number of atoms present in a unit cell is three.

(a) A – (2), B – (4), C – (3, 5), D – (1)
(b) A – (2, 3), B – (3, 4), C – (3, 5), D – (1, 4)
(c) A – (3, 4), B – (2, 3), C – (3), D – (1)
(d) A – (5), B – (3, 4), C – (1, 4), D – (2)

3. Match the columns

Column-I (Crystal system)	**Column-II (Compounds)**
(A) Rhombohedral	(1) KNO_3
(B) Orthorhombic	(2) Zinc blende
(C) Cubic	(3) CdS
(D) Hexagonal	(4) Calcite

(a) A – (1), B – (2), C – (4), D – (3)
(b) A – (3), B – (1), C – (2), D – (4)
(c) A – (4), B – (1), C – (2), D – (3)
(d) A – (2), B – (3), C – (4), D – (1)

4. Match the columns

Column-I	**Column-II**
(A) Square close packing in two dimensions	(1) Triangular voids
(B) Hexagonal close packing in two dimensions	(2) Pattern of spheres is repeated every fourth layer
(C) Hexagonal close packing in three dimensions	(3) Coordination number 4
(D) Cubic close packing in three dimensions	(4) Pattern of sphere is repeated alternate layers

(a) A – (3), B – (1), C – (4), D – (2)
(b) A – (1), B – (4), C – (2), D – (3)
(c) A – (4), B – (1), C – (2), D – (4)
(d) A – (3), B – (1), C – (4), D – (2)

5. Match Column-I (Type of close packed structure) with Column-II (Coordination number) and choose the correct option.

Column-I	**Column-II**
(A) One dimensional close packed arrangement.	(1) 12
(B) Square close packing in two dimensions.	(2) 6
(C) Two dimensional hexagonal close packing.	(3) 2

(D) Cubic close packed arrangement. (4) 4

(a) A – (3), B – (4), C – (2), D – (1)
(b) A – (3), B – (4), C – (1), D – (2)
(c) A – (4), B – (3), C – (2), D – (1)
(d) A – (4), B – (2), C – (1), D – (3)

6. Match the columns

Column-I	Column-II
(A) Impurity defect	(1) NaCl with anionic sites F-centres
(B) Metal excess defect	(2) FeO with Fe^{3+}
(C) Metal deficiency defect	(3) NaCl with Sr^{2+} and some cationic sites vacant

(a) A – (3), B – (1), C – (2)
(b) A – (1), B – (2), C – (3)
(c) A – (3), B – (2), C – (1)
(d) A – (2), B – (1), C – (3)

7. Match the columns

Column-I	Column-II
(A) Mg in solid state	(1) *p*-Type semiconductor
(B) $MgCl_2$ in molten state	(2) *n*-Type semiconductor
(C) Silicon with phosphorus	(3) Electrolytic conductors
(D) Germanium with boron	(4) Electronic conductors

(a) A – (2), B – (1), C – (3), D – (4)
(b) A – (1), B – (2), C – (4), D – (3)
(c) A – (4), B – (3), C – (2), D – (1)
(d) A – (3), B – (4), C – (1), D – (2)

8. Match the columns

Column-I (Molecule/ion)	Column-II (Magnetic property)
(A) C_6H_6	(1) Antiferromagnetic
(B) CrO_2	(2) Ferrimagnetic
(C) MnO	(3) Ferromagnetic
(D) Fe_3O_4	(4) Paramagnetic
(E) Fe^{3+}	(5) Diamagnetic

(a) A – (5), B – (3), C – (2), D – (1), E – (4)
(b) A – (3), B – (5), C – (1), D – (4), E – (2)
(c) A – (5), B – (3), C – (1), D – (2), E – (4)
(d) A – (5), B – (3), C – (1), D – (4), E – (2)

9. Match the columns

Column-I (Compound)	Column-II (Magnetic Property)
(A) NaCl	(1) Ferrimagnetic
(B) MnO	(2) Paramagnetic
(C) $CrCl_3$	(3) Ferromagnetic
(D) CrO_2	(4) Diamagnetic
(E) $MgFe_2O_4$	(5) Antiferromagnetic

(a) A – (1), B – (3), C – (2), D – (5), E – (4)
(b) A – (5), B – (2), C – (3), D – (1), E – (4)
(c) A – (3), B – (5), C – (2), D – (1), E – (4)
(d) A – (4), B – (5), C – (2), D – (3), E – (1)

Critical Thinking Type Questions :

1. Which of the following features are not shown by quartz glass ?
(i) This is a crystalline solid.
(ii) Refractive index is same in all the directions.
(iii) This has definite heat of fusion.
(iv) This is also called super cooled liquid.
(a) (i) and (iii)
(b) (iii) and (iv)
(c) (i), (ii) and (iv)
(d) (iii) only

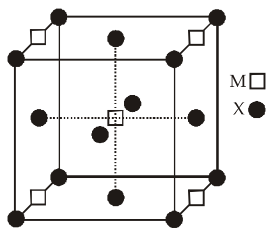
2. Na and Mg crystallize in *bcc* and *fcc* type crystals respectively, then the number of atoms of Na and Mg present in the unit cell of their respective crystal is
(a) 4 and 2
(b) 9 and 14
(c) 14 and 9
(d) 2 and 4

3. In a cubic lattice A atom occupy all the corners. If B atom occupy one of the opposite face, and atom C occupy the remaining faces. The simplest formulae of the compound is
(a) ABC_3
(b) ABC_2
(c) ABC
(d) AB_2C

4. A solid has a structure in which 'W' atoms are located at the corners of a cubic lattice 'O' atoms at the centre of edges and Na atoms at the centre of the cube. The formula for the compound is

(a) Na_2WO_3 (b) Na_2WO_2
(c) $NaWO_2$ (d) $NaWO_3$

5. A compound M_pX_q has cubic close packing (ccp) arrangement of X. Its unit cell structure is shown below. The empirical formula of the compound is



(a) MX (b) MX_2
(c) M_2X (d) M_5X_{14}

6. In which of the following structures coordination number for cations and anions in the packed structure will be same?

(a) Cl^- ion form *fcc* lattice and Na^+ ions occupy all octahedral voids of the unit cell.
(b) Ca^{2+} ions form *fcc* lattice and F^- ions occupy all the eight tetrahedral voids of the unit cell.
(c) O^{2-} ions form *fcc* lattice and Na^+ ions occupy all the eight tetrahedral voids of the unit cell.
(d) S^{2-} ions form *fcc* lattice and Zn^{2+} ions go into alternate tetrahedral voids of the unit cell.

7. If '*a*' stands for the edge length of the cubic systems : simple cubic, body centred cubic and face centred cubic, then the ratio of radii of the spheres in these systems will be respectively,

(a) $\frac{1}{2}a : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a$

(b) $\frac{1}{2}a : \sqrt{3}a : \frac{1}{\sqrt{2}}a$

(c) $\frac{1}{2}a : \frac{\sqrt{3}}{2}a : \frac{\sqrt{3}}{2}a$

(d) $1a : \sqrt{3}a : \sqrt{2}a$

8. The edge length of unit cell of a metal having molecular weight 75 g/mol is 5Å which crystallizes in cubic lattice. If the density is 2g/cc then find the radius of metal atom. ($N_A = 6 \times 10^{23}$). Give the answer in pm.

(a) 217 pm (b) 210 pm
(c) 220 pm (d) 205 pm

9. Al (at. wt 27) crystallizes in the cubic system with a cell edge of 4.05 Å . Its density is 2.7 g per cm^3. Determine the unit cell type calculate the radius of the Al atom

(a) fcc, 2.432 Å (b) bcc, 2.432 Å
(c) bcc, 1.432 Å (d) fcc, 1.432 Å

16 Solutions

Fill in the Blanks :

1. The vapour pressure of pure benzene at 25°C is 640 mm Hg and that of solution of solute A is 630 mm Hg. The molality of solution is _______ .

2. On adding a solute to a solvent having vapour pressure 0.80 atm, vapour pressure reduces to 0.60 atm. Mole fraction of solute is _______ .

3. When a solid solute is added to the solvent, some solute dissolves and its concentration increases in solution. This process is known as _______ . Some solute particles in solution collide with the solid solute particles and get separated out of solution. This process is known as ____ .

4. _______ do not affect solubility of solid solute in liquid.

5. At equillibrium the rate of dissolution of a solid solute in a volatile liquid solvent is equal to the rate of _______ .

6. A beaker contains a solution of substance 'A'. Precipitation of substance 'A' takes place when small amount of 'A' is added to the solution. The solution is _______ .

7. Maximum amount of a solid solute that can be dissolved in a specified amount of a given liquid solvent does **not** depend upon _______ .

8. Low concentration of oxygen in the blood and tissues of people living at high altitude is due to _______ .

9. Value of Henry's constant K_H increases with _______ in temperature.

10. Scuba divers may experience a condition called ______. To avoids this, the tanks used by scuba divers are filled with air diluted with _____ .

11. The vapour pressure of the solution at a given temperature is found to be _______ than the vapour pressure of the pure solvent at the same temperature.

12. We have three aqueous solutions of NaCl labelled as 'A', 'B' and 'C' with concentrations 0.1M, 0.01M and 0.001M, respectively. The value of van't Hoff factor for these solutions will be in the order ________.

True/ False :

1. 3.62 mass percentage of sodium hypochlorite in water is used as commercial bleaching solution.

2. 35% volume percentage of ethylene glycol is used as an antifreeze (as coolent in car engines).

3. Higher the value of K_H at a given temperature, lower is the solubility of the nature of gas in the liquid.

4. Solubility of gases increases with increase of temperature.

5. Polar solutes dissolve in a polar solvent.

6. Non-polar solutes dissolve in a non-polar solvent.

7. The liquid boils at the temperature at which its vapour pressure is equal to the atmospheric pressure.

8. In bromoethane and chloroethane mixture intermolecular interactions of A-A and B-B type are nearly same as A-B type interactions.

9. In chloroform and acetone mixture A-A or B-B type intermolecular interactions are weaker than A-B type interactions.

10. A 0.5 m NaBr solution has a higher vapour pressure than a 0.5 m $BaCl_2$ solution at the same temperature

11. Pure water freezes at the higher temperature than pure methanol

12. During osmosis ,solvent molecules always flow from higher concentration to lower concentration of solution.

Conceptual MCQs

1. An ideal solution is formed when its components
   (a) have no volume change on mixing
   (b) have no enthalpy change on mixing
   (c) have both the above characteristics
   (d) have high solubility.
2. Formation of a solution from two components can be considered as
   (i) Pure solvent $\rightarrow$ separated solvent molecules, ΔH_1
   (ii) Pure solute $\rightarrow$ separated solute molecules, ΔH_2
   (iii) Separted solvent & solute molecules $\rightarrow$ Solution, ΔH_3
   Solution so formed will be ideal if
   (a) H_{soln} H_3 H_1 H_2
   (b) H_{soln} H_1 H_2 H_3
   (c) H_{soln} H_1 H_2 H_3
   (d) H_{soln} H_1 H_2 H_3
3. Which of the following colligative property can provide molar mass of proteins (or polymers or colloids) with greatest precision ?
   (a) Osmotic pressure
   (b) Elevation of boiling point
   (c) Depression of freezing point
   (d) Relative lowering of vapour pressure
4. 25.3 g of sodium carbonate, Na_2CO_3 is dissolved in enough water to make 250 mL of solution. If sodium carbonate dissociates completely, molar concentration of sodium ions, Na^+ and carbonate ions, CO_3^{2-} are respectively (Molar mass of Na_2CO_3 = 106 g mol^{-1})
   (a) 0.955 M and 1.910 M
   (b) 1.910 M and 0.955 M
   (c) 1.90 M and 1.910 M
   (d) 0.477 M and 0.477 M
5. A solution of acetone in ethanol
   (a) shows a positive deviation from Raoult's law
   (b) behaves like a non ideal solution
   (c) obeys Raoult's law
   (d) shows a negative deviation from Raoult's law
6. A solution of urea (mol. mass 56 g mol^{-1}) boils at 100.18°C at the atmospheric pressure. If K_f and K_b for water are 1.86 and 0.512 K kg mol^{-1} respectively, the above solution will freeze at
   (a) 0.654°C (b) – 0.654°C
   (c) 6.54°C (d) – 6.54°C
7. P_A and P_B are the vapour pressure of pure liquid components, A and B, respectively of an ideal binary solution. If X_A represents the mole fraction of component A, the total pressure of the solution will be.
   (a) $P_A + X_A (P_B - P_A)$ (b) $P_A + X_A (P_A - P_B)$
   (c) $P_B + X_A (P_B - P_A)$ (d) $P_B + X_A (P_A - P_B)$
8. Which one of the following salts will have the same value of van't Hoff factor (i) as that of $K_4[Fe(CN)_6]$.
   (a) $Al_2(SO_4)_3$ (b) NaCl
   (c) $Al(NO_3)_3$ (d) Na_2SO_4.
9. How many grams of concentrated nitric acid solution should be used to prepare 250 mL of 2.0M HNO_3 ? The concentrated acid is 70% HNO_3
   (a) 90.0 g conc. HNO_3 (b) 70.0 g conc. HNO_3
   (c) 54.0 g conc. HNO_3 (d) 45.0 g conc. HNO_3
10. Colligative properties of the solution depend on
    (a) Nature of solute
    (b) Nature of solvent
    (c) Number of particles present in the solution
    (d) Number of moles of solvent only
11. Which is not a colligative property ?
    (a) Freezing point
    (b) Lowering of vapour pressure
    (c) Depression of freezing point
    (d) Elevation of boiling point
12. For a dilute solution, Raoult's law states that
    (a) the lowering of vapour pressure is equal to the mole fraction of the solute
    (b) the relative lowering of vapour pressure is equal to the mole fraction of the solute
    (c) the relative lowering of vapour pressure is proportional to the amount of solute in solution
    (d) the vapour pressure of the solution is equal to the mole fraction of the solvent
13. The osmotic pressures of equimolar solution of $BaCl_2$, NaCl and sucrose will be in the order
    (a) Sucrose > NaCl > $BaCl_2$
    (b) Sucrose > $BaCl_2$ > NaCl
    (c) NaCl > $BaCl_2$ > Sucrose
    (d) $BaCl_2$ > NaCl > Sucrose
14. Osmotic pressure of a sugar solution at 24°C is 2.5 atmosphere. The concentration of the solution in gm mole per litre is
    (a) 10.25 (b) 1.025
    (c) 102.5 (d) 0.1025

15. For preparing 0.1 N solution of a compound from its impure sample of which the percentage purity is known, the weight of the substance required will be
(a) less than the theoretical weight
(b) more than the theoretical weight
(c) same as the theoretical weight
(d) none of these

16. The freezing point of a solution prepared from 1.25 gm of a non electrolyte and 20 gm of water is 271.94 K. If K_f is 1.86 $Kmol^{-1}$. Then the molar mass of the solute will be nearly :
(a) 109 (b) 106
(c) 115 (d) 93

17. A solution is obtained by dissolving 12 gm of urea (mol. wt. 60) in a litre of water. Another solution is obtained by dissolving 68.4 gm of cane sugar (mol. wt. 342) in a litre of water at the same temperature. The lowering of vapour pressure in the first solution is
(a) same as that of 2nd solution
(b) nearly one-fifth of the 2nd solution
(c) double that of 2nd solution
(d) nearly five times that of 2nd solution

18. The following equation is a completely balanced equation?

$$3Sn + 12HCl + 4HNO_3 \longrightarrow 3SnCl_4 + 4NO + 8H_2O$$

In the above reaction, the number of equivalent per formula weight of HNO_3 is
(a) 3 (b) 4
(c) 1 (d) 2

19. If $\frac{N}{10}$ 50 ml H_2SO_4, $\frac{N}{3}$ 30 ml HNO_3, $\frac{N}{2}$ 10 ml HCl is mixed and solution is made to 1L. Then normality of resultant solution is
(a) $\frac{N}{20}$ (b) $\frac{N}{40}$
(c) $\frac{N}{50}$ (d) N

20. The 5.85 g of NaCl and one kg of water is added to prepare a solution. What is the strength of NaCl in this solution ?
(Molecular weight of NaCl = 58.5)
(a) 0.1 Normal (b) 0.1 Molal
(c) 0.1 Molar (d) 0.1 Formal

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*
(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Molarity of a solution in liquid state changes with temperature.
Reason : The volume of a solution changes with change in temperature.

2. **Assertion :** If a liquid solute more volatile than the solvent is added to the solvent, the vapour pressure of the solution may increase i.e., $p_s > p^o$.
Reason : In the presence of a more volatile liquid solute, only the solute will form the vapours and solvent will not.

3. **Assertion :** If one component of a solution obeys Raoult's law over a certain range of composition, the other component will not obey Henry's law in that range.
Reason : Raoult's law is a special case of Henry's law.

4. **Assertion :** Azeotropic mixtures are formed only by non-ideal solutions and they may have boiling points either greater than both the components or less than both the components.
Reason : The composition of the vapour phase is same as that of the liquid phase of an azeotropic mixture.

5. **Assertion :** When methyl alcohol is added to water, boiling point of water increases.
Reason : When a volatile solute is added to a volatile solvent elevation in boiling point is observed.

6. **Assertion :** When NaCl is added to water a depression in freezing point is observed.
Reason : The lowering of vapour pressure of a solution causes depression in the freezing point.

7. **Assertion :** When a solution is separated from the pure solvent by a semi- permeable membrane, the solvent molecules pass through it from pure solvent side to the solution side
Reason : Diffusion of solvent occurs from a region of high concentration solution to a region of low concentration solution.

Matching Based Questions :

1. Match the columns

Column -I	Column-II
(A) Mass percentage	(1) Medicine and pharmacy
(B) Mass by volume	(2) Concentration of pollutants in water
(C) ppm	(3) Industrial chemical application
(D) Volume percentage	(4) Liquid solutions

(a) A – (2), B – (1), C – (4), D – (3)
(b) A – (4), B – (3), C – (1), D – (2)
(c) A – (3), B – (2), C – (4), D – (1)
(d) A – (3), B – (1), C – (2), D – (4)

2. Match the columns

Column-I	Column-II
(A) Na-Hg Amalgam	(1) gas - solid
(B) H_2 in Pd	(2) gas - liquid
(C) Camphor in nitrogen gas	(3) liquid - solid
(D) Oxygen dissolved in water	(4) solid - gas

(a) A – (2), B – (4), C – (3), D – (1)
(b) A – (5), B – (1), C – (2), D – (4)
(c) A – (3), B – (1), C – (4), D – (2)
(d) A – (4), B – (2), C – (1), D – (1)

3. Match the Column I, II & III and choose the correct option.

Column-I	Column-II	Column-III
(A) Gaseous solutions	(1) Solid-liquid	(h) Copper dissolved in gold
(B) Liquid solutions	(2) Solid-solid	(i) Chloroform mixed with nitrogen
(C) Solid solutions	(3) Liquid-gas	(j) Common salt dissolved in water

(a) (A) – (3) – (h), (B) – (3) – (i), (C) – (1) – (j)
(b) (A) – (3) – (i), (B) – (1) – (j), (C) – (2) – (h)
(c) (A) – (3) – (j), (B) – (1) – (h), (C) – (2) – (i)
(d) (A) – (3) – (j), (B) – (2) – (i), (C) – (1) – (h)

4. Match the columns

Column-I	Column-II
(A) Saturated solution	(1) Solution having same osmotic pressure at a given temperature as that of given solution.
(B) Binary solution	(2) A solution whose osmotic pressure is less than that of another.
(C) Isotonic solution	(3) Solution with two components
(D) Hypotonic solution	(4) A solution which contains maximum amount of solute that can be dissolved in a given amount of solvent at a given temperature.

(a) A – (4), B – (3), C – (1), D – (2)
(b) A – (3), B – (1), C – (4), D – (2)
(c) A – (3), B – (4), C – (2), D – (1)
(d) A – (2), B – (1), C – (3), D – (4)

5. Match the laws given in the Column-I with expression given in Column-II.

Column-I	Column-II
(A) Raoult's law	(1) $\Delta T_f = K_f m$
(B) Henry's law	(2) $\pi = CRT$
(C) Elevation of boiling point	(3) $p = x_1 p_1^o + x_2 p_2^o$
(D) Depression in freezing point	(4) $\Delta T_b = K_b m$
(E) Osmotic pressure	(5) $p = K_H . x$

(a) A – (3), B – (5), C – (4), D – (1), E – (2)
(b) A – (5), B – (3), C – (2), D – (4), E – (1)
(c) A – (1), B – (5), C – (3), D – (2), E – (4)
(d) A – (4), B – (1), C – (2), D – (3), E – (5)

Critical Thinking Type Questions :

1. When a gas is bubbled through water at 298 K, a very dilute solution of the gas is obtained. Henry's law constant for the gas at 298 K is 100 kbar. If the gas exerts a partial pressure of 1 bar, the number of millimoles of the gas dissolved in one litre of water is

(a) 0.555 (b) 5.55
(c) 0.0555 (d) 55.5

2. K_H value for Ar(g), CO_2(g), HCHO (g) and CH_4(g) are 40.39, 1.67, 1.83×10^{-5} and 0.413 respectively. Arrange these gases in the order of their increasing solubility.

(a) HCHO < CH_4 < CO_2 < Ar
(b) HCHO < CO_2 < CH_4 < Ar
(c) Ar < CO_2 < CH_4 < HCHO
(d) Ar < CH_4 < CO_2 < HCHO

3. The normality of orthophosphoric acid having purity of 70 % by weight and specific gravity 1.54 is

(a) 11 N (b) 22 N
(c) 33 N (d) 44 N

4. Consider a and b are two components of a liquid mixture, their corresponding vapour pressure (mmHg) are respectively 450 and 700 in pure states and total pressure given is 600. Then corresponding composition in liquid phase will be

(a) 0.4, 0.6 (b) 0.5, 0.5
(a) 0.6, 0.4 (d) 0.3, 0.7

5. At 300 K the vapour pressure of an ideal solution containing 1 mole of liquid A and 2 moles of liquid B is 500 mm of Hg. The vapour pressure of the solution increases by 25 mm of Hg, if one more mole of B is added to the above ideal solution at 300 K. Then the vapour pressure of A in its pure state is

(a) 300 mm of Hg (b) 400 mm of Hg
(c) 500 mm of Hg (d) 600 mm of Hg

6. The vapour pressure of a solvent decreases by 10 mm of Hg when a non-volatile solute was added to the solvent. The mole fraction of the solute in the solution is 0.2. What should be the mole fraction of the solvent if the decrease in the vapour pressure is to be 20 mm of Hg ?

(a) 0.8 (b) 0.6
(c) 0.4 (d) 0.2

7. The difference between the boiling point and freezing point of an aqueous solution containing sucrose (molecular wt = 342 g mole^{-1}) in 100 g of water is 105°C. If K_f and K_b of water are 1.86 and 0.51 K kg mol^{-1} respectively, the weight of sucrose in the solution is about

(a) 34.2 g (b) 342 g
(c) 7.2 g (d) 72 g

8. An 1% solution of KCl (I), NaCl (II), $BaCl_2$ (III) and urea (IV) have their osmotic pressure at the same temperature in the ascending order (molar masses of NaCl, KCl, $BaCl_2$ and urea are respectively 58.5, 74.5, 208.4 and 60 g mole^{-1}). Assume 100% ionization of the electrolytes at this temperature

(a) I < III < II < IV
(b) III < I < II < IV
(c) I < II < III < IV
(d) III < IV < I < II

9. If the elevation in boiling point of a solution of non-volatile, non-electrolytic and non-associating solute in a solvent (K_b = x K kg mol^{-1}) is y K, then the depression in freezing point of solution of same concentration would be (K_f of the solvent = z K kg mol^{-1})

(a) $\frac{2xz}{y}$ (b) $\frac{yz}{x}$

(c) $\frac{xz}{y}$ (d) $\frac{yz}{2x}$

17 Electrochemistry

Fill in the Blanks :

1. The more _______ the standard reduction potential, the _______ is its ability to displace hydrogen from acids.
2. The electrical conductivity of a solution of acetic acid will be _______ if a solution of sodium hydroxide is added.
3. The difference between the electrode potentials of two electrodes when no current is drawn through the cell is called _______ .
4. The _______ electrode is made by using Hg_2Cl_2
5. In the electrochemical reaction

   $$2Fe^{3+} + Zn \longrightarrow Zn^{2+} + 2Fe^{2+},$$

   on _______ the concentration of Fe^{2+} cell emf decreases.
6. The standard emf of a cell, involving one electron change is found to be 0.591 V at 25°C. The equilibrium constant of the reaction is (F = 96500 C mol^{-1}) _______ .
7. The unit of equivalent conductivity is ______ .
8. The cell constant of a conductivity cell _______ for a cell.
9. In electrolysis of dilute H_2SO_4 using _______ electrodes H_2 is evolved at cathode
10. When 0.1 mol MnO_4^{2-} is oxidised the quantity of electricity required to completely oxidise MnO_4^{2-} to MnO_4^{-} is _______ .

True/ False :

1. According to a convention cell potential of hydrogen electrode (S.H.E.) is considered to be zero at all temperatures.
2. e.m.f. of the cell Pt(s)/H_2(g, 1 bar)/H^+(aq, 1 M) $\|\, Zn^{2+}(aq, 1M)/Zn$ is – 0.76. This negative value indicates that Zn^{2+} ion reduces less easily then H^+ ions.
3. Copper does not dissolve in HCl but dissolves in HNO_3 as in nitric acid it gets oxidised by nitrate ion.
4. Inert metals like Pt or Au are used in certain electrodes i.e., these metals does not participate in reaction but provide surface for oxidation and reduction reactions.
5. Fluorine has the highest electrode potential thereby making it strongest oxidising agent whereas lithium with lowest electrode potential is the weakest oxidising and strongest reducing agent.
6. Molar conductivity for strong electrolytes increases gradually and of weak electrolytes increases rapidly on dilution.
7. Molar conductivity of CaX_2 increases rapidly on dilution.
8. According to Faraday's second law amounts of different substances liberated by same quantity of electricity passing through the electrolytic solution are proportional to their chemical equivalent weights.
9. 1 F = 96487 Cmol^{-1} $\simeq$ 96500 Cmol^{-1} (for more accurate calculation).
10. As per electrode reactions

    $$K^+ + e^- \longrightarrow K$$

    $$Al^{3+} + 3e^- \longrightarrow Al$$

    one mole of K^+ and Al^{3+} require 1(1F) and 3(3F) mol of electrons respectively.

Conceptual MCQs

1. Which of the following expressions correctly represents the equivalent conductance at infinite dilution of $Al_2(SO_4)_3$, Given that $\Lambda^\circ_{Al^{3+}}$ and $\Lambda^\circ_{SO_4^{2-}}$ are the equivalent conductances at infinite dilution of the respective ions?

(a) $\frac{1}{3}\Lambda^{\circ}_{Al^{3+}} + \frac{1}{2}\Lambda^{\circ}_{SO_4^{2-}}$

(b) $2\Lambda^{\circ}_{Al^{3+}} + 3\Lambda^{\circ}_{SO_4^{2-}}$

(c) $\Lambda^{\circ}_{Al^{3+}} + \Lambda^{\circ}_{SO_4^{2-}}$

(d) $\left(\Lambda^{\circ}_{Al^{3+}} + \Lambda^{\circ}_{SO_4^{2-}}\right) \times 6$

2. The conductivity of strong electrolyte
(a) Increases on dilution slightly
(b) Decreases on dilution
(c) Does not change with dilution
(d) Depends upon density of electrolytes itself

3. In electrolytic cell, cathode acts as an/a
(a) oxidising agent (b) reducing agent
(c) either of the two (d) neither (a) nor (b)

4. Which of the following is non-electrolyte?
(a) NaCl (b) $CaCl_2$
(c) $C_{12}H_{22}O_{11}$ (d) CH_3COOH

5. Standard electrode potential of three metals X, Y and Z are – 1.2 V, + 0.5 V and – 3.0 V, respectively. The reducing power of these metals will be :
(a) $Y > Z > X$ (b) $X > Y > Z$
(c) $Z > X > Y$ (d) $X > Y > Z$

6. Aluminium displaces hydrogen from acids but copper does not. A galvanic cell prepared by combining Cu / Cu^{2+} and Al/Al^{3+} has an e.m.f of 2.0 V at 298°K. If the potential of copper electrode is + 0.34 V, that of aluminium is
(a) $+1.66$ (b) -1.66
(c) $+2.34$ (d) -2.3 V

7. The unit of equivalent conductivity is
(a) $S\ cm^{-2}$
(b) ohm cm^2 (g - equivalent)
(c) ohm cm
(d) $ohm^{-1}cm^2$ (g equivalent)$^{-1}$

8. Two electrolytic cells, one containing acidified ferrous chloride and another acidified ferric chloride, are connected in series. The ratio of iron deposited at cathodes in the two cells will be :
(a) 3 : 1 (b) 2 : 1
(c) 1 : 1 (d) 3 : 2

9. The standard electrode potentials of four elements A, B, C and D are –3.05, –1.66, –0.40 and +0.80. The highest chemical reactivity will be exhibited by :
(a) A (b) B
(c) C (d) D

10. The standard reduction potentials at 25°C of Li^+ / Li, Ba^{2+} / Ba, Na^+ / Na and Mg^{2+} / Mg are $-3.03, -2.73, -2.71$ and -2.37 volt respectively. Which one of the following is the strongest oxidising agent?
(a) Na^+ (b) Li^+
(c) Ba^{2+} (d) Mg^{2+}

11. An electrochemical cell is set up as: Pt; H_2 (1atm)|HCl(0.1 M) || CH_3COOH (0.1 M)| H_2 (1atm); Pt. The e.m.f of this cell will not be zero, because
(a) the temperature is constant
(b) e.m.f depends on molarities of acids used
(c) acids used in two compartments are different
(d) pH of 0.1 M HCl and 0.1 M CH_3COOH is not same

12. If the E°_{cell} for a given reaction has a negative value, then which of the following gives the correct relationships for the values of ΔG° and K_{eq} ?
(a) $\Delta G^{\circ} > 0 ; K_{eq} > 1$ (b) $\Delta G^{\circ} < 0 ; K_{eq} > 1$
(c) $\Delta G^{\circ} < 0 ; K_{eq} < 1$ (d) $\Delta G^{\circ} > 0 ; K_{eq} < 1$

13. Equivalent conductances of NaCl, HCl and CH_3COONa at infinite dilution are 126.45, 426.16 and 91 ohm^{-1} cm^2 respectively. The equivalent conductance of CH_3COOH at infinite dilution would be
(a) 101.38 ohm^{-1} cm^2 (b) 253.62 ohm^{-1} cm^2
(c) 390.71 ohm^{-1} cm^2 (d) 678.90 ohm^{-1} cm^2

14. E° for the cell, $Zn \left| Zn^{2+} (aq) \right|\left| Cu^{2+} (aq) \right| Cu$ is 1.10 V at 25°C. The equilibrium constant for the cell reaction:

$$Zn + Cu^{2+} (aq) \rightleftharpoons Cu + Zn^{2+} (aq),$$

is of the order of
(a) 10^{-18} (b) 10^{-37}
(c) 10^{18} (d) 10^{37}

15. Standard potentials (E°) for some half-reactions are given below :

(1) $Sn^{4+} + 2e \rightarrow Sn^{2+}$; E° = +0.15 V

(2) $2Hg^{2+} + 2e \rightarrow Hg_2^{2+}$; E° = +0.92 V

(3) $PbO_2 + 4H^+ + 2e \rightarrow Pb^{2+} + 2H_2O$;
E° = +1.45 V

Based on the above, which one of the following statements is correct ?

(a) Sn^{4+} is a stronger oxidising agent than Pb^{4+}
(b) Sn^{2+} is a stronger reducing agent than Hg_2^{2+}
(c) Hg^{2+} is a stronger oxidising agent than Pb^{4+}
(d) Pb^{2+} is a stronger reducing agent than Sn^{2+}

16. Limiting molar conductivity of NH_4OH $\left(\text{i.e., } \overset{o}{\Lambda}_{m(NH_4OH)}\right)$ is equal to :

(a) $\overset{o}{\Lambda}_{m(NH_4Cl)} + \overset{o}{\Lambda}_{m(NaCl)} - \overset{o}{\Lambda}_{m(NaOH)}$
(b) $\overset{o}{\Lambda}_{m(NaOH)} + \overset{o}{\Lambda}_{m(NaCl)} - \overset{o}{\Lambda}_{m(NH_4Cl)}$
(c) $\overset{o}{\Lambda}_{m(NH_4OH)} + \overset{o}{\Lambda}_{m(NH_4Cl)} - \overset{o}{\Lambda}_{m(HCl)}$
(d) $\overset{o}{\Lambda}_{m(NH_4Cl)} + \overset{o}{\Lambda}_{m(NaOH)} - \overset{o}{\Lambda}_{m(NaCl)}$

17. In the silver plating of copper, $K[Ag(CN)_2]$ is used instead of $AgNO_3$. The reason is
(a) A thin layer of Ag is formed on Cu
(b) More voltage is required
(c) Ag^+ ions are completely removed from solution
(d) Less availability of Ag^+ ions, as Cu cannot displace Ag from $[Ag(CN)_2]^-$ ion

18. The e.m.f. of a Daniell cell at 298 K is E_1.

$$Zn\left|\begin{array}{c} ZnSO_4 \\ (0.01\text{ M})\end{array}\right|\left|\begin{array}{c} CuSO_4 \\ (1.0\text{ M})\end{array}\right|Cu$$

When the concentration of $ZnSO_4$ is 1.0 M and that of $CuSO_4$ is 0.01 M, the e.m.f. changed to E_2. What is the relationship between E_1 and E_2?

(a) $E_2 = 0 \neq E_1$ (b) $E_1 > E_2$
(c) $E_1 < E_2$ (d) $E_1 = E_2$

19. The chemical reaction,

$$2AgCl_{(s)} + H_{2(g)} \longrightarrow 2HCl_{(aq)} + 2Ag(s)$$

taking place in a galvanic cell is represented by the notation

(a) $Pt_{(s)} \mid H_{2(g)}, 1\text{ bar} \mid 1M\,KCl_{(aq)} \mid AgCl_{(s)} \mid Ag_{(s)}$
(b) $Pt_{(s)} \mid H_{2(g)}, 1\text{ bar} \mid 1M\,HCl_{(aq)} \mid 1M\,Ag^+_{(aq)} \mid Ag_{(s)}$
(c) $Pt_{(s)} \mid H_{2(g)}, 1\text{ bar} \mid 1M\,HCl_{(aq)} \mid AgCl_{(s)} \mid Ag_{(s)}$
(d) $Pt_{(s)} \mid H_{2(g)}, 1\text{ bar} \mid 1M\,HCl_{(aq)} \mid Ag_{(s)} \mid AgCl_{(s)}$

20. A hypothetical electrochemical cell is shown below

$$\overset{\ominus}{A} \mid A^+(xM) \parallel B^+(yM) \mid \overset{\oplus}{B}$$

The emf measured is +0.20 V. The cell reaction is

(a) $A^+ + e^- \to A;\ B^+ + e^- \to B$
(b) The cell reaction cannot be predicted
(c) $A + B^+ \to A^+ + B$
(d) $A^+ + B \to A + B^+$

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The resistivity for a substance is its resistance when it is one meter long and its area of cross section is one square meter.
Reason : The SI units of resistivity is ohm metre (Ωm).

2. **Assertion :** On increasing dilution, the specific conductance keep on increasing.
Reason : On increasing dilution, degree of ionisation of weak electrolyte increases and molality of ions also increases.

3. **Assertion :** Galvanised iron does not rust.
Reason : Zinc has a more negative electrode potential than iron.

4. **Assertion:** Electrical conductivity of copper increases with increase in temperature
Reason: The electrical conductivity of metals is due to motion of electrons.

5. **Assertion :** A small amount of acid or alkali is added before electrolysis of water.
Reason : Pure water is weak electrolyte.

6. **Assertion :**The cell potential of mercury cell is 1.35V, which remains constant.
Reason : In mercury cell, the electrolyte is a paste of KOH and ZnO.

7. **Assertion :** If $\lambda^o_{Na^+}$ and $\lambda^o_{Cl^-}$ are molar limiting conductivity of sodium and chloride ions respectively, then the limiting molar conductivity for sodium chloride is given by the equation :
$\Lambda^o_{NaCl} = \lambda^o_{Na^+} + \lambda^o_{Cl^-}$
Reason : This is according to Kohlrausch law of independent migration of ions.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the Column-I (functioning of Daniel cell) with Column-II (value of E_{ext}) and choose the correct option.

Column-I	Column-II
(A) Flow of electrons from Cu to Zn and current flows from Zn to Cu	(1) E = 1.1 V
(B) No flow of electrons or current	(2) E < 1.1 V
(C) Zn dissolves at anode and copper deposits at cathode	(3) E > 1.1 V

(a) (A) – (2), (B) – (1), (C) – (3)
(b) (A) – (3), (B) – (1), (C) – (2)
(c) (A) – (1), (B) – (3), (C) – (2)
(d) (A) – (3), (B) – (2), (C) – (1)

2. Match the items of Column I and Column II on the basis of data given below :
$E^{\ominus}_{F_2/F^-} = 2.87\ V$, $E^{\ominus}_{Li^+/Li} = -3.5\ V$, $E^{\ominus}_{Au^{3+}/Au} = 1.4\ V$, $E^{\ominus}_{Br_2/Br^-} = 1.09\ V$

Column-I	Column-II
(A) F_2	(1) metal is the strongest reducing agent.
(B) Li	(2) anion that can be oxidised by Au^{3+}
(C) Au^{3+}	(3) non metal which is the best oxidising agent
(D) Br^-	(4) metal ion which is an oxidising agent

(a) (A) – (3), (B) – (1), (C) – (4), (D) – (2)
(b) (A) – (1), (B) – (3), (C) – (4), (D) – (2)
(c) (A) – (2), (B) – (1), (C) – (4), (D) – (3)
(d) (A) – (3), (B) – (4), (C) – (1), (D) – (2)

3. Match the columns.

Column-I	Column-II
(A) Λ_m	(1) intensive property
(B) $E^{\ominus}_{cell}$	(2) Depends on number of ions/ volume
(C) κ	(3) Extensive property
(D) $\Delta_r G_{cell}$	(4) Increases with dilution

(a) (A) – (1), (B) – (4), (C) – (2), (D) – (3)
(b) (A) – (4), (B) – (1), (C) – (2), (D) – (3)
(c) (A) – (4), (B) – (2), (C) – (1), (D) – (3)
(d) (A) – (4), (B) – (1), (C) – (3), (D) – (2)

4. Match the columns.

Column-I	Column-II
(A) κ	(1) $I \times t$
(B) Λ_m	(2) Λ_m / Λ^o_m
(C) α	(3) $\frac{\kappa}{c}$
(D) Q	(4) $\frac{G^*}{R}$

(a) (A) – (1), (B) – (3), (C) – (2), (D) – (4)
(b) (A) – (4), (B) – (2), (C) – (3), (D) – (1)
(c) (A) – (3), (B) – (4), (C) – (2), (D) – (1)
(d) (A) – (4), (B) – (3), (C) – (2), (D) – (1)

5. Match the columns

	Column-I		Column-II
(A)	Cell in which electrolyte is a paste of KOH and ZnO. This cell is used in low current devices like hearing aids, watches, etc.	(1)	H_2-O_2 fuel cell
(B)	Cell in which 38% H_2SO_4 solution is used as an electrolyte.	(2)	Mercury cell
(C)	Cell in which vapours produced during electro-chemical reaction were condensed and added to drinking water	(3)	Lead storage battery
(D)	Cell having longer life than lead storage cell and is expensive to manufacture	(4)	Nickel – Cadmium cell

(a) (A) – (3), (B) – (2), (C) – (1), (D) – (4)
(b) (A) – (2), (B) – (3), (C) – (1), (D) – (4)
(c) (A) – (2), (B) – (3), (C) – (1), D) – (4)
(d) (A) – (2), (B) – (3), (C) – (4), (D) – (1)

Critical Thinking Type Questions :

1. At 298K the standard free energy of formation of H_2O (ℓ) is –237.20 kJ/mole while that of its ionisation into H^+ ion and hydroxyl ions is 80 kJ/mole, then the emf of the following cell at 298 K will be
[Take Faraday constant F = 96500C]
$H_2(g, 1\text{ bar})\,|\,H^+(1M)\,||\,OH^-(1M)\,|\,O_2(g, 1\text{ bar})$
(a) 0.40V (b) 0.81V
(c) 1.23 V (d) – 0.40 V

2. $Cu^+(aq)$ is unstable in solution and undergoes simultaneous oxidation and reduction according to the reaction :

$$2Cu^+(aq) \rightleftharpoons Cu^{2+}(aq) + Cu(s)$$

Choose correct E° for given reaction if $E°$ Cu^{2+}/Cu = 0.34 V and $E°$ Cu^{2+}/Cu^+ = 0.15 V
(a) –0.38 V (b) +0.49 V
(c) +0.38 V (d) –0.19 V

3. The cell, $Zn\,|\,Zn^{2+}(1\,M)\,||\,Cu^{2+}(1\,M)\,|\,Cu\ (E°_{cell} = 1.10\text{ V})$ was allowed to be completely discharged at 298 K. The relative concentration of Zn^{2+} to Cu^{2+} $\left(\dfrac{[Zn^{2+}]}{[Cu^{2+}]}\right)$ is
(a) 9.65×10^4 (b) antilog (24.08)
(c) 37.3 (d) $10^{37.3}$.

4. The equivalent conductances of two strong electrolytes at infinite dilution in H_2O (where ions move freely through a solution) at 25°C are given below :

$$\Lambda°_{CH_3COONa} = 91.0\text{ S cm}^2/\text{equiv.}$$

$$\Lambda°_{HCl} = 426.2\text{ S cm}^2/\text{equiv.}$$

What additional information/ quantity one needs to calculate $\Lambda°$ of an aqueous solution of acetic acid?
(a) $\Lambda°$ of chloroacetic acid ($ClCH_2COOH$)
(b) $\Lambda°$ of NaCl
(c) $\Lambda°$ of CH_3COOK
(d) the limiting equivalent coductance of $H^+(\lambda°_{H^+})$.

5. The limiting molar conductivities of HCl, CH_3COONa and NaCl are respectively 425, 90 and 125 mho cm^2 mol^{-1} at 25°C. The molar conductivity of 0.1 M CH_3COOH solutions is 7.8 mho cm^2 mol^{-1} at the same temperature. The degree of dissociation of 0.1 M acetic acid solution at the same temperature is

(a) 0.10 (b) 0.02

(c) 0.15 (d) 0.03

6. A weak electrolyte having the limiting equivalent conductance of 400 S cm^2. $equivalent^{-1}$ at 298 K is 2% ionized in its 0.1 N solution. The resistance of this solution (in ohms) in an electrolytic cell of cell constant 0.4 cm^{-1} at this temperature is

(a) 200 (b) 300

(c) 400 (d) 500

7. Mark the false statement?

(a) A salt bridge is used to eliminate liquid junction potential

(b) The Gibbs free energy change, ΔG is related with electromotive force E as $\Delta G = -nFE$

(c) Nernst equation for single electrode potential is $E = E^o - \frac{RT}{nF} \log_a M^{n+}$

(d) The efficiency of a hydrogen-oxygen fuel cell is 23%

8. On passing current through two cells, connected in series containing solution of $AgNO_3$ and $CuSO_4$, 0.18 g of Ag is deposited. The amount of the Cu deposited is:

(a) 0.529 g (b) 10.623 g

(c) 0.0529 g (d) 1.2708 g

18

CHEMICAL KINETICS

Fill in the Blanks :

1. The rate of chemical change is directly proportional to _______ .
2. The hydrolysis of ethyl acetate in _______ medium is a _______ order reaction.
3. For the reaction $N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$, under certain conditions of temperature and partial pressure of the reactants, the rate of formation of NH_3 is 0.001 kg h^{-1}. The rate of conversion of H_2 under the same condition is _______ kg h^{-1}.
4. In the Arrhenius equation, $k = A \exp(-E_a/RT)$, A may be termed as the rate constant at ____ .
5. In a slow reaction, rate of reaction generally _______ with time:
6. The rate of reaction between two specific time intervals is called _______ .
7. In a reaction, when the concentration of reactant is increased two times, the increase in rate of reaction was four times. Order of reaction is _______ .
8. The value of rate constant of a pseudo first order reaction depends on the concentration of _______ present in excess.

True/ False :

1. For a first order reaction, the rate of the reaction doubles as the concentration of the reactant (s) doubles.
2. Catalyst makes a reaction more exothermic.
3. Catalyst does not affect the energy of activation in a chemical reaction.
4. The rate of an exothermic reaction increases with increasing temperature.
5. For a reaction

$$pP + qQ \longrightarrow rR + sS$$

$$\text{Rate} = k[P]^x[Q]^y \text{ where } x = p \text{ and } y = q$$

6. Rate law is the expression in which reaction rate is given in terms of molar concentration of reactants with each term raised to some power, which may or may not be same as the stichiometric coefficient of the reacting species in a balanced chemical equation.
7. Molecularity helps in understanding the mechanism of reaction.
8. Complex reactions involving more than three molecules take place in more than one step.
9. Order of reaction can be fractional or zero.
10. Slowest step in the complex reaction is considered as a rate determining step.
11. Order is applicable to elementary as well as complex reactions whereas molecularity is applicable only for elementary reactions.
12. Rate constant k is equal to collision frequency A if $E_a = 0$.
13. On taking log both side Arrhenius equation will become

$$\log k = -\frac{E_a}{RT} + \log A$$

Conceptual MCQs

1. The plot of concentration of the reactant vs. time for a reaction is a straight line with a negative slope. The reaction follows a
   (a) zero order rate equation
   (b) first order rate equation
   (c) second order rate equation
   (d) third order rate equation

2. For the reaction A + B $\longrightarrow$ products, it is observed that:

(1) On doubling the initial concentration of A only, the rate of reaction is also doubled and

(2) On doubling the initial concentrations of both A and B, there is a change by a factor of 8 in the rate of the reaction.

The rate of this reaction is given by:

(a) rate = k [A] $[B]^2$ (b) rate = k $[A]^2$ $[B]^2$

(c) rate = k [A] [B] (d) rate = k $[A]^2$ [B]

3. For an exothermic reaction, the energy of activation of the reactants is

(a) equal to the energy of activation of products

(b) less than the energy of activation of products

(c) greater than the energy of activation of products

(d) Sometimes greater and sometimes less than that of the products

4. In a reversible reaction the energy of activation of the forward reaction is 50 kcal. The energy of activation for the reverse reaction will be

(a) < 50 kcal

(b) either greater than or less than 50 kcal

(c) 50 kcal

(d) > 50 kcal

5. In the following reaction, how is the rate of appearance of the underlined product related to the rate of disappearance of the underlined reactant ?

$$BrO^-_{3(aq)} + \underline{5Br^-}_{(aq)} + 6H^+_{(aq)} \longrightarrow \underline{3Br_{2(l)}} + 3H_2O_{(l)}$$

(a) $\frac{d[Br_2]}{dt} = -\frac{5}{3}\frac{d[Br^-]}{dt}$ (b) $\frac{d[Br_2]}{dt} = -\frac{d[Br^-]}{dt}$

(c) $\frac{d[Br_2]}{dt} = \frac{3}{5}\frac{d[Br^-]}{dt}$ (d) $\frac{d[Br_2]}{dt} = -\frac{3}{5}\frac{d[Br^-]}{dt}$

6. For the reaction $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$, the equilibrium constant is K_1. The equilibrium constant is K_2 for the reaction

$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$.

What is K for the reaction

$$NO_2(g) \rightleftharpoons \frac{1}{2}N_2(g) + O_2(g) ?$$

(a) $1/(2K_1K_2)$ (b) $1/(4K_1K_2)$

(c) $[1/K_1K_2]^{½}$ (d) $1/(K_1K_2)$

7. The temperature dependence of rate constant (k) of a chemical reaction is written in terms of Arrhenius equation, $k = Ae^{E_a^*/RT}$. Activation energy (E_a^*) of the reaction can be calculated by plotting

(a) $\log k$ vs $\frac{1}{\log T}$ (b) k vs T

(c) k vs $\frac{1}{\log T}$ (d) $\log k$ vs $\frac{1}{T}$

8. For the reaction $2A + B \rightarrow 3C + D$ which of the following does not express the reaction rate ?

(a) $-\frac{d[B]}{dt}$ (b) $\frac{d[D]}{dt}$

(c) $-\frac{1}{2}\frac{d[A]}{dt}$ (d) $\frac{1}{3}\frac{d[C]}{dt}$

9. Activation energy (E_a) and rate constants (k_1 and k_2) of a chemical reaction at two different temperatures (T_1 and T_2) are related by :

(a) $\ln\frac{K_2}{K_1} = -\frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

(b) $\ln\frac{K_2}{K_1} = -\frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

(c) $\ln\frac{K_2}{K_1} = -\frac{E_a}{R}\left(\frac{1}{T_2} + \frac{1}{T_1}\right)$

(d) $\ln\frac{K_2}{K_1} = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

10. The rate of reaction between two reactants A and B decreases by a factor of 4 if the concentration of reactant B is doubled. The order of this reaction with respect to reactant B is:

(a) 2 (b) –2

(c) 1 (d) –1

11. The reaction of hydrogen and iodine monochloride is given as:

$$H_{2(g)} + 2ICl_{(g)} \longrightarrow 2HCl_{(g)} + I_{2(g)}$$

The reaction is of first order with respect to $H_{2(g)}$ and $ICl_{(g)}$, following mechanisms were proposed.

Mechanism A:

$$H_{2(g)} + 2ICl_{(g)} \longrightarrow 2HCl_{(g)} + I_{2(g)}$$

Mechanism B:

$$H_{2(g)} + ICl_{(g)} \longrightarrow HI_{(g)}; \text{slow}$$

$$HI_{(g)} + ICl_{(g)} \longrightarrow HCl_{(g)} + I_{2(g)}; \text{fast}$$

Which of the above mechanism(s) can be consistent with the given information about the reaction?

(a) A and B both (b) neither A nor B
(c) A only (d) B only

12. The rate of reaction between A and B increases by a factor of 100, when the concentration of A is increased 10 folds, the order of reaction with respect to A is

(a) 10 (b) 1
(c) 4 (d) 2

13. For the reaction $H_{2(g)} + Br_{2(g)} \rightleftharpoons 2HBr_{(g)}$, the rate law is rate $= k[H_2][Br_2]^{1/2}$. Which of the following statement is true about this reaction

(a) The reaction is a second order one
(b) Molecularity of the reaction is 3/2
(c) The unit of k is s^{-1}
(d) Molecularity of the reaction is 2

14. The rate constant of a reaction depends on

(a) temperature
(b) initial concentration of the reactants
(c) time of reaction
(d) extent of reaction

15. Which one of the following statement for order of reaction is not correct?

(a) Order can be determined experimentally
(b) Order of reaction is equal to sum of the powers of concentration terms in differential rate law.
(c) It is not affected with the stoichiometric coefficient of the reactants
(d) Order cannot be fractional.

16. Consider a reaction $aG + bH \rightarrow$ Products. When concentration of both the reactants G and H is doubled, the rate increases by eight times. However, when concentration of G is doubled keeping the concentration of H fixed, the rate is doubled. The overall order of the reaction is

(a) 0 (b) 1
(c) 2 (d) 3

17. The rate equation for a reaction,
$N_2O \longrightarrow N_2 + 1/2O_2$
is Rate $= k[N_2O]^0 = k$. If the initial concentration of the reactant is a mol Lit^{-1}, the half-life period of the reaction is

(a) $t_{\frac{1}{2}} = \dfrac{a}{2k}$ (b) $-t_{\frac{1}{2}} = ka$
(c) $t_{\frac{1}{2}} = \dfrac{a}{k}$ (d) $t_{\frac{1}{2}} = \dfrac{k}{a}$

18. The chemical reaction $2O_3 \longrightarrow 3O_2$ proceeds as follows :

$$O_3 \xrightarrow{\text{Fast}} O_2 + O \;; \quad O + O_3 \xrightarrow{\text{Slow}} 2O_2$$

the rate law expression should be

(a) $r = k[O_3]^2$ (b) $r = k[O_3]^2[O_2]^{-1}$
(c) $r = k^3[O_3][O_2]^2$ (d) $r = [O_3][O_2]^2$

19. The rate law for the reaction

$xA + yB \longrightarrow mP + nQ$ is Rate $= k[A]^c[B]^d$.

What is the total order of the reaction?

(a) $(x + y)$ (b) $(m + n)$
(c) $(c + d)$ (d) x/y

20. According to the collision theory of reaction rates, the rate of reaction increases with temperature due to

(a) greater number of collision
(b) higher velocity of reacting molecules
(c) greater number of molecules having the activation energy
(d) decrease in the activation energy

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** If in a zero order reaction, the concentration of the reactant is doubled. the half-life period is also doubled.
   Reason : For a zero order reaction, the rate of reaction is independent of initial concentration.
2. **Assertion :** If the activation energy of a reaction is zero, temperature will have no effect on the rate constant.
   Reason : Lower the activation energy, faster is the reaction.
3. **Assertion :** According to steady state hypothesis, in a multistep reaction, the change in concentration with time for reactive intermediates is zero.
   Reason : The intermediates are so reactive that after a brief initial period their concentrations rise from zero to a small value and remains constant for most of the duration of the reaction.
4. **Assertion:** A catalyst is more effective in finely divided form.
   Reason: Finely divided form has more surface area.
5. **Assertion :** According to transition state theory for the formation of an activated complex, one of the vibrational degree of freedom is converted into a translational degree of freedom.
   Reason : Energy of the activated complex is higher than the energy of reactant molecules.
6. **Assertion :** The kinetics of the reaction–
   $$mA + nB + pC \rightarrow m'X + n'Y + p'Z$$
   obeys the rate expression as–
   $$\frac{dx}{dt} = k[A]^m[B]^n$$
   Reason : The rate of reaction does not depend upon the concentration of C.
7. **Assertion :**The order of a reaction can have fractional value.
   Reason : The order of a reaction cannot be written from balanced equation of a reaction.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

	Column-I		Column-II
(A)	Mathematical expression for rate of reaction	(1)	rate constant
(B)	Rate of reaction for zero order reaction is equal to	(2)	rate law
(C)	Units of rate constant for zero order reaction is same as that of	(3)	order of slowest step
(D)	Order of a complex reaction is determined by	(4)	rate of reaction

(a) A – (2), B – (1), C – (4), D – (3) (b) A – (3), B – (1), C – (4), D – (2)
(c) A – (2), B – (4), C – (1), D – (3) (d) A – (1), B – (2), C – (4), D – (3)

2. Match the columns

	Column-1		Column-II
(A)	Zero order reaction	(1)	L $mole^{-1}$ sec^{-1}
(B)	First order reaction	(2)	mole L^{-1} sec^{-1}
(C)	Second order reaction	(3)	sec^{-1}

(a) A – (2), B – (3) ,C – (1) (b) A – (2), B – (1) ,C – (3)
(c) A – (1), B – (2) ,C – (3) (d) A – (1), B – (3) ,C – (2)

3. Match the columns

	Column-I		Column-II
(A)	The decomposition of gaseous ammonia on a hot platinum surface	(1)	Zero order reaction

(B)	The thermal decomposition of HI on gold surface	(2)	Pseudo first order reaction.
(C)	All natural and artificial radioactive decay of unstable nuclei	(3)	Zero order reaction at high pressure
(D)	Inversion of cane sugar	(4)	First order reaction.

(a) A – (3), B – (1), C – (4), D – (2) (b) A – (3), B – (4), C – (2), D – (1)
(c) A – (2), B – (4), C – (1), D – (3) (d) A – (2), B – (1), C – (4), D – (1)

4. Match the columns.

	Column-I		**Column-II**
(A)	Catalyst alters the rate of reaction	(1)	cannot be fraction or zero
(B)	Molecularity	(2)	proper orientation is not there always.
(C)	Second half life of first order reaction	(3)	by lowering the activation energy
(D)	Energetically favourable reactions are sometimes slow	(4)	is same as the first

(a) A – (2), B – (3), C – (4), D – (1) (b) A – (3), B – (4), C – (1), D – (2)
(c) A – (3), B – (1), C – (4), D – (2) (d) A – (1), B – (3), C – (4), D – (2)

5. Match the columns

	Column - I		**Column - II**
(A)	$k = \frac{[R_0]-[R]}{t}$	(1)	$k = \frac{2.303}{t_{1/2}} \log 2$
(B)	$k = \frac{2.303}{t} \log \frac{[R_0]}{[R]}$	(2)	Rate constant for zero order reaction
(C)	Value of k for first order reaction when $t = t_{\frac{1}{2}}$ and $[R] = \frac{[R]_0}{2}$	(3)	$k = \frac{[R]_0}{2t_{1/2}}$
(D)	Value of k for zero order reaction when $t = t_{1/2}$ and $[R] = \frac{[R]_0}{2}$	(4)	Rate constant for first order reaction

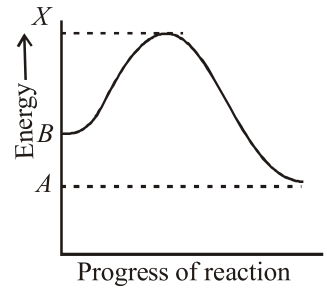
(a) A – (4), B – (2), C – (1), D – (3) (b) A – (2), B – (4), C – (1), D – (3)
(c) A – (2), B – (1), C – (4), D – (3) (d) A – (2), B – (4), C – (1), D – (5)

6. Match the columns

	Column - I		**Column - II**
(A)	Number of collisions per second per unit volume of the reaction mixture.	(1)	Effective collisions.
(B)	Fraction of molecules with energies equal to or greater than E_a	(2)	Collision frequency
(C)	Molecules for which Rate = $Z_{AB}e^{-E_a/RT}$ shows significant deviations	(3)	$e^{-E_a/RT}$
(D)	Collision in which molecules collide with sufficient K.E. and proper orientation.	(4)	Complex molecules

(a) A – (2), B – (3), C – (4), D – (1) (b) A – (3), B – (2), C – (4), D – (1)
(c) A – (2), B – (4), C – (3), D – (1) (d) A – (2), B – (3), C – (1), D – (4)

7. Consider the energy diagram of a reaction : $B \rightarrow A$, on the basis of given diagram select the correct code for matching Column-I and Column-II.



Column-I		Column-II
(A) $X - A$	(1)	Enthalpy of reaction
(B) $X - B$	(2)	Energy of transition state
(C) $A - B$	(3)	Activation energy of forward reaction
(D) X	(4)	Activation energy of backward reaction

(a) A – (4), B – (3), C – (2), D – (1)
(b) A – (2), B – (3), C – (1), D – (4)
(c) A – (3), B – (4), C – (1), D – (2)
(d) A – (4), B – (3), C – (1), D – (2)

Critical Thinking Type Questions :

1. $CHCl_3 + Cl_2 \longrightarrow CCl_4 + HCl$
Rate law for above reaction will be
Rate = $k[CHCl_3][Cl_2]^{\frac{1}{2}}$
On the basis of information provided which of the following option will be correct ?
(a) Rate law for any chemical reaction can be predicted accurately by looking at balanced chemical equation.
(b) Rate law for a chemical reaction has to determine experimentally.
(c) Either determined experimentally or obtained from balanced chemical reaction, rate law will be same.
(d) None of the above is correct.

2. The initial rates of reaction
$3A + 2B + C \longrightarrow$ Products, at different initial concentrations are given below:

Initial rate, Ms^{-1}	$[A]_0$, M	$[B]_0$, M	$[C]_0$, M
5.0×10^{-3}	0.010	0.005	0.010
5.0×10^{-3}	0.010	0.005	0.015
1.0×10^{-2}	0.010	0.010	0.010
1.25×10^{-3}	0.005	0.005	0.010

The order with respect to the reactants, A, B and C are respectively
(a) 3, 2, 0
(b) 3, 2, 1
(c) 2, 2, 0
(d) 2, 1, 0

3. The bromination of acetone that occurs in acid solution is represented by this equation.
$CH_3COCH_3(aq) + Br_2(aq) \rightarrow CH_3COCH_2Br(aq) + H^+(aq) + Br^-(aq)$
These kinetic data were obtained for given reaction concentrations.

Initial Concentrations, M			Initial rate, disappearance of Br_2, Ms^{-1}
$[CH_3COCH_3]$	$[Br_2]$	$[H^+]$	
0.30	0.05	0.05	5.7×10^{-5}
0.30	0.10	0.05	5.7×10^{-5}
0.30	0.10	0.10	1.2×10^{-4}
0.40	0.05	0.20	3.1×10^{-4}

Based on given data, the rate equations is:
(a) Rate = $k[CH_3COCH_3][H^+]$
(b) Rate = $k[CH_3COCH_3][Br_2]$
(c) Rate = $k[CH_3COCH_3][Br_2][H^+]^2$
(d) Rate = $k[CH_3COCH_3][Br_2][H^+]$

4. Consider the following reaction at 25°C:
$(CH_3)_3COH(l) + HCl(aq) \rightarrow (CH_3)_3CCl(l) + H_2O(l)$
The experimentally determined rate law for this reaction indicates that the reaction is of first order in $(CH_3)_3COH$ and that the reaction is of first order overall. Which of the following would produce an increase in the rate of this reaction?
(a) Increasing the concentration of $(CH_3)_3COH$

(b) Increasing the concentration of HCl

(c) Decreasing the concentration of HCl

(d) Decreasing the concentration of $(CH_3)_3CCl$

5. The following data pertains to reaction between A and B :

S. No.	$[A]$ mol L^{-1}	$[B]$ mol L^{-1}	Rate (mol L^{-1} time^{-1})
1	1.0×10^{-2}	2.0×10^{-2}	2.0×10^{-4}
2	2.0×10^{-2}	2.0×10^{-2}	4.0×10^{-4}
3	2.0×10^{-2}	4.0×10^{-2}	8.0×10^{-4}

Which of the following inference(s) can be drawn from the above data ?

(i) Rate constant of the reaction is 1.0×10^{-4}.

(ii) Rate law of the reaction is : rate = $k[A][B]$

(iii) Rate of reaction increases four times on doubling the concentration of both the reactants.

Select the correct answer using the codes given below :

(a) (i), (ii) and (iii) (b) (i) and (ii)

(c) (ii) and (iii) (d) (iii) only

6. For a first order reaction A→P, the temperature (T) dependent rate constant (k) was found to follow the equation $\log k = -(2000)\frac{1}{T} + 6.0$.

The pre-exponential factor A and the activation energy E_a, respectively, are

(a) 1.0×10^6 s^{-1} and 9.2 kJ mol^{-1}

(b) 6.0 s^{-1} and 16.6 kJ mol^{-1}

(c) 1.0×10^6 s^{-1} and 16.6 kJ mol^{-1}

(d) 1.0×10^6 s^{-1} and 38.3 kJ mol^{-1}

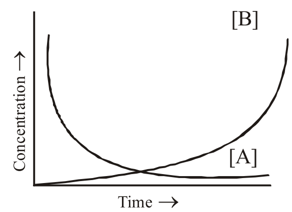
7. The rate constant, the activation energy and the arrhenius parameter of a chemical reaction at 25°C are $3.0 \times 10^{-4} s^{-1}$, 104.4 kJ mol^{-1} and 6.0×10^{14} s^{-1} respectively. The value of the rate constant as T → ∞ is

(a) 2.0×10^{18} s^{-1} (b) 6.0×10^{14} s^{-1}

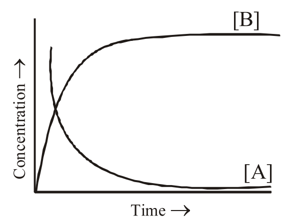
(c) Infinity (d) 3.6×10^{30} s^{-1}

8. Consider the reaction A f B. The concentration of both the reactants and the products varies exponentially with time. Which of the following figures correctly describes the change in concentration of reactants and products with time?

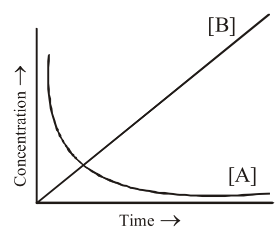
(a)



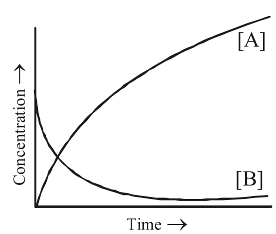
(b)



(c)



(d)



19

Surface Chemistry

Fill in the Blanks :

1. The term ‘sorption’ stands for _______ .
2. Extent of physisorption of a gas increases with _______ in temperature.
3. Extent of adsorption of adsorbate from solution phase increases with _______ in amount of adsorbate in solution.
4. Physical adsorption of a gaseous species may change to chemical adsorption with _______ in temperature
5. In physisorption adsorbent does not show specificity for any particular gas because involved _______ forces are universal.
6. In Freundlich adsorption isotherm, the value of $1/n$ is: between 0 and _______ in all cases
7. The role of a catalyst in a reversible reaction is to allow the _______ to be achieved quickly
8. Hydrolysis of urea is an example of _______ .
9. Milk is a colloid in which a liquid is dispersed in a _____.
10. The formation of micelles takes place only above ____ .

True/ False :

1. The material on the surface of which the adsorption takes place is called adsorbent.
2. An important zeolite catalyst used in the petroleum industry in ZSM-5.
3. Enzyme catalysis to work effectively requires optimum temperature (298-310 K) and optimum pH (3-5)
4. Catalyst used in Ostwald’s process is platinised asbestos at 673 K.
5. Catalyst used in contact process is platinised asbestos or V_2O_5 at 673-723 K.
6. Gelatine sol if evaporated off it can be reobtained simply by mixing gelatine obtained on evaporation with suitable dispersion medium.
7. S_8 being a macromolecule forms macromolecular colloid.
8. Starch and proteins are natural whereas polythene and polystyrene are man-made macromolecules.
9. Tyndall effect is used to distinguish between a colloidal and true solution.
10. Random bombardment of the colloidal particles by the molecules of the dispersion medium does not allow colloids to settle thereby providing stability to them.
11. Most acceptable phenomena to account for the charge of sol particles is electrodispersion.

Conceptual MCQs

1. If x is amount of adsorbate and m is amount of adsorbent, which of the following relations is not related to adsorption process ?
   (a) $x / m = f(p)$ at constant T.
   (b) $x / m = f(T)$ at constant p.
   (c) $p = f(T)$ at constant (x / m).
   (d) $\frac{x}{m} = p' \; T$
2. The extra stability of lyophilic colloids is due to
   (a) Charge on their particles
   (b) A layer of medium of dispersion on their particles
   (c) The smaller size of their particles
   (d) The large size of their particles
3. When dispersed phase is liquid and dispersion medium is gas then the colloidal system is called
   (a) Smoke (b) Clouds
   (c) Jellies (d) Emulsions

4. Substances whose solutions can readily diffuse through parchment membrane are
(a) Colloids (b) Crystalloids
(c) Electrolytes (d) Non electrolytes

5. Which one of the following in not a colloidal solution?
(a) Smoke (b) Ink
(c) Blood (d) Air

6. Which one of the following statements is incorrect in the case of heterogeneous catalysis ?
(a) The catalyst lowers the energy of activation
(b) The catalyst actually forms a compound with the reactant
(c) The surface of the catalyst plays a very important role
(d) There is no change in the energy of activation.

7. Wood charcoal is used to decolourise sugar because it
(a) adsorbs coloured material
(b) absorbs decolourised material
(c) reduces coloured material
(d) None of these

8. Point out the false statement ?
(a) Brownian movement and Tyndall effect are shown by colloidal systems.
(b) Gold number is a measure of the protective power of a lyophillic colloid
(c) The colloidal solution of a liquid in liquid is called gel
(d) Hardy-Schulze rule is related with coagulation.

9. In colloid particles, range of diameters is
(a) 1 to 100 nm (b) 1 to 1000 cm
(c) 1 to 1000 mm (d) 1 to 100 km

10. Adsorption of gases on solid surface is exothermic reaction because
(a) free energy increases
(b) enthalpy is positive
(c) entropy increases
(d) enthalpy is negative

11. During dialysis
(a) only solvent molecules can diffuse
(b) solvent molecules, ions and colloidal particles can diffuse
(c) all kinds of particles can diffuse through the semi-permeable membrane
(d) solvent molecules and ions can diffuse

12. The ability of an ion to bring about coagulation of a given colloid depends upon
(a) its size
(b) the magnitude of its charge
(c) the sign of the charge alone
(d) both magnitude and sign of its charge

13. Hardy-Schulze rule explains the effect of electrolytes on the coagulation of colloidal solution. According to this rule, coagulation power of cations follow the order
(a) $Ba^{+2} > Na^{+} > Al^{+3}$ (b) $Al^{+3} > Na^{+} > Ba^{+2}$
(c) $Al^{+3} > Ba^{+2} > Na^{+}$ (d) $Ba^{+2} > Al^{+3} > Na^{+}$

14. Which is not correct regarding the adsorption of a gas on surface of solid?
(a) On increasing temperature, adsorption increases contineuously
(b) Enthalpy and entropy changes are –ve
(c) Adsorption is more for some specific substance
(d) This Phenomenon is reversible

15. Position of non-polar and polar part in micelle is
(a) Polar at outer surface and non-polar at inner surface
(b) Polar at inner surface and non-polar at outer surface
(c) Distributed all over the surface
(d) Present in the surface only

16. According to the adsorption theory of catalysis, the speed of the reaction increases because-
(a) Adsorption lowers the activation energy of the reaction
(b) The concentration of reactant molecules at the active centres of the catalyst becomes high due to strong adsorption
(c) In the process of adsorption, the activation energy of the molecules becomes large
(d) Adsorption produces heat which increases the speed of the reaction

17. The Langmuir adsorption isotherm is deduced using the assumption
(a) the adsorption sites are equivalent in their ability to adsorb the particles
(b) the heat of adsorption varies with coverage
(c) the adsorbed molecules interact with each other
(d) the adsorption takes place in multilayers.

18. Gold numbers of protective colloids A, B, C and D are 0.50, 0.01, 0.10 amd 0.005, respectively. the correct order of their protective powers is
(a) $D < A < C < B$ (b) $C < B < D < A$
(c) $A < C < B < D$ (d) $B < D < A < C$

19. Preparation of Lyophobic sols by chemical method involves
(a) double decomposition
(b) oxidation & reduction
(c) hydrolysis
(d) all of these

20. The protecting power of lyophilic colloidal sol is expressed in terms of :
(a) Coagulation value
(b) Gold number
(c) Critical miscelle concentration
(d) Oxidation number

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*
(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The relation $\frac{x}{m} = k.p^{1/n}$ is known as Freundlich adsorption isotherm, where x is the mass of gas adsorbed by m grams of adsorbate, p is the equilibrium pressure, k and n are constants for given system and temperature.
Reason : When several substances have same value of $\frac{1}{n}$, the lines by which their adsorption isotherms can be represented will meet at a point.

2. **Assertion :** The enthalpy of physisorption is greater than chemisorption.
Reason : Molecules of adsorbate and adsorbent are held by van der Waal's forces in physisorption and by chemical bonds in chemisorption.

3. **Assertion :** According to Freundlich: $\frac{x}{m} = K.p^{1/n}$.
Reason : The isotherm shows variation of the amount of gas adsorbed by the adsorbent with temperature.

4. **Assertion:** Detergents with low CMC are more economical to use.
Reason: Cleansing action of detergents involves the formation of micelles. These are formed when the concentration of detergents becomes equal to CMC.

5. **Assertion:** An ordinary filter paper impregnated with collodion solution stops the flow of colloidal particles.
Reason: Pore size of the filter paper becomes more than the size of colloidal particle.

6. **Assertion :** The value of colligative properties are of small order for colloids as compared to true solution.
Reason : Number of particles in colloidal solution is comparatively smaller than true solutions.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I	Column-II
(A) $\frac{x}{m} = kc^{1/n}$	(1) Adsorption varies directly with pressure
(B) $\log\frac{x}{m} = \log k + \frac{1}{n}\log p$ $\left(\frac{1}{n} = 0\right)$	(2) Adsorption from solution phase

(C) $\log \frac{x}{m} = \log k + \frac{1}{n} \log p$ $\left(\frac{1}{n} = 1\right)$ (3) Freudlich isotherm cannot be explained

(D) $\frac{x}{m} = kp^{1/n}$ (high pressure) (4) Adsorption is independent of pressure

(a) A – (2), B – (4), C – (1), D – (3) (b) A – (2), B – (1), C – (4), D – (3)
(c) A – (3), B – (1), C – (4), D – (2) (d) A – (3), B – (4), C – (1), D – (2)

2. Match the columns

Column-I (Biochemical reactions)	**Column-II (Enzymes)**
(A) $C_6H_{12}O_6(aq) \longrightarrow 2C_2H_5OH(aq) + 2CO_2(g)$	(1) Zymase
(B) $NH_2CONH_2(aq) + H_2O(l) \longrightarrow 2NH_3(g) + CO_2(g)$	(2) Pepsin
(C) Proteins $\longrightarrow$ Peptides	(3) Urease
(D) $C_{12}H_{22}O_{11}(aq) + H_2O(l) \longrightarrow C_6H_{12}O_6(aq) + C_6H_{12}O_6(aq)$	(4) Invertase

(a) A – (1), B – (3), C – (2), D – (4) (b) A – (1), B – (2), C – (3), D – (4)
(c) A – (3), B – (1), C – (2), D – (4) (d) A – (1), B – (3), C – (4), D – (2)

3. Match the columns

Column-I (Catalyst)	**Column-II (Industrial product)**
(A) V_2O_5	(1) High density poly-ethylene
(B) Ziegler-Natta	(2) Polyacrylonitrile
(C) Peroxide	(3) NH_3
(D) Finely divided Fe	(4) H_2SO_4

(a) A – (4), B – (1), C – (2), D – (3) (b) A – (4), B – (3), C – (2), D – (1)
(c) A – (3), B – (1), C – (2), D – (4) (d) A – (4), B – (2), C – (1), D – (3)

4. Match the columns

Column-I	**Column-II**
(A) Oil in water emulsion	(1) Clouds
(B) Aerosols containing small droplets of water suspended in air	(2) Vanishing cream
(C) When river water meets the sea water	(3) Smoke
(D) Colloidal solution of carbon, arsenic compounds, dust etc. in air	(4) Formation of delta

(a) A – (2), B – (1), C – (4), D – (3) (b) A – (1), B – (2), C – (4), D – (3)
(c) A – (2), B – (4), C – (1), D – (3) (d) A – (2), B – (1), C – (3), D – (4)

5. Match the columns

	Column-I		Column-II
(A)	As_2S_3 sol	(1)	Bredig's Arc method
(B)	$Fe(OH)_3$ sol	(2)	Double decomposition
(C)	Colloidal sols of metals like Au, Ag, Pt, etc.	(3)	Peptization
(D)	Conversion of freshly prepared precipitate into a colloidal sol	(4)	Hydrolysis

(a) A – (2), B – (4), C – (3), D – (1) (b) A – (2), B – (1), C – (4), D – (3)
(c) A – (4), B – (2), C – (1), D – (3) (d) A – (2), B – (4), C – (1), D – (3)

6. Match the columns

	Column-I		Column-II
(A)	In this process molecules and ions diffuse through membrane outside and pure colloidal solution is left behind.	(1)	Dialysis
(B)	This process is used if the dissolved substance in the impure colloidal solution is only an electrolyte	(2)	Ultrafilteration
(C)	In this process ordinary filter paper is soaked into collodion (4% solution of nitrocellulose in a mixture of alcohol and ether)	(3)	Electro-dialysis

(a) A – (1), B – (3), C – (2) (b) A – (3), B – (1), C – (2)
(c) A – (1), B – (2), C – (3) (d) A – (2), B – (3), C – (1)

7. Match the columns

	Column-I		Column-II
(A)	Sulphur vapours passed through cold water	(1)	Normal electrolyte solution
(B)	Soap mixed with water above critical micelle concentration	(2)	Molecular colloids
(C)	White of egg whipped with water	(3)	Associated colloid
(D)	Soap mixed with water below critical micelle concentration	(4)	Macro molecular colloids

(a) A – (2), B – (3), C – (4), D – (1) (b) A – (3), B – (2), C – (4), D – (1)
(c) A – (1), B – (3), C – (4), D – (2) (d) A – (2), B – (4), C – (3), D – (1)

8. Match the columns

	Column-I		Column-II
(A)	Protective colloid	(1)	$FeCl_3 + NaOH$
(B)	Liquid - liquid colloid	(2)	Lyophilic colloids
(C)	Positively charged colloid	(3)	Emulsion
(D)	Negatively charged colloid	(4)	$FeCl_3$ + hot water

(a) A – (2), B – (3), C – (1), D – (4)
(b) A – (1), B – (3), C – (4), D – (2)
(c) A – (2), B – (3), C – (4), D – (1)
(d) A – (3), B – (2), C – (4), D – (1)

9. Match the columns

Column-I	Column-II
(A) Dialysis	(1) Cleansing action of soap
(B) Peptisation	(2) Coagulation
(C) Emulsification	(3) Colloidal sol formatioin
(D) Electrophoresis	(4) Purification

(a) A – (4), B – (3), C – (1), D – (2)
(b) A – (2), B – (3), C – (1), D – (4)
(c) A – (4), B – (1), C – (3), D – (2)
(d) A – (4), B – (3), C – (2), D – (1)

10. Match the columns

Column-I	Column-II
(A) Butter	(1) dispersion of liquid in liquid
(B) Pumice stone	(2) dispersion of solid in liquid
(C) Milk	(3) dispersion of gas in solid
(D) Paints	(4) dispersion of liquid in solid

(a) A – (3), B – (4), C – (1), D – (2)
(b) A – (4), B – (3), C – (1), D – (2)
(c) A – (2), B – (3), C – (1), D – (4)
(d) A – (4), B – (3), C – (2), D – (1)

11. Match the columns

Column-I	Column-II
(A) Argyrol	(1) Kalazar
(B) Antimony	(2) Intramuscular injection
(C) Colloidal gold	(3) Stomach disorders
(D) Milk of magnesia	(4) Eye lotion

(a) A – (3), B – (1), C – (4), D – (2)
(b) A – (3), B – (1), C – (2), D – (4)
(c) A – (4), B – (2), C – (1), D – (4)
(d) A – (4), B – (1), C – (2), D – (3)

Critical Thinking Type Questions :

1. Which of the following statements is incorrect regarding physisorptions?
(a) More easily liquefiable gases are adsorbed readily.
(b) Under high pressure it results into multimolecular layer on adsorbent surface.
(c) Enthalpy of adsorption ($\Delta H_{adsorption}$) is low and positive.
(d) It occurs because of van der Waal's forces.

2. Methylene blue, from its aqueous solution, is adsorbed on activated charcoal at 25°C. For this process, which of the following statement is correct ?
(a) The adsorption requires activation at 25°C
(b) The adsorption is accompanied by a decrease in enthalpy
(c) The adsorption increases with increase of temperature
(d) The adsorption is irreversible

3. Which of the following is not an application of adsorption?
(a) In metallurgy for concentration of sulphide ores.
(b) In heterogeneous catalysis involving solid catalyst.
(c) In homogeneous catalysis.
(d) Separation of inert gas.

4. Which of the following statements about a catalyst is true ?
(a) A catalyst accelerates the reaction by bringing down the free energy of activation
(b) A catalyst also takes part in the reaction mechanism

(c) A catalyst makes the reaction more feasible by making the ΔG^o more negative
(d) A catalyst makes the equilibrium constant of the reaction more favourable for the forward reaction

5. Which of the following feature of catalysts is described in reactions given below?

(i) $CO(g)+2H_2(g)\xrightarrow{Cu/ZnO-Cr_2O_3}CH_3OH(g)$

(ii) $CO(g)+H_2(g)\xrightarrow{Cu}HCHO(g)$

(iii) $CO(g)+3H_2(g)\xrightarrow{Ni}CH_4(g)+H_2O(g)$

(a) Activity
(b) Selectivity
(c) Catalytic promoter
(d) Catalytic poison

6. Point out the false statement :

(a) The colloidal solution of a liquid in liquid is called gel
(b) Hardy Schulze rule is related with coagulation
(c) Brownian movement and Tyndall effect are shown by colloidal system
(d) Gold number is a measure of the protective power of lyophilic colloid

7. The disperse phase in colloidal iron (III) hydroxide and colloidal gold is positively and negatively charged, respectively. Which of the following statements is NOT correct?

(a) Coagulation in both sols can be brought about by electrophoresis
(b) Mixing the sols has no effect
(c) Sodium sulphate solution causes coagulation in both sols
(d) Magnesium chloride solution coagulates, the gold sol more readily than the iron (III) hydroxide sol.

8. Which of the following statements is incorrect?

(a) Colloidal gold is used for intramuscular injection.
(b) Colloidal solution of latex is used in preparation of rubber.
(c) Photographic films are prepared by coating an emulsion of AgBr in gelatin over glass plate.
(d) Tannin used in leather industry contains positively charged colloidal particles.

20 GENERAL PRINCIPLES AND PROCESSES FOR ISOLATION OF ELEMENTS

Fill in the Blanks :

1. Casseterite is ore of _______ .
2. In the thermite process _______ is used as reducing agent.
3. In the basic Bessemer process for the manufacture of steel the lining of the converter is made of _______ . The slag formed consists of _______ .
4. In extractive metallurgy of zinc partial fusion of ZnO with coke is called _______ and reduction of the ore to the molten metal is called _______ .
   (smelting, calcining, roasting, sintering)
5. Cassiterite is an ore of _______ .
6. Froth floatation process is used for the metallurgy of _______ .
7. Cassiterite is concentrated by _______ .
8. Heating of pyrites in air for oxidation of sulphur is called _______ .
9. Process followed before reduction of carbonate ore is _______ .
10. In the blast furnace iron oxide is reduced by _______ .
11. The process of zone refining is used in the purification of _______ .
12. Electrometallurgical process is used to extract _______ .

True/ False :

1. Depressant NaCN used in case of ore containing mixture of ZnS and PbS allows ZnS to come with froth and prevents PbS from coming to the froth.
2. For concentration powdered bauxite ore is digested with conc.NaOH at 473–523K and 35–36 bar pressure.
3. Each Ellingham plot is represented by a straight line untill unless there is some change in phase i.e. solid$\rightarrow$liquid, liquid $\rightarrow$ gas and gas $\rightarrow$ liquid occurs.
4. Diagrams similar to Ellingham can be constructed for sulphides and halides which clearly indicates why reduction of M_xS is difficult in comparison to M_xO.
5. Cast iron is used in the manufacture of railway sleepers
6. Wrought iron is used in the manufacture of anchors, bolts, chains etc.
7. Nickel steel is used in making pendulums.
8. The principle that the impurities are more soluble in the melt than in the solid state is used in the manufacture of high purity semi-conductors.
9. Van Arkel method of refining Zr involves heating of crude metal with Cl_2 to form corresponding halide.
10. Mond process for refining of nickel involves formation of metal carbonyls as an intermediate.

Conceptual MCQs

1. Which one of the following ores is best concentrated by froth-flotation method ?
   (a) Galena (b) Cassiterite
   (c) Magnetite (d) Malachite
2. During the process of electrolytic refining of copper, some metals present as impurity settle as 'anode mud'. These are
   (a) Fe and Ni (b) Ag and Au
   (c) Pb and Zn (d) Sn and Ag

3. Carbon and CO gas are used to reduce which of the following pairs of metal oxides for extraction of metals ?
(a) FeO, SnO (b) SnO, ZnO
(c) BaO, Na_2O_2 (d) FeO, ZnO

4. Among the following statements, the incorrect one is
(a) calamine and siderite are carbonates
(b) argentite and cuprite are oxides
(c) zinc blende and pyrites are sulphides
(d) malachite and azurite are ores of copper

5. The chemical composition of 'slag' formed during the smelting process in the extraction of copper is
(a) $Cu_2O + FeS$
(b) $FeSiO_3$
(c) $CuFeS_2$
(d) $Cu_2S + FeO$ FeO

6. Sulphide ores of metals are usually concentrated by froth flotation process. Which one of the following sulphide ores offer an exception and its concentrated by chemical leaching?
(a) Galena (b) Copper pyrite
(c) Sphalerite (d) Argentite

7. Match list I with list II and select the correct answer using the codes given below the lists:

List I	List II
I. Cyanide process	A. Ultrapure Ge
II. Floatation process	B. Pine oil
III. Electrolytic reduction	C. Extraction of Al
IV. Zone refining	D. Extraction of Au

Codes:
(a) I-C, II-A, III-D, IV-B
(b) I-D,II-B,III-C,IV-A
(c) I-C,II-B,III-D, IV-A
(d) I-D,II-A,III-C,IV-B

8. Which of the following pairs of metals is purified by van Arkel method ?
(a) Ga and In (b) Zr and Ti
(c) Ag and Au (d) Ni and Fe

9. Which of the following condition favours the reduction of a metal oxide to metal?
(a) $\Delta H = +ve$, $T\Delta S = +$ ve at low temperature
(b) $\Delta H = +ve$, $T\Delta S = -$ ve at any temperature
(c) $\Delta H = -ve$, $T\Delta S = -$ ve at high temperature
(d) $\Delta H = -ve$, $T\Delta S = +$ ve at any temperature

10. The commonest method for the extraction of metals from oxide ores involves :
(a) Reduction with carbon
(b) Reduction with aluminium
(c) Reduction with hydrogen
(d) Electrolytic method

11. Which of the following is an ore of silver?
(a) Argentite (b) Stibnite
(c) Haematite (d) Bauxite

12. In the extraction of copper from its sulphide ore, the metal is finally obtained by the reduction of cuprous oxide with :
(a) Copper (I) sulphide (Cu_2S)
(b) Sulphur dioxide (SO_2)
(c) Iron sulphide (FeS)
(d) Carbon monoxide (CO)

13. Which is not a basic flux ?
(a) $CaCO_3$ (b) Lime
(c) SiO_2 (d) CaO

14. In the froth floatation process for the purification of ores, the ore particles float because
(a) They are light
(b) Their surface is hydrodphobic i.e. not easily wetted by water
(c) They bear electrostatic charge
(d) They are insoluble

15. Electrolytic reduction method is used in the extraction of
(a) Highly electronegative elements
(b) Highly electropositive elements
(c) Transition metals
(d) Noble metals.

16. A compound is formed which is used in the metallurgy of Al and which is used to remove the impurities :
(a) Slag (b) Flux
(c) Acidic Flux (d) Basic Flux

17. In alumino thermite process which of the following is reduced :
(a) Aluminium (b) Oxide
(c) Sulphide (d) Carbonate

18. Which one of the following metals is not obtained by electrolysis in their aq state :
(a) Cu (b) Mg
(c) Ni (d) Cr

19. In the extraction of Cu, the reaction which takes place in Bessemer converter is
    (a) $2FeS + 3\ O_2 \longrightarrow 2FeO + 2SO_2$
    (b) $2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$
    (c) $2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$
    (d) $2CuFeS_2 + O_2 \longrightarrow Cu_2S + FeS + SO_2$
20. Refractory metals are used in construction of furnaces because
    (a) they can withstand high temperature
    (b) they are chemically inert
    (c) their melting point is high
    (d) None of these

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*
(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Levigation is used for the separation of oxide ores from impurities.
   Reason : Ore particles are removed by washing in a current of water.
2. **Assertion :** Zinc can be used while copper cannot be used in the recovery of Ag from the complex $[Ag(CN)_2]^-$.
   Reason : Zinc is a powerful reducing agent than copper.
3. **Assertion :** Leaching is a process of reduction.
   Reason : Leaching involves treatment of the ore with a suitable reagent so as to make it soluble while impurities remains insoluble.
4. **Assertion :** Coke and flux are used in smelting.
   Reason : The phenomenon in which ore is mixed with suitable flux and coke is heated to fusion is known as smelting.
5. **Assertion :** Copper obtained after bessemerization is known as blister copper.
   Reason : Blisters are produced on the surface of the metal due to escaping of dissolved SO_2.
6. **Assertion :** Lead, tin and bismuth are purified by liquation method.
   Reason : Lead, tin and bismuth have low m.p. as compared to impurities.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column - I	Column - II
(A) $Fe_2O_3.xH_2O(s) \xrightarrow{\Delta} Fe_2O_3(s) + xH_2O(g)$	(1) Slag formation
(B) $FeO + SiO_2 \longrightarrow FeSiO_3$	(2) Reduction of iron oxide
(C) Discharge gas produced during this process is utilised in manufacture of H_2SO_4.	(3) Calcination
(D) $Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO$	(4) Roasting

(a) A–(3), B–(1), C–(4), D–(2)
(b) A–(1), B–(3), C–(4), D–(2)
(c) A–(3), B–(4), C–(1), D–(2)
(d) A–(3), B–(1), C–(2), D–(4)

2. Match the columns

Column - I		Column - II	
(A)	According to $\Delta_r G^{\ominus}$ vsT graph, oxide of this metal can be easily reduced to corresponding metal by heating with coke	(1)	Sulphur oxide
(B)	Substance responsible for the blistered appearence of the copper obtained as result of extraction of copper from cuprous oxide	(2)	Copper
(C)	Metal which during purification is distilled off and collected by rapid chilling	(3)	Na_3AlF_6 or CaF_2
(D)	On addition to Al_2O_3 its melting point gets reduced and conductivity gets enhanced	(4)	Zinc

(a) A – (1), B – (2), C – (4), D – (3)
(b) A – (2), B – (4), C – (1), D – (3)
(c) A – (2), B – (1), C – (4), D – (3)
(d) A – (2), B – (1), C – (3), D – (4)

3. Match the columns.

Column-I		Column-II	
(A)	Blisterred Cu	(1)	Aluminium
(B)	Blast furnace	(2)	$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$
(C)	Reverberatory furnace	(3)	Iron
(D)	Hall-Heroult process	(4)	$FeO + SiO_2 \rightarrow FeSiO_3$
		(5)	$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$

(a) A – (2), B – (3), C – (4), D – (1)
(b) A – (1), B – (2), C – (3), D – (5)
(c) A – (5), B – (4), C – (3), D – (2)
(d) A – (4), B – (5), C – (3), D – (2)

4. Match the columns.

Column-I		Column-II	
(A)	Coloured bands	(1)	Zone refining
(B)	Impure metal to volatile complex	(2)	Fractional distillation
(C)	Purification of Ge and Si	(3)	Mond Process
(D)	Purification of mercury	(4)	Chromatography
		(5)	Liquation

(a) A – (1), B – (2), C – (4), D – (5)
(b) A – (4), B – (3), C – (1), D – (2)
(c) A – (3), B – (4), C – (1), D – (2)
(d) A – (5), B – (4), C – (3), D – (2)

5. Match the columns.

Column-I		Column-II	
(A)	Cyanide process	(1)	Ultrapure Ge
(B)	Froth Floatation Process	(2)	Dressing of ZnS
(C)	Electrolytic reduction	(3)	Extraction of Al
(D)	Zone refining	(4)	Extraction of Au
		(5)	Purification of Ni

(a) A – (4), B – (2), C – (3), D – (1)
(b) A – (2), B – (3), C – (1), D – (5)
(c) A – (1), B – (2), C – (3), D – (4)
(d) A – (3), B – (4), C – (5), D – (1)

6. Match the columns

Column-I		Column-II	
(A)	Cyanide process	(1)	Ultrapure Ge
(B)	Floatation process	(2)	Pine oil

(C) Electrolytic reduction (3) Extraction of Al
(D) Zone refining (4) Extraction of Au

(a) A – (3), B – (1), C – (4), D – (2)
(b) A – (4), B – (2), C – (3), D – (1)
(c) A – (3), B – (2), C – (4), D – (1)
(d) A – (4), B – (1), C – (3), D – (2)

7. Match the columns

Column-I	Column-II
(A) Distillation	(1) Zr
(B) Electrolytic refining	(2) Ga
(C) Liquation	(3) Cu
(D) Zone refining	(4) Hg
(E) Vapour phase refining	(5) Sn

(a) A – (3), B – (4), C – (5), D – (2), E – (1)
(b) A – (4), B – (3), C – (5), D – (2), E – (1)
(c) A – (4), B – (5), C – (3), D – (2), E – (1)
(d) A – (4), B – (3), C – (1), D – (2), E – (5)

8. Match the columns

Column-I	Column-II
(A) This metal is used in extraction of chromium and manganese.	(1) Zinc
(B) Common metal in brass and bronze.	(2) Aluminium
(C) Common metal in brass and german silver.	(3) Copper
(D) Substance used in making cycles, automobiles, utensils, etc.	(4) Stainless steel

(a) A – (2), B – (3), C – (1), D – (4)
(b) A – (3), B – (2), C – (1), D – (4)
(c) A – (2), B – (1), C – (3), D – (4)
(d) A – (2), B – (3), C – (4), D – (1)

Critical Thinking Type Questions :

1. In the cyanide extraction process of silver from argentite ore, the oxidising and reducing agents used are
(a) O_2 and CO respectively
(b) O_2 and Zn dust respectively
(c) HNO_3 and Zn dust respectively
(d) HNO_3 and CO respectively

2. Which of the following statements, about the advantage of roasting of sulphide ore before reduction is not true?
(a) The ΔG_f^o of the sulphide is greater than those for CS_2 and H_2S.
(b) The ΔG_f^o is negative for roasting of sulphide ore to oxide.
(c) Roasting of the sulphide to the oxide is thermo-dynamically feasible.
(d) Carbon and hydrogen are suitable reducing agents for reduction of metal sulphides.

3. Which of the following statement is not correct about Ellingham diagram?
(a) ΔG increases with an increase in temperature
(b) It consists of plots of $\Delta_f G^o$ vs T for formation of oxides
(c) a coupling reaction can be well expressed by this diagram
(d) It express the kinetics of the reduction process

4. Before introducing FeO in blast furnace , it is converted to Fe_2O_3 by roasting so that
(a) it may not be removed as slag with silica
(b) it may not evaporate in the furnace
(c) presence of it may increase the m.pt. of charge
(d) None of these.

5. When copper ore is mixed with silica, in a reverberatory furnace copper matte is produced. The copper matte contains________.
(a) sulphides of copper (II) and iron (II)
(b) sulphides of copper (II) and iron (III)
(c) sulphides of copper (I) and iron (II)
(d) sulphides of copper (I) and iron (III)

6. Which of the following statements regarding metallurgy of iron is incorrect ?

(a) Reaction $Fe_3O_4 + 4CO \longrightarrow 3Fe + 4CO_2$ belongs to lower temperature range (500 – 800K) of the blast furnace.

(b) Reaction $FeO + CO \longrightarrow Fe + CO_2$ belongs to higher temperature range (900 – 1500K) of the blast furnace.

(c) The iron obtained from blast furnace is cast iron with 3% carbon.

(d) For reduction of iron oxide to occur ΔG of the couple of following reactions should be negative

$$FeO(s) \longrightarrow Fe(s) + \frac{1}{2}O_2(g)$$

$$C(s) + \frac{1}{2}O_2(g) \longrightarrow CO(g)$$

7. Which of the following reaction(s) occur in temperature range 500 – 800 K in blast furnace.

(i) $Fe_2O_3 + CO \longrightarrow 2FeO + CO_2$

(ii) $Fe_3O_4 + 4CO \longrightarrow 3Fe + 4CO_2$

(iii) $FeO + CO \longrightarrow Fe + CO_2$

(iv) $C + CO_2 \longrightarrow 2CO$

(a) (i) and (ii) (b) (i), (ii) and (iii)

(c) (iii) and (iv) (d) (iv) only

8. In electro-refining of metal the impure metal is used to make the anode and a strip of pure metal as the cathode, during the electrolysis of an aqueous solution of a complex metal salt. This method cannot be used for refining of

(a) Silver (b) Copper

(c) Aluminium (d) Sodium

9. Which of the following statements regarding electrolytic refining of copper is incorrect ?

(a) In this process anode is made up of impure copper and pure copper strips are taken as cathode.

(b) Acidic or basic solution of copper sulphate is used as electrolyte

(c) Antimony, tellurium, silver and gold are some of the metals deposits as anode mud during this process

(d) Zinc can be also refined by electrolytic refining method.

21 The P-Block Elements (Group 15, 16, 17 and 18)

Fill in the Blanks :

1. The lowest possible oxidation state of nitrogen is _______ .
2. Iodine reacts with hot NaOH solution. The products are NaI and _______ .
3. _______ is a weak acid. (HF, HCl, HI)
4. The increase in the solubility of iodine in an aqueous solution of potassium iodide is due to the formation of _______ .
5. _______ phosphorus is reactive because of its highly strained tetrahedral structure.
6. _______ acid gives hypo _______ ion. (hydrobromic, hypobromous, perbromic, bromide, bromite, perbromate)
7. Sulphur acts as _______ agent in vulcanization of rubber.
8. The basicity of phosphorous acid (H_3PO_3) is _______ .
9. In P_4O_{10}, the number of oxygen atoms bonded to each phosphorus atom is _______ .
10. Solubility of iodine in water is greatly increased by the addition of iodide ions because of the formation of _____ .

True/ False :

1. Red phosphorus is less volatile than white phosphorus because the former has a tetrahedral structure.
2. In aqueous solution chlorine is a stronger oxidizing agent than fluorine.
3. The H-N-H bond angle in NH_3 is greater than the H-As-H bond angle is AsH_3.
4. Nitric oxide, though an odd electron molecule, is diamagnetic in liquid state.
5. HBr is a stronger acid than HI because of hydrogen bonding.
6. Phosphorus, arsenic and antimony are found mainly as sulphide minerals.
7. Elements of group 15 have extra stability and higher ionisation energy due to exactly half filled ns^2np^3 electronic configuration.
8. Intermediate oxidation states for both nitrogen and phosphorus disproportionate in both acid and alkali.
9. All the three N—O bond lengths in HNO_3 are equal.
10. P_4 molecule in white phohsphorus have angular strain therefore white phosphorus is very reactive.
11. Oxygen shows only –2 oxidation state whereas S, Se and Te shows +4 O.S in their compounds with oxygen and +6 with fluorine.
12. Dimeric monohalides of group 16 undergo disproportionation.
13. $H_2S_2O_8$ contains four S = O, two S – OH and one O–O bond
14. Iodine has same physical state but different colour as compare to other members of the group.
15. ClF undergoes hydrolysis as below,

$$ClF + H_2O \longrightarrow HF + HOCl$$

Conceptual MCQs

1. Oxygen is more electronegative than sulphur, yet H_2S is acidic while H_2O is neutral. This is because
   (a) Water is a highly associated
   (b) H—S bond is weaker than H—O bond
   (c) H_2S is a gas while H_2O is a liquid
   (d) The molecular weight of H_2S is more than that of H_2O

2. Which of the following statements is not valid for oxoacids of phosphorus?
(a) Orthophosphoric acid is used in the manufacture of triple superphosphate.
(b) Hypophosphorous acid is a diprotic acid.
(c) All oxoacids contain tetrahedral four coordinated phosphorus.
(d) All oxoacids contain atleast one P = O and one P — OH group.

3. In which of the following arrangements the given sequence is not strictly according to the property indicated against it ?
(a) HF < HCl < HBr < HI : increasing acidic strength
(b) $H_2O < H_2S < H_2Se < H_2Te$: increasing pK_a values
(c) $NH_3 < PH_3 < AsH_3 < SbH_3$: increasing acidic character
(d) $CO_2 < SiO_2 < SnO_2 < PbO_2$: increasing oxidising power

4. Of the following which is paramagnetic and has three electron bond in its structure
(a) N_2O (b) NO
(c) N_2O_3 (d) N_2O_5

5. With respect to protonic acids, which of the following statements is correct ?
(a) PH_3 is more basic than NH_3
(b) PH_3 is less basic than NH_3
(c) PH_3 is equally basic as NH_3
(d) PH_3 is amphoteric while NH_3 is basic.

6. The sequence of acidic character is
(a) $SO_2 > CO_2 > CO > N_2O_5$
(b) $SO_2 > N_2O_5 > CO > CO_2$
(c) $N_2O_5 > SO_2 > CO > CO_2$
(d) $N_2O_5 > SO_2 > CO_2 > CO$

7. If you touch concentrated HNO_3 with your finger and immediately wash it with water, then the skin at the place where it came into contact with HNO_3 becomes yellow. This is because of :
(a) the formation of Xanthoprotein
(b) the absorption of HNO_3 by skin
(c) the blood absorbing HNO_3
(d) the absorption of yellow/brown NO_2 gas

8. Difference between S and S^{2-} as S^{2-} has
(a) larger radii and large size
(b) smaller radii and large size
(c) larger radii and small size
(d) smaller radii and small size

9. PCl_5 is possible but NCl_5 does not exist :
(a) in N, d-sub-shell is absent
(b) ionization energy of N is very high
(c) it does not like Cl
(d) none of these

10. The boiling points of the following hydrides follow the order of
(a) $SbH_3 > NH_3 > AsH_3 > PH_3$
(b) $NH_3 > AsH_3 > PH_3 > SbH_3$
(c) $SbH_3 > AsH_3 > PH_3 > NH_3$
(d) $NH_3 > PH_3 > AsH_3 > SbH_3$

11. Which of the following fluorides of xenon is impossible?
(a) XeF_2 (b) XeF_3
(c) XeF_4 (d) XeF_6

12. The correct order of acidic strength is
(a) HF < HCl < HBr < HI
(b) HBr < HCl < HI < HF
(c) HCl < HBr < HF < HI
(d) HI < HBr < HCl < HF

13. P_4O_{10} is not used to dry NH_3 gas because
(a) P_4O_{10} reacts with moisture in NH_3
(b) P_4O_{10} is not a drying agent
(c) P_4O_{10} is acidic and NH_3 is basic
(d) P_4O_{10} is basic and NH_3 is acidic

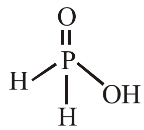
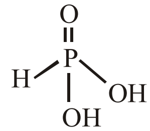
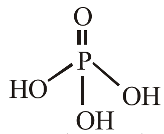
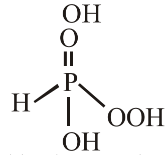
14. The structure of XeF_6 is
(a) Distorted octahedral
(b) Pyramidal
(c) Tetrahedral
(d) None of the above.

15. Which of the following statements is correct ?
(a) Only iodine forms oxy acid
(b) Only chlorine and bromine form oxy acid
(c) all the halogens form oxy acid
(d) all the halogens form oxy acids except fluorine

16. Of the four elements, the one having maximum electron affinity is :
(a) Fluorine (b) Chlorine
(c) Bromine (d) Iodine

17. Which of the following statements is not correct for nitrogen ?
(a) Its electronegativity is very high
(b) d-orbitals are available for bonding
(c) It is a typical non-metal
(d) Its molecular size is small

18. The structural formula of hypophosphorous acid is

(a) 
(b) 
(c) 
(d) 

19. What are the products formed in the reaction or xenon hexafluoride with silicon dioxide ?

(a) $XeSiO_4 + HF$ (b) $XeF_2 + SiF_4$
(c) $XeOF_4 + SiF_4$ (d) $XeO_3 + SiF_2$

20. Which of the following statements is false ?

(a) Radon is obtained from the decay of radium
(b) Helium is inert gas
(c) Xenon is the most reactive among the rare gases
(d) The most abundant rare gas found in the atmosphere is helium

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Dinitrogen is inert at room temperature.
Reason : Dinitrogen directly combines with lithium to form ionic nitrides.

2. **Assertion :** N_2 is less reactive than P_4.
Reason : Nitrogen has more electron gain enthalpy than phosphorus.

3. **Assertion :** When a metal is treated with conc. HNO_3 it generally yields a nitrate, NO_2 and H_2O.
Reason : Conc. HNO_3 reacts with metal and first produces a metal nitrate and nascent hydrogen. The nascent hydrogen then further reduces HNO_3 to NO_2.

4. **Assertion :** White phosphorus is more reactive than red phosphorus.
Reason : Red phosphorus consists of P_4 tetrahedral units linked to one another to form linear chains.

5. **Assertion :** Bond angle of H_2S is smaller than H_2O.
Reason : Electronegativity of the central atom increases, bond angle decreases.

6. **Assertion :** Both rhombic and monoclinic sulphur exist as S_8 but oxygen exists as O_2.
Reason : Oxfygen forms $p\pi - p\pi$ multiple bond due to small size and small bond length but $p\pi - p\pi$ bonding is not possible in sulphur.

7. **Assertion :** SF_6 cannot be hydrolysed but SF_4 can be.
Reason : Six F atoms in SF_6 prevent the attack of H_2O on sulphur atom of SF_6.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

	Column-I		Column-II
(A)	$2Pb(NO_3)_2 \xrightarrow{673K} 4NO_2 + 2PbO + O_2$	(1)	High pressure favours the formation of product
(B)	$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$	(2)	Product formed is acidic brown gas
(C)	$NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$	(3)	This reaction occurs at a high temperature about 2000 K

(D) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ (4) Product formed is a neutral colourless gas

(a) A – (3, 4), B – (2), C – (4), D – (1) (b) A – (2), B – (3, 4), C – (4), D – (1)

(c) A – (2), B – (4), C – (3, 4), D – (1) (d) A – (2), B – (3, 4), C – (1), D – (4)

2. Match the columns

Column - I	Column - II
(A) Used in manufacture of calcium cyanamide	(1) Ammonia
(B) Used in manufacture of nitric acid	(2) Nitric acid
(C) Used in pickling of stainless steel	(3) Dinitrogen

(a) A – (3), B – (1), C – (2) (b) A – (1), B – (3), C – (2)

(c) A – (3), B – (2), C – (1) (d) A – (2), B – (1), C – (3)

3. Match the columns.

Column-I (Oxyacid)	Column-II (Materials for preparation)
(A) H_3PO_2	(1) Red P + alkali
(B) H_3PO_3	(2) $P_4O_{10} + H_2O$
(C) H_3PO_4	(3) $P_2O_3 + H_2O$
(D) $H_4P_2O_6$	(4) White P + alkali

(a) (A) – (4), (B) – (3), (C) – (2), (D) – (1) (b) (A) – (1), (B) – (3), (C) – (2), (D) – (4)

(c) (A) – (4), (B) – (3), (C) – (1), (D) – (2) (d) (A) – (2), (B) – (3), (C) – (1), (D) – (4)

4. Match the columns

Column - I	Column - II
(A) $POCl_3$	(1) Contains four P – OH two P = O and one P – O – P
(B) $H_4P_2O_5$	(2) Yellowish white chloride of phosphorus reacts with moist air
(C) $H_4P_2O_6$	(3) Contains four P – OH, two P = O and one P – P bond
(D) $H_4P_2O_7$	(4) Colourless oily chloride of phosphorus reacts with orthophosphoric acid

(a) A – (2), B – (4), C – (1), D – (3) (b) A – (4), B – (2), C – (3), D – (1)

(c) A – (2), B – (4), C – (3), D – (1) (d) A – (2), B – (3), C – (4), D – (1)

5. Match the columns

Column - I	Column - II
(A) Metal that shows no reaction with dioxygen	(1) Platinum
(B) Metal forms strong acidic oxide with oxygen	(2) Nitrogen
(C) A non-metal discharge of whose oxide might be slowly depleting the concentration of the ozone layer	(3) Manganese
(D) Metal which forms amphoteric oxide	(4) Aluminium

(a) A – (1), B – (3), C – (2), D – (4) (b) A – (3), B – (1), C – (2), D – (4)

(c) A – (1), B – (2), C – (3), D – (4) (d) A – (1), B – (3), C – (4), D – (2)

6. Match the columns.

Column-I	Column-II
(A) Pb_3O_4	(1) Neutral oxide
(B) N_2O	(2) Acidic oxide
(C) Mn_2O_7	(3) Basic oxide
(D) Bi_2O_3	(4) Mixed oxide

(a) A – (1), B – (2), C – (3), D – (4)
(b) A – (4), B – (1), C – (2), D – (3)
(c) A – (3), B – (2), C – (4), D – (1)
(d) A – (4), B – (3), C – (1), D – (2)

7. Match the columns.

Column-I	Column-II
(A) SF_4	(1) Tetrahedral
(B) BrF_3	(2) Pyramidal
(C) BrO_3^-	(3) Sea-saw shaped
(D) NH_4^+	(4) Bent T-shaped

(a) A – (3), B – (2), C – (1), D – (4)
(b) A – (3), B – (4), C – (2), D – (1)
(c) A – (1), B – (2), C – (3), D – (4)
(d) A – (1), B – (4), C – (3), D – (2)

8. Match the columns

Column - I	Column - II
(A) $HClO_2$	(1) Contains all different bonds
(B) $HClO_3$	(2) Contains maximum Cl = O bond
(C) HClO	(3) Contains Cl with lowest O.S.
(D) $HClO_4$	(4) Contains three types of bonds

(a) A – (4), B – (1, 3), C – (1, 3), D – (2, 4)
(b) A – (1, 4), B – (4), C – (1, 3), D – (2, 4)
(c) A – (4), B – (1, 3), C – (1, 4), D – (2, 4)
(d) A – (1, 4), B – (4), C – (2, 4), D – (1, 3)

9. Match the columns.

Column-I (Oxides of halogens)	Column - II (Uses)
(A) O_2F_2	(1) in water treatment
(B) ClO_2	(2) in estimation of CO
(C) I_2O_5	(3) for removing plutonium from spent nuclear fuel.

(a) A – (2) , B – (1), C – (3)
(b) A – (3), B – (1), C – (2)
(c) A – (1), B – (3), C – (2)
(d) A – (3), B – (2), C – (1)

10. Match the columns

Column - I	Column - II
(A) XeF_4	(1) Contains similar types of bonds
(B) $XeOF_4$	(2) Contains maximum lone pair
(C) XeF_2	(3) Square pyramidal geometry
(D) XeO_3	(4) Contains one lone pair

(a) A – (1), B – (3, 4), C – (1, 2), D – (1, 4)
(b) A – (3, 4), B – (1), C – (3, 4), D – (1, 4)
(c) A – (1), B – (1, 2), C – (3, 4), D – (1, 4)
(d) A – (1), B – (3, 4), C – (1, 4), D – (1, 2)

11. Match the columns.

Column-I	Column-II
(A) Partial hydrolysis of the compound does not change oxidation state of central atom	(1) He
(B) It is used in modern diving	(2) XeF_6
(C) It is used to provide inert apparatus atmosphere for filling electrical bulbs	(3) XeF_4

(D) Its central atom is in sp^3d^2 hybridisation (4) Ar

(a) A – (1), B – (4), C – (1), D – (3)
(b) A – (1), B – (2), C – (3), D – (4)
(c) A – (2), B – (1), C – (4), D – (3)
(d) A – (1), B – (3), C – (2), D – (4)

12. Match the columns.

Column-I	Column-II
(A) XeF_6	(1) sp^3d^3– distorted octahedral
(B) XeO_3	(2) sp^3d^2 – square planar
(C) $XeOF_4$	(3) sp^3 – pyramidal
(D) XeF_4	(4) sp^3d^2 – square pyramidal

(a) A – (1), B – (3), C – (4), D – (2)
(b) A – (1), B – (2), C – (4), D – (3)
(c) A – (4), B – (3), C – (1), D – (2)
(d) A – (4), B – (1), C – (2), D – (4)

Critical Thinking Type Questions :

1. In which of the following equations the product formed has similar oxidation state for nitrogen?

(i) $NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$

(ii) $2Pb(NO_3)_2 \xrightarrow{673K} 4NO_2 + 2PbO + O_2$

(iii) $4HNO_3 + P_4O_{10} \longrightarrow 4HPO_3 + 2N_2O_5$

(iv) $2NO_2 \underset{\text{Heat}}{\overset{\text{Cool}}{\rightleftharpoons}} N_2O_4$

(a) (i) and (iii)
(b) (ii) and (iv)
(c) (i) and (v)
(d) (iii) and (iv)

2. What is Z in following reaction

$CuSO_4 + Z \rightarrow Cu_3P_2 + H_2SO_4$

$HgCl_2 + Z \rightarrow Hg_3P_2 + HCl$

(a) White phosphorus
(b) Red phosphorus
(c) Phosphine
(d) Orthophosphoric acid

3. Which one of the following arrangements does not give the correct picture of the trends indicated against it ?

(i) $F_2 > Cl_2 > Br_2 > I_2$: Oxidizing power
(ii) $F_2 > Cl_2 > Br_2 > I_2$: Electron gain enthalpy
(iii) $F_2 > Cl_2 > Br_2 > I_2$: Bond dissociation energy
(iv) $F_2 > Cl_2 > Br_2 > I_2$: Electronegativity.

(a) (ii) and (iv)
(b) (i) and (iii)
(c) (ii) and (iii)
(d) (ii), (iii) and (iv)

4. Which of the following order is/are incorrect regarding the property indicated against it?

(i) $HF > HI > HBr > HCl$: Thermal stability
(ii) $Cl_2O_7 > Cl_2O_6 > ClO_2 > Cl_2O$: Acidic character
(iii) $SbCl_3 > SbCl_5$: Covalent character
(iv) $MCl > MBr$: Ionic character

(a) (iii) only
(b) (ii) only
(c) (i) and (iii)
(d) (ii) and (iv)

5. Which of the following is correct about the reaction?

$3NaClO \xrightarrow{\text{heat}} NaClO_3 + 2NaCl$

(a) It is disproportionation reaction
(b) Oxidation number of Cl decreases as well as increases in this reaction
(c) This reaction is used for the manufacture of halates
(d) All of these

6. The formation of $O_2^+[PtF_6]^-$ is the basis for the formation of xenon fluorides. This is because

(a) O_2 and Xe have comparable sizes
(b) both O_2 and Xe are gases
(c) O_2 and Xe have comparable ionisation energies
(d) Both (a) and (c)

22 The d and f -Block Elements

Fill in the Blanks :

1. Mn^{2+} can be oxidised to MnO_4^- by _______ . (SnO_2, PbO_2, BaO_2)
2. Silver jewellery items tarnish slowly in the air due to their reaction with _______ .
3. The number of unpaired electrons in gaseous species of Mn^{3+}, Cr^{3+} and V^{3+} respectively are 4, 3 and _______ .
4. _______ transition element does not exhibit variable oxidation state.
5. Gun metal is an alloy of _______ .
6. CrO_3 dissolves in aqueous NaOH to give _______ .
7. $KMnO_4$ acts as an oxidising agent in alkaline medium. When alkaline $KMnO_4$ is treated with KI, iodide ion is oxidised to _______ .
8. The starting material for the manufacture of $KMnO_4$ is _______ .
9. Total number of inner transition elements in the periodic table is _______ .
10. The maximum oxidation state exhibited by actinide ions is _______ .

True/ False :

1. The maximum oxidation state of Mn with the oxygen is +VII while with fluorine is +IV.
2. Seven fluorine cannot be accommodated around Mn.
3. Number of unpaired electrons is greater in Cr than other elements of series 1.
4. Small size and presence of vacant *d*-orbitals make transition metal ions suitable for formation of complex compounds.
5. Catalytic action of transition metals involves the increase of reactant concentration at catalyst surface and weakening of the bonds in the reacting molecules.
6. Some boride containing interstitial compounds are very hard comparable to that of diamond.
7. IE_2 is high for Cr and Cu whereas IE_3 is very high for Zn.
8. In any transition series maximum number of oxidation states is shown by middle elements or elements near middle elements.
9. $La(OH)_3$ is the least basic among hydroxides of lanthanides.
10. Out of all lanthanides Ce,Pr,Nd,Dy and Ho shows +4 oxidation state.
11. M^{4+} ion of Th is the only diamagnetic M^{4+} ion of actinoid series.
12. Electrons present in the 5f orbitals of actinides can participate in bonding to a firm greater extent as compared to electrons present in 4f orbitals of lanthanides.

Conceptual MCQs

1. The complex ion $[Co(NH_3)_6]^{3+}$ is formed by sp^3d^2 hybridisation. Hence the ion should possess
   (a) Octahedral geometry
   (b) Tetrahedral geometry
   (c) Square planar geometry
   (d) Tetragonal geometry.
2. Which one of the following statements is not correct ?
   (a) Nickel forms $Ni(CO)_4$
   (b) All the transition metals form monometallic carbonyls
   (c) Carbonyls are formed by transition metals
   (d) Transition metals form complexes

3. A blue colouration is not obtained when
(a) Ammonium hydroxide dissolves in copper sulphate
(b) Copper sulphate solution reacts with $K_4[Fe(CN)_6]$
(c) Ferric chloride reacts with sod. ferrocyanide
(d) Anhydrous $CuSO_4$ is dissolved in water

4. The lanthanide contraction is responsible for the fact that
(a) Zr and Y have about the same radius
(b) Zr and Nb have similar oxidation state
(c) Zr and Hf have about the same radius
(d) Zr and Zn have the same oxidation states
(Atomic numbers : Zr = 40, Y = 39, Nb = 41, Hf = 72, Zn = 30)

5. Which one of the following ionic species will impart colour to an aqueous solution?
(a) Ti^{4+} (b) Cu^{+}
(c) Zn^{2+} (d) Cr^{3+}

6. Of the following transition metals, the maximum numbers of oxidation states are exhibited by:
(a) Chromiun (Z = 24) (b) Manganese (Z = 25)
(c) Iron (Z = 26) (d) Titanium (Z=22)

7. A compound of a metal ion $M^{x+}(Z = 24)$ has a spin only magnetic moment of $\sqrt{15}$ Bohr Magnetons. The number of unpaired electrons in the compound are
(a) 2 (b) 4
(c) 5 (d) 3

8. The correct order of ionic radii of Y^{3+}, La^{3+}, Eu^{3+} and Lu^{3+} is
(a) $La^{3+} < Eu^{3+} < Lu^{3+} < Y^{3+}$
(b) $Y^{3+} < La^{3+} < Eu^{3+} < Lu^{3+}$
(c) $Y^{3+} < Lu^{3+} < Eu^{3+} < La^{3+}$
(d) $Lu^{3+} < Eu^{3+} < La^{3+} < Y^{3+}$
(Atomic nos. Y =39, La = 57, Eu = 63, Lu = 71)

9. The basic character of the transition metal monoxides follows the order
(Atomic Nos., Ti = 22, V = 23, Cr = 24, Fe = 26)
(a) TiO > VO > CrO > FeO
(b) VO > CrO > TiO > FeO
(c) CrO > VO > FeO > TiO
(d) TiO > FeO > VO > CrO

10. The main reason for larger number of oxidation states exhibited by the actinoids than the corresponding lanthanoids, is
(a) more energy difference between 5f and 6d orbitals than between 4f and 5d orbitals.
(b) lesser energy difference between 5f and 6d orbitals than between 4f and 5d orbitals.
(c) larger atomic size of actinoids than the lanthanoids.
(d) greater reactive nature of the actinoids than the lanthanoids.

11. Among the following series of transition metal ions, the one where all metal ions have $3d^2$ electronic configuration is(At. nos. Ti = 22; V = 23; Cr = 24; Mn = 25)
(a) $Ti^{3+}, V^{2+}, Cr^{3+}, Mn^{4+}$
(b) $Ti^{+}, V^{4+}, Cr^{6+}, Mn^{7+}$
(c) $Ti^{4+}, V^{3+}, Cr^{2+}, Mn^{3+}$
(d) $Ti^{2+}, V^{3+}, Cr^{4+}, Mn^{5+}$

12. Four successive members of the first row transition elements are listed below with their atomic numbers. Which one of them is expected to have the highest third ionization enthalpy?
(a) Vanadium (Z = 23)
(b) Chromium (Z = 24)
(c) Manganese (Z = 25)
(d) Iron (Z = 26)

13. The catalytic activity of transition metals and their compounds is ascribed mainly due to :
(a) their magnetic behaviour
(b) their unfilled d-orbitals
(c) their ability to adopt variable oxidation state
(d) their chemical reactivity

14. Identify the incorrect statement among the following:
(a) Lanthanoid contraction is the accumulation of successive shrinkages.
(b) As a result of lanthanoid contraction, the properties of 4d series of the transition elements have no similarities with the 5d series of elements.
(c) Shielding power of 4f electrons is quite weak.
(d) There is a decrease in the radii of the atoms or ions as one proceeds from La to Lu.

15. Which of the following statement is incorrect ?
(a) Silver glance mainly contains silver sulphide
(b) Gold is found in native state
(c) Zinc blende mainly contains zinc chloride
(d) Copper pyrites also contain Fe_2S_3.

16. In the extraction of silver from argentite ore. The ore is treated with dil. solution of NaCN in water in the presence of Y, whereby the following reaction takes place :
$Ag_2X + 4NaCN + 2Y \rightarrow 2Na[Ag(CN)_2] + Na_2XO_4$ · X and Y in this reaction are respectively :
(a) Sb and S (b) S and O_2
(c) O and O_2 (d) O and S

17. Which of the following statement is not true about Mohr's salt ?
(a) It decolourises $KMnO_4$
(b) It is a primary standard
(c) It is a double salt
(d) Oxidation state of iron is +3 in it

18. When excess of $SnCl_2$ is added to a solution of $HgCl_2$, a white precipitate turning to grey is obtained. This grey colour is due to the formation of
(a) Hg_2Cl_2 (b) $SnCl_4$
(c) Sn (d) Hg.

19. Out of TiF_6^{2-}, CoF_6^{3-}, Cu_2Cl_2 and $NiCl_4^{2-}$ (Z of Ti = 22, Co = 27, Cu = 29, Ni = 28), the colourless species are:
(a) Cu_2Cl_2 and $NiCl_4^{2-}$
(b) TiF_6^{2-} and Cu_2Cl_2
(c) CoF_6^{3-} and $NiCl_4^{2-}$
(d) TiF_6^{2-} and CoF_6^{3-}

20. Four successive members of the first series of the transition metals are listed below. For which one of them the standard potential $\left(E^0_{M^{2+}/M}\right)$ value has a positive sign?
(a) Co (Z = 27) (b) Ni (Z = 28)
(c) Cu (Z = 29) (d) Fe (Z = 26)

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*
(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Cuprous ion (Cu^+) has unpaired electrons while cupric ion (Cu^{++}) does not.
Reason : Cuprous ion (Cu^+) is colourless whereas cupric ion (Cu^{++}) is blue in the aqueous solution

2. **Assertion :** Transition metals show variable valency.
Reason : Transition metals have a large energy difference between the ns^2 and $(n-1)d$ electrons.

3. **Assertion :** Transition metals are good catalysts.
Reason : V_2O_5 or Pt is used in the preparation of H_2SO_4 by contact process.

4. **Assertion :** Magnetic moment values of actinides are lesser than the theoretically predicted values.
Reason : Actinide elements are strongly paramagnetic.

5. ***Assertion :*** Cuprous ion (Cu^+) has unpaired electrons while cupric ion (Cu^{2+}) does not.
Reason : Cuprous ion (Cu^+) is colourless whereas cupric ion (Cu^{2+}) is blue in the aqueous solution.

6. **Assertion :** Solution of Na_2CrO_4 in water is intensely coloured.
Reason : Oxidation state of Cr in Na_2CrO_4 is +VI

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I		Column-II	
(A)	Metal of the 3*d*-series which does not form MO type oxide.	(1)	Manganese
(B)	Metal of the 3*d*-series which forms most covalent oxide.	(2)	Vanadium
(C)	Metal of the 3*d*-series which forms the amphoteric oxide.	(3)	Scandium

(a) A – (1), B – (3), C – (2) (b) A – (3), B – (1), C – (2)

(c) A – (3), B – (2), C – (1) (d) A – (2), B – (1), C – (3)

2. Match the columns

Column-I (Ion)		Column-II ($M_{calculated}$)	
(A)	Ti^{2+}	(1)	2.84
(B)	Zn^{2+}	(2)	5.92
(C)	Mn^{2+}	(3)	0
(D)	Sc^{3+}	(4)	4.90

(a) A – (4), B – (1), C – (2), D – (3). (b) A – (3), B – (1), C – (2), D – (4).

(c) A – (1), B – (3), C – (2), D – (4). (d) A – (1), B – (4), C – (2), D – (3).

3. Match the columns

Column-I		Column-II	
(A)	Compound formed when yellow CrO_4^{2-} is acidified.	(1)	acidified MnO_4^-
(B)	reagent oxidises Fe^{2+} to Fe^{3+}	(2)	$Cr_2O_7^{2-}$
(C)	Compound produced when MnO_2 is fused with KNO_3	(3)	K_2MnO_4
(D)	Compound having dark purple crystals isostructural with $KClO_4$	(4)	$KMnO_4$

(a) A – (2),B – (1), C – (3), D – (4) (a) A – (1),B – (2), C – (3), D – (4)

(a) A – (2),B – (3), C – (1), D – (4) (a) A – (2),B – (1), C – (4), D – (3)

4. Match the columns

Column-I		Column-II	
(A)	Lanthanide hard as steel.	(1)	Lu
(B)	Lanthanide with maximum paramagnetic character in Ln^{4+} state.	(2)	Tb
(C)	Lanthanide with maximum value of E° for reaction $Ln^{3+}(aq)+3e^- \longrightarrow Ln(s)$.	(3)	Sm
(D)	Lanthanide whose Ln^{3+} ion is diamagnetic in nature	(4)	Eu

(a) A – (3), B – (4), C – (1), D – (2) (b) A – (3), B – (2), C – (4), D – (1)

(c) A – (4), B – (3), C – (2), D – (1) (d) A – (3), B – (4), C – (2), D – (1)

Critical Thinking Type Questions :

1. Highest oxidation state of manganese in fluoride is +4 (MnF_4) but highest oxidation state in oxides is +7 (Mn_2O_7) because _______.
(a) fluorine is more electronegative than oxygen.
(b) fluorine does not possess *d*-orbitals.
(c) fluorine stabilises lower oxidation state.
(d) in covalent compounds fluorine can form single bond only while oxygen forms double bond.

2. For the ions Zn^{2+}, Ni^{2+} and Cr^{3+} which among the following statements is correct?
(atomic number of Zn = 30, Ni = 28 and Cr = 24)
(a) All these are colourless
(b) All these are coloured
(c) Only Ni^{2+} is coloured and Zn^{2+} and Cr^{3+} are colourless
(d) Only Zn^{2+} is colourless and Ni^{2+} and Cr^{3+} are coloured

3. The colour of the following ions V^{2+}, V^{3+}, V^{4+}, Fe^{2+}, Fe^{3+} are respectively
(a) green, violet, blue, green, yellow
(b) yellow, green, violet, green, blue
(c) violet, green, yellow, green, blue
(d) yellow, green, blue, green, violet

4. Which of the statements is not true?
(a) On passing H_2S through acidified $K_2Cr_2O_7$ solution, a milky colour is observed.
(b) $Na_2Cr_2O_7$ is preferred over $K_2Cr_2O_7$ in volumetric analysis.
(c) $K_2Cr_2O_7$ solution in acidic medium is orange.
(d) $K_2Cr_2O_7$ solution becomes yellow on increasing the pH beyond 7.

5. Which one of the following is an amphoteric oxide ?
(i) Mn_2O_7 (ii) CrO
(iii) V_2O_4 (iv) Cr_2O_3
(a) (i) and (ii) (b) (ii), (iii) and (iv)
(c) (iii) and (iv) (d) (ii) and (iv)

6. When a small amount of $KMnO_4$ is added to concentrated H_2SO_4, a green oily compound is obtained which is highly explosive in nature. Compound may be
(a) $MnSO_4$ (b) Mn_2O_7
(c) MnO_2 (d) Mn_2O_3

7. Which of the following oxidising reaction of $KMnO_4$ occurs in acidic medium?
(i) Fe^{2+} (green) is converted to Fe^{3+} (yellow).
(ii) Iodide is converted to iodate.
(iii) Thiosulphate oxidised to sulphate.
(iv) Nitrite is oxidised to nitrate.
(a) (i) and (iii) (b) (i) and (iv)
(c) (iv) only (d) (ii) and (iv)

8. Solution of oxalate is colourless. It is made acidic by adding excess of H^+, then titrated with $KMnO_4$. Now at a moment if someone has added large amount of $KMnO_4$, in it then no. of possible products are
(a) CO_2, Mn^{2+}, H_2O
(b) CO_2, MnO_2, H_2O
(c) MnO_2, H_2O, CO_2
(d) CO_2, MnO_2, H_2O, Mn^{2+}

9. Knowing that the chemistry of lanthanoids(Ln) is dominated by its + 3 oxidation state, which of the following statements is incorrect?
(a) The ionic size of Ln (III) decrease in general with increasing atomic number
(b) Ln (III) compounds are generally colourless.
(c) Ln (III) hydroxide are mainly basic in character.
(d) Because of the large size of the Ln (III) ions the bonding in its compounds is predominantly ionic in character.

10. Although + 3 is the characteristic oxidation state for lanthanoids but cerium also shows + 4 oxidation state because _________ .
(i) it has variable ionisation enthalpy
(ii) it has a tendency to attain noble gas configuration
(iii) it has a tendency to attain f^0 configuration
(iv) it resembles Pb^{4+}
(a) (ii) and (iii) (b) (i) and (iv)
(c) (ii) and (iv) (d) (i), (ii) and (iii)

23 Co-ordination Compounds

Fill in the Blanks :

1. The type of magnetism exhibited by $[Mn(H_2O)_6]^{2+}$ ion is _______ .
2. The IUPAC name of $[Co(NH_3)_6]Cl_3$ is ______.
3. The number of ions formed on dissolving one molecule of $FeSO_4(NH_4)_2SO_4.6H_2O$ in water is _______ .
4. The coordination number and the oxidation state of the element 'E' in the complex $[E(en)_2(C_2O_4)]NO_2$ (where (en) is ethylene diamine) are, respectively, 6 and _______ .
5. Denticity of the ligand ethylenediaminetetra actetate ion is _______ .
6. The number of geometrical isomers for $[Pt(NH_3)_2Cl_2]$ is _______ .
7. For $[Co_2(CO)_8]$, total number of metal-carbon and metal–metal bonds are _______ and _______ .
8. In $Fe(CO)_5$, the Fe – C bond possesses _______ character.

True/ False :

1. $[EDTA]^{4-}$ can bind through two oxygen and four nitrogen atom.
2. Coordination number of the central atom/ion is determined only by the number of sigma bonds formed by the ligand with central atom/ion
3. During nomenclature names of neutral ligands are kept same except for H_2O, NH_3 and CO.
4. While writing formula of coordination compounds polydentate ligands are listed alphabeticaly.
5. Square planar complexes of MABXL type show three isomers-two *cis* and one *trans*.
6. Optical isomerism is common in octahedral complexes involving bidentate ligands.
7. Hydrate isomerism is another name of solvate isomerism.
8. When light of wavelength 600nm is absorbed by complex $[Ti(H_2O)_6]^{3+}$ its configuration changes from $t_{2g}^1 e_g^0 \longrightarrow t_{2g}^0 e_g^1$ and it appears violet in colour.
9. Anhydrous $CuSO_4$ is white but $CuSO_4.5H_2O$ is blue in colour as presence of H_2O as a ligand causes crystal field spitting.
10. Ruby is aluminum oxide containing 0.5 – 1% Cr^{3+} ions with d^3 configuration.
11. In metal carbonyls M–C σ bond is formed by the donation of lone pair of electrons on the carbonyl carbon into a vacant orbital of metal.
12. Bonding in metal carbonyls is called synergic bonding.

Conceptual MCQs

1. Among the following, the compound that is both paramagnetic and coloured is
   (a) $K_2Cr_2O_7$ (b) $(NH_4)_2(TiCl_6)$
   (c) $CoSO_4$ (d) $K_3[Cu(CN)_4]$
2. Which of the following is an organometallic compound?
   (a) Lithium methoxide
   (b) Lithium acetate
   (c) Lithium dimethylamide
   (d) Methyl lithium.
3. The complex, $[Pt(Py)(NH_3)BrCl]$ will have how many geometrical isomers ?
   (a) 3 (b) 4
   (c) 0 (d) 2

4. The species having tetrahedral shape is
(a) $[PdCl_4]^{2-}$ (b) $[Ni(CN)_4]^{2-}$
(c) $[Pd(CN)_4]^{2-}$ (d) $[NiCl_4]^{2-}$

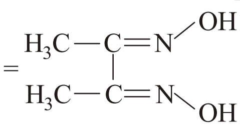
5. Which kind of isomerism is exhibited by octahedral $Co(NH_3)_4Br_2Cl$?
(a) Geometrical and Ionization
(b) Geometrical and Optical
(c) Optical and Ionization
(d) Geometrical only

6. The IUPAC name of $[Ni(NH_3)_4][NiCl_4]$ is
(a) Tetrachloronickel (II) - tetraamminenickel (II)
(b) Tetraamminenickel (II) - tetrachloronickel (II)
(c) Tetraamminenickel (II) - tetrachloronickelate (II)
(d) Tetrachloronickel (II) - tetrachloronickelate

7. Which of the following **does not** show optical isomerism?
(a) $[Co(NH_3)_3Cl_3]^0$
(b) $[Co(en)Cl_2(NH_3)_2]^+$
(c) $[Co(en)_3]^{3+}$
(d) $[Co(en)_2Cl_2]^+$ (en = ethylenediamine)

8. Which of the following statements is correct ?
(Atomic number of Ni = 28)
(a) $Ni(CO)_4$ is diamagnetic and $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ are paramagnetic
(b) $Ni(CO)_4$ and $[Ni(CN)_4]^{2-}$ are diamagnetic and $[NiCl_4]^{2-}$ is paramagnetic
(c) $Ni(CO)_4$ and $[NiCl_4]^{2-}$ are diamagnetic and $[Ni(CN)_4]^{2-}$ is paramagnetic
(d) $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ are diamagnetic and $Ni(CO)_4$ is paramagnetic

9. Red precipitate is obtained when ethanol solution of dimethylglyoxime is added to ammoniacal Ni(II). Which of the following statements is not true ?
(a) Red complex has a square planar geometry.
(b) Complex has symmetrical H-bonding
(c) Red complex has a tetrahedral geometry.
(d) Dimethylglyoxime functions as bidentate ligand.

[dimethylglyoxime = ]

10. Low spin complex of d^6-cation in an octahedral field will have the following energy :
(a) $\frac{-12}{5}\Delta_0 + P$ (b) $\frac{-12}{5}\Delta_0 + 3P$
(c) $\frac{-2}{5}\Delta_0 + 2P$ (d) $\frac{-2}{5}\Delta_0 + P$
(Δ_0= Crystal Field Splitting Energy in an octahedral field, P = Electron pairing energy)

11. IUPAC name of $[Pt(NH_3)_3(Br)(NO_2)Cl]Cl$ is
(a) Triamminechlorobromonitroplatinum (IV) chloride
(b) Triamminebromonitrochloroplatinum (IV) chloride
(c) Triamminebromochloronitroplatinum (IV) chloride
(d) Triamminenitrochlorobromoplatinum (IV) chloride

12. In which of the following compounds does iron exhibit zero oxidation state?
(a) $[Fe(H_2O)_6](NO_3)_3$
(b) $K_3[Fe(CN)_6]$
(c) $K_4[Fe(CN)_6]$
(d) $[Fe(CO)_5]$

13. Which one of the following will show paramagnetism corresponding to 2 unpaired electrons?(Atomic numbers : Ni = 28, Fe = 26)
(a) $[FeF_6]^{3-}$ (b) $[NiCl_4]^{2-}$
(c) $[Fe(CN)_6]^{3-}$ (d) $[Ni(CN)_4]^{2-}$

14. When $AgNO_3$ is added to a solution of $Co(NH_3)_5Cl_3$, the precipitate of AgCl shows two ionizable chloride ions. This means :
(a) Two chlorine atoms satisfy primary valency and one secondary valency
(b) One chlorine atom satisfies primary as well as secondary valency
(c) Three chlorine atoms satisfy primary valency
(d) Three chlorine atoms satisfy secondary valency

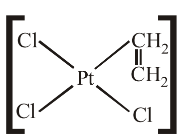
15. Which of the following organometallic compound is σ and π bonded?
(a) $[Fe(\eta^5-C_5H_5)_2]$
(b) $Fe(CH_3)_3$
(c) $K[PtCl_3(\eta^2-C_2H_4)]$
(d) $[Co(CO)_5NH_3]^{2+}$

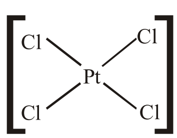
16. The hypothetical complex chlorodiaquatriammine cobalt (III) chloride can be represented as
(a) $[CoCl(NH_3)_3(H_2O)_2]Cl_2$
(b) $[Co(NH_3)_3(H_2O)Cl_3]$
(c) $[Co(NH_2)_3(H_2O)_2Cl]$
(d) $[Co(NH_3)_3(H_2O)_3]Cl_3$

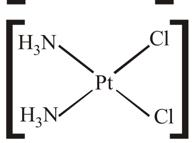
17. Which of the following does not have a metal-carbon bond?
(a) $Al(OC_2H_5)_3$
(b) C_2H_5MgBr
(c) $K[Pt(C_2H_4)Cl_3]$
(d) $Ni(CO)_4$

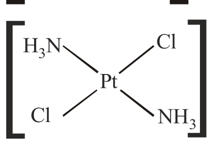
18. For the square planar complex [M (a) (b) (c) (d)] (where M = central metal and a, b, c and d are monodentate ligands), the number of possible geometrical isomers are
(a) 1 (b) 2
(c) 3 (d) 4

19. Which of the following is considered to be an anticancer species ?

(a) 

(b) 

(c) 

(d) 

20. The d electron configurations of Cr^{2+}, Mn^{2+}, Fe^{2+} and Ni^{2+} are $3d^4$, $3d^5$, $3d^6$ and $3d^8$ respectively. Which one of the following aqua complexes will exhibit the minimum paramagnetic behaviour?
(a) $[Fe(H_2O)_6]^{2+}$ (b) $[Ni(H_2O)_6]^{2+}$
(c) $[Cr(H_2O)_6]^{2+}$ (d) $[Mn(H_2O)_6]^{2+}$
(At. No. Cr = 24, Mn = 25, Fe = 26, Ni = 28)

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** NF_3 is a weaker ligand than $N(CH_3)_3$.
Reason : NF_3 ionizes to give F^- ions in aqueous solution.

2. **Assertion :** $[Fe(CN)_6]^{3-}$ is weakly paramagnetic while $[Fe(CN)_6]^{4-}$ is diamagnetic.
Reason : $[Fe(CN)_6]^{3-}$ has +3 oxidation state while $[Fe(CN)_6]^{4-}$ has +2 oxidation state.

3. **Assertion :** $[Ti(H_2O)_6]^{3+}$ is coloured while $[Sc(H_2O)_6]^{3+}$ is colourless.
Reason : *d-d* transition is not possible in $[Sc(H_2O)_6]^{3+}$.

4. **Assertion :** C – O bond in metal carbonyls is long.
Reason : There is delocalisation of electrons from filled *d* orbitals into the empty orbitals on the CO ligands.

5. **Assertion :** $[Co(NO_2)_3(NH_3)_3]$ does not show optical isomerism.
Reason : It has a plane of symmetry.

6. **Assertion :** $[Ni(en)_3]Cl_2$ (en = ethylene- diamine) has more stability than $[Ni(NH_3)_6]Cl_2$.
Reason : In $[Ni(en)_3]Cl_2$, the geometry of Ni is trigonal bipyramidal.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns.

Column-I (Ligand)	**Column-II (Type of ligand)**
(A) Triphenylphosphine	(1) Unidenate
(B) BF_3	(2) Didentate
(C) Ethylenediamine	(3) Not a ligand
(D) Ethylenediaminetetracetateion	(4) Hexadenate

(a) A – (1), B – (3), C – (2), D – (4)
(b) A – (1), B – (2), C – (3), D – (4)
(c) A – (1), B – (3), C – (2), D – (4)
(d) A – (1), B – (2), C – (4), D – (1)

2. Match the complex species given in Column-I with the isomerism exhibited in Column-II and assign the correct code:

Column-I (Complex species)	**Column-II (Isomerism)**
(A) $[Co[NH_3)_4Cl_2]^+$	(1) optical
(B) *cis*-$[Co(en)_2Cl_2]^+$	(2) ionisation
(C) $[Co(NH_3)_5(NO_2)]Cl_2$	(3) coordination
(D) $[Co(NH_3)_6][Cr(CN)_6]$	(4) geometrical

(a) A – (4), B – (1), C – (2), D – (3)
(b) A – (1), B – (3), C – (2), D – (4)
(c) A – (2), B – (4), C – (1), D – (3)
(d) A – (1), B – (3), C – (4), D – (2)

3. Match the columns.

Column-I	**Column-II**
(A) $[Ni(CN)_4]^{2-}$	(1) Ti^{4+}
(B) Chlorophyll	(2) sp^3; paramagnetic
(C) Ziegler - Natta catalyst	(3) Non-planar
(D) $[NiCl_4]^{2-}$	(4) Mg^{2+}
(E) Deoxyhaemoglobin	(5) Planar
	(6) dsp^2; diamagnetic

(a) A – (6), B – (4), C – (1), D – (2), E – (3)
(b) A – (2), B – (4), C – (1), D – (6), E – (3)
(c) A – (2), B – (4), C – (1), D – (6), E – (5)
(d) A – (6), B – (4), C – (1), D – (2), E – (5)

4. Match the columns.

Column-I (Complexes)	**Column-II (Absorbed Light)**
(A) $[Ni(H_2O)_4(en)]^{2+}(aq)$	(1) Yellow Orange
(B) $[Ni(H_2O)_4(en)_2]^{2+}(aq)$	(2) Blue–Green
(C) $[Ni(en)_3]^{2+}(aq)$	(3) Red

(a) A – (3), B – (2), C – (1)
(b) A – (1), B – (3), C – (2)
(c) A – (2), B – (3), C – (1)
(d) A – (3), B – (1), C – (1)

5. Match the columns.

	Column-I		Column-I
(A)	Estimation of water hardness.	(1)	$[Ag(CN)_2]^-$
(B)	Extraction of silver.	(2)	$[Ni(CO)_4]$
(C)	Hydrogenation of alkenes.	(3)	Na_2EDTA
(D)	Photography	(4)	$[(Ph_3P)_3RhCl]$
(E)	Purification of Nickel.	(5)	$[Ag(S_2O_3)_2]^{3-}$

(a) A – (3) , B – (1), C – (3), D – (5), E– (2) (b) A – (1) , B – (3), C – (3), D – (5), E– (2)
(c) A – (3) , B – (4), C – (1), D – (5), E– (2) (d) A – (3) , B – (1), C – (4), D – (2), E– (5)

6. Match the columns.

	Column-I (Coordination compound)		Column-II (Central metal atom)
(A)	Chlorophyll	(1)	Rhodium
(B)	Blood pigment	(2)	Cobalt
(C)	Wilkinson catalyst	(3)	Calcium
(D)	Vitamin B_{12}	(4)	Iron
		(5)	Magnesium

(a) A – (5), B – (4), C – (1), D – (1) (b) A – (4), B – (2), C – (1), D – (3)
(c) A – (1), B – (2), C – (3), D – (4) (d) A – (3), B – (5), C – (1), D – (2)

Critical Thinking Type Questions :

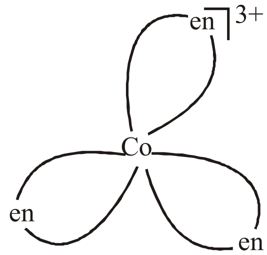
1. A co-ordination complex compound of cobalt has the molecular formula containing five ammonia molecules, one nitro group and two chlorine atoms for one cobalt atom. One mole of this compound produces three mole ions in an aqueous solution. On reacting this solution with excess of $AgNO_3$ solution, we get two moles of AgCl precipitate. The ionic formula for this complex would be
(a) $[Co(NH_3)_4(NO_2)Cl][(NH_3)Cl]$
(b) $[Co(NH_3)_5Cl][Cl(NO_2)]$
(c) $[Co(NH_3)_5(NO_2)]Cl_2$
(d) $[Co(NH_3)_5][(NO_2)_2Cl_2]$

2. $C_{63}H_{88}CoN_{14}O_{14}P$ is the formulae of the Cyanocobalamine, (vitamin B_{12}) it contain CN^- and CN^- is very poisonous, than why this compound does not prove to be fatal for us? (it inhibit the electron transport chain ?
(a) CN^- forms covalent bond
(b) CN^- is coordinating to the cobalt as the ligand
(c) CN^- hydrolysis immediately
(d) All of these

3. $[Co(NH_3)_4(NO_2)_2]Cl$ exhibits
(a) linkage isomerism, ionization isomerism and geometrical isomerism
(b) ionization isomerism, geometrical isomerism and optical isomerism
(c) linkage isomerism, geometrical isomerism and optical isomerism
(d) linkage isomerism, ionization isomerism and optical isomerism

4. Identify the optically active compounds from the following :
(i) $[Co(en)_3]^{3+}$
(ii) *trans* – $[Co(en)_2Cl_2]^+$
(iii) *cis* – $[Co(en)_2Cl_2]^+$
(iv) $[Cr(NH_3)_5Cl]$
(a) (i) and (iii) (b) (ii) and (iii)
(c) (iii) and (iv) (d) (i), (iii) and (iv)

5. The complex given is



(i) non-superimposable on its mirror images
(ii) optically inactive
(iii) rotate plane polarised light
(iv) planar

(a) (i) and (ii) (b) (i) and (iv)
(c) (i), (ii) and (iii) (d) (ii) only

6. The d electron configurations of Cr^{2+}, Mn^{2+}, Fe^{2+} and Ni^{2+} are $3d^4$, $3d^5$, $3d^6$ and $3d^8$ respectively. Which one of the following aqua complexes will exhibit the minimum paramagnetic behaviour?

(a) $[Fe(H_2O)_6]^{2+}$ (b) $[Ni(H_2O)_6]^{2+}$
(c) $[Cr(H_2O)_6]^{2+}$ (d) $[Mn(H_2O)_6]^{2+}$

(At. No. Cr = 24, Mn = 25, Fe = 26, Ni = 28)

7. Correct statements about the following complexes $[MnCl_6]^{3-}$ and $[Mn(CN)_6]^{3-}$ respectively are.

(a) Magnetic moment is 4.8 and 2.8
(b) inner sphere and outer sphere complexes.
(c) sp^3d^2 and d^2sp^3 complexes.
(d) Both (a) and (c).

8. In which of the following coordination entities the magnitude Δ_0 (CFSE in octahedral field) will be maximum?

(a) $[Co(H_2O)_6]^{3+}$ (b) $[Co(NH_3)_6]^{3+}$
(c) $[Co(CN)_6]^{3-}$ (d) $[Co(C_2O_4)_3]^{3-}$

(At. No. Co = 27)

24 Haloalkanes and Haloarenes

Fill in the Blanks :

1. The halogen which is most reactive in the halogenation of alkanes under sunlight is _______ . (chlorine, bromine, iodine)
2. The compound prepared by the action of magnesium on dry ethyl bromide in ether is known as _______ reagent.
3. Structural isomers possible for a compound with molecular formula C_3H_7Cl are _______ .
4. IUPAC name of
$CH_3CH_2C(Br) = CH — Cl$ is _______ .
5. S_N2 mechanism proceeds through intervention of _____ .
6. Freon used as refrigerant is _______ .
7. _______ is used in fire extinguishers.
8. Tertiary alkyl halides are practically inert to substitution by S_N2 mechanism because of _______ .

True/ False :

1. *m*-Chlorobromobenzene is an isomer of *m*-bromochlorobenzene.
2. The reaction of vinyl chloride with hydrogen iodide to give 1-chloro-1-iodoethane is an example of anti-Markovnikov's rule.
3. The general formula of aryl halides is $C_nH_{n-1}X$
4. In alkyl halides halogen atom(s) is attached to sp^2 hybridised carbon atom
5. For the same alkyl group, the boiling points of alkyl halides decreases in the order.
$RI > RBr > RCl > RF$
6. The boiling points of isomeric haloalkanes decrease with increase in branching.
7. Among isomeric dihalobenzenes the para-isomers have higher melting point than their ortho and meta-isomers.
8. Tertiary alkyl halides are least reactive towards S_N2 reactions and show high reactivity towards S_N1 reaction.
9. S_N1 reactions are two step reactions in which step 1 is fast and irreversible.
10. Allylic and benzylic halides show high reactivity toward S_N1 reactions.
11. S_N2 reaction proceed with complete stereochemical inversion.
12. A dextrorotatory compound rotate the plane polarised light to the left.

Conceptual MCQs

1. The reaction of toluene with Cl_2 in presence of $FeCl_3$ gives 'X' and reaction in presence of light gives 'Y'. Thus, 'X' and 'Y' are :
(a) X = Benzal chloride, Y = *o* – Chlorotoluene
(b) X = *m* – Chlorotoluene,
Y = *p* –Chlorotoluene
(c) X = o –and *p* – Chlorotoluene,
Y = Trichloromethyl – benzene
(d) X = Benzyl chloride, Y = *m* – Chlorotoluene
2. When chlorine is passed through poropene at 400°C, which of the following is formed ?
(a) PVC
(b) Allyl chloride
(c) Nikyl chloride
(d) 1, 2-Dichloroethane
3. An organic compound A (C_4H_9Cl) on reaction with Na/diethyl ether gives a hydrocarbon which on monochlorination gives only one chloro derivative, then A is
(a) tert-butyl chloride
(b) sec-butyl chloride
(c) isobutyl chloride
(d) n-butyl chloride

4. Reactivity order of halides for dehydrohalogenation is
(a) $R-F > R-Cl > R-Br > R-I$
(b) $R-I > R-Br > R-Cl > R-F$
(c) $R-I > R-Cl > R-Br > R-F$
(d) $R-F > R-I > R-Br > R-Cl$

5. $CH_3CH_2Cl \xrightarrow{NaCN} X \xrightarrow{Ni/H_2} Y$

$Y \xrightarrow[\text{anhydride}]{\text{Acetic}} Z$

Z in the above reaction sequence is
(a) $CH_3CH_2CH_2NHCOCH_3$
(b) $CH_3CH_2CH_2NH_2$
(c) $CH_3CH_2CH_2CONHCH_3$
(d) $CH_3CH_2CH_2CONHCOCH_3$

6. When $CH_3CH_2CHCl_2$ is treated with $NaNH_2$, the product formed is
(a) $CH_3-CH=CH_2$
(b) $CH_3-C\equiv CH$
(c) $CH_3CH_2CH\begin{cases}NH_2\\NH_2\end{cases}$
(d) $CH_3CH_2CH\begin{cases}Cl\\NH_2\end{cases}$

7. An alkyl halide reacts with metallic sodium in dry ether the reaction is known as
(a) Frankland reaction
(b) Sandmeyer reaction
(c) Wurtz reaction
(d) Kolbe reaction

8. Benzene reacts with CH_3Cl in the presence of anhydrous $AlCl_3$ to form:
(a) chlorobenzene (b) benzylchloride
(c) xylene (d) toluene

9. Identify X, Y, Z in the following series

$C_2H_5I \xrightarrow{\text{alc. KOH}} X \xrightarrow{Br_2} Y \xrightarrow{KCN} Z$

(a) $BrCH_2CH_2CN$
(b) $BrCH_2CH_2CN$
(c) $CN-CH_2-CH_2-CN$
(d) $Br-CH=CH-CN$

10. Which one is most reactive towards S_N1 reaction ?
(a) $C_6H_5CH(C_6H_5)Br$
(b) $C_6H_5CH(CH_3)Br$
(c) $C_6H_5C(CH_3)(C_6H_5)Br$
(d) $C_6H_5CH_2Br$

11. The pesticide DDT slowly changes to
(a) CCl_3-CHO and chlorobenzene
(b) *p, p′*-Dichlorodiphenylethene
(c) *p, p′*-Dichlorodiphenyldichloroethane
(d) *p, p′*-Dichlorodiphenyldichloroethene

12. Which of the following possesses highest melting point?
(a) Chlorobenzene
(b) m-dichlorobenzene
(c) o-dichlorobenzene
(d) p-dichlorobenzene

13. On sulphonation of C_6H_5Cl
(a) benzene sulphonic acid is formed
(b) metachlorobenzene sulphonic acid is formed
(c) orthochlorobenzene sulphonic acid is formed
(d) ortho and para chlorobenzene sulphonic acids are formed.

14. S_N2 mechanism is involved in the following substitution :
(a) $CH_3-CH_2-Cl+OH^-$
(b) $CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{Cl}{|}}{C}}-CH_3+OH^-$
(c) $CH_3-\overset{\overset{Cl}{|}}{CH}-CH_3+OH^-$
(d) $CH_3-CH_2-\underset{\underset{CH_3}{|}}{\overset{\overset{Cl}{|}}{C}}-CH_3+OH^-$

15. Which of the following is an example of S_N2 reaction?

(a) $CH_3Br + OH^- \longrightarrow CH_3OH + Br^-$

(b) $CH_3-\underset{\displaystyle Br}{\underset{|}{C}H}-CH_3 + OH^- \longrightarrow CH_3-\underset{\displaystyle OH}{\underset{|}{C}H}-CH_3$

(c) $CH_3CH_2OH \xrightarrow{-H_2O} CH_2=CH_2$

(d) $(CH_3)_3C-Br + OH^- \longrightarrow (CH_3)_3COH + Br^-$

16. Identify the set of reagent / reaction conditions 'X' and 'Y' in the following set of transformations

$$CH_3-CH_2-CH_2Br \xrightarrow{X} \text{Product} \xrightarrow{Y} CH_3-\underset{\displaystyle Br}{\underset{|}{C}H}-CH_3$$

(a) X = dilute aqueous NaOH, 20°C;
Y = HBr/acetic acid, 20°C

(b) X = concentrated alcoholic NaOH, 80°C;
Y = HBr/acetic acid, 20°C

(c) X = dilute aqueous NaOH, 20°C ;
Y = $Br_2/CHCl_3$, 0°C

(d) X = concentrated alcoholic NaOH, 80°C;
Y = $Br_2/CHCl_3$, 0°C

17. The chief reaction product of reaction between *n*-butane and bromine at 130ºC is :

(a) $CH_3CH_2CH_2CH_2Br$

(b) $CH_3CH_2\underset{\displaystyle CH_3}{\underset{|}{C}}HBr$

(c) $CH_3-CH_2\underset{\displaystyle CH_2Br}{\underset{|}{C}}HBr$

(d) $CH_3CH_2\underset{\displaystyle CH_3}{\underset{|}{C}}Br_2$

18. The reaction conditions leading to the best yields of C_2H_5Cl are :

(a) $C_2H_6\text{ (excess)} + Cl_2 \xrightarrow{\text{uv light}}$

(b) $C_2H_6 + Cl_2 \xrightarrow[\text{room temperature}]{\text{dark}}$

(c) $C_2H_6 + Cl_2\text{ (excess)} \xrightarrow{\text{uv light}}$

(d) $C_2H_6 + Cl_2 \xrightarrow{\text{uv light}}$

19. The reaction of toluene with chlorine in presence of ferric chloride gives predominantly :

(a) benzoyl chloride
(b) *m*-chlorotoluene
(c) benzyl chloride
(d) *o*- and *p*-chlorotoluene

20. The number of structural and configurational isomers of a bromo compound, C_5H_9Br, formed by the addition of HBr to 2-pentyne respectively are

(a) 1 and 2 (b) 2 and 4
(c) 4 and 2 (d) 2 and 1

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** S_N2 reaction of an optically active aryl halide with an aqueous solution of KOH always gives an alcohol with opposite sign of rotation.
Reason : S_N2 reactions always proceed with inversion of configuration.

2. **Assertion :** Alkylbenzene is not prepared by Friedel-Crafts alkylation of benzene.
Reason : Alkyl halides are less reactive than acyl halides.

3. **Assertion :** Exposure of ultraviolet rays to human causes the skin cancer, disorder and disrupt the immune system.
Reason : Carbon tetrachloride is released into air it rises to atmosphere and depletes the ozone layer.

4. **Assertion :** $CHCl_3$ is stored in dark bottles.
Reason : $CHCl_3$ is oxidised in dark.

5. **Assertion :** CCl_4 is not a fire extinguisher.
Reason : CCl_4 is insoluble in water.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column - I		**Column - II**
(A) $CH_2=CH-CH_2Cl$	(1)	Gem-dichloride
(B) $CH_2=CHX$	(2)	Vinylic halide
(C) CH_3CHCl_2	(3)	Dichloride
(D) CH_2ClCH_2Cl	(4)	Allylic halide

(a) A – (3), B – (2), C – (1), D – (4)   (b) A – (2), B – (1), C – (4), D – (3)
(c) A – (4), B – (2), C – (1), D – (3)   (d) A – (3), B – (1), C – (4), D – (2)

2. Match the columns

Column - I		**Column - II**
(A) $C_2H_6 \xrightarrow{Cl_2\,/\,UV\ light} C_2H_5Cl$	(1)	Finkelstein reaction
(B) $C_6H_5NH_2 \xrightarrow[273-278K]{NaNO_2+HCl/Cu_2Cl_2} C_6H_5Cl$	(2)	Free radical substitution
(C) $CH_3Cl + NaI \longrightarrow CH_3I + NaCl$	(3)	Swarts reaction
(D) $CH_3-Br + AgF \longrightarrow CH_3F + AgBr$	(4)	Sandmeyer's reaction

(a) A – (2), B – (4), C – (1), D – (3)   (b) A – (2), B – (3), C – (1), D – (4)
(c) A – (3), B – (1), C – (4), D – (2)   (d) A – (4), B – (3), C – (1), D – (2)

3. Match the columns

Column - I		**Column - II**
(A) Chloroform	(1)	Antiseptic
(B) Iodoform	(2)	Insecticide
(C) Trichloromethane	(3)	Anesthetic
(D) DDT	(4)	Propellant

(a) A – (4), B – (1), C – (3), D – (2)   (b) A – (3), B – (1), C – (4), D – (2)
(c) A – (2), B – (4), C – (1), D – (2)   (d) A – (3), B – (4), C – (1), D – (2)

4. Match the columns.

Column - I (Haloalkane/arene)		**Column - II (Applications)**
(A) Iodoform	(1)	CF_4
(B) BHC	(2)	Antiseptic
(C) Freon - 14	(3)	Moth repellant
(D) Halothanes	(4)	Inhalative anesthetic
(E) p-dichlorobenzene	(5)	Termite pesticide

(a) A – (2), B – (4), C – (5), D – (3), E – (1)   (b) A – (2), B – (5), C – (1), D – (4), E – (3)
(c) A – (3), B – (4), C – (2), D – (1), E – (5)   (d) A – (1), B – (3), C – (5), D – (2), E – (4)

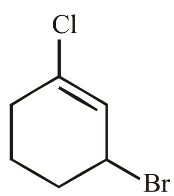
5. Match the columns

Column-I		Column-II	
(A)	Chloramphenicol	(1)	Goiter
(B)	Thyroxine	(2)	Surgery
(C)	Chloroquine	(3)	Typhoid
(D)	Halothane	(4)	Malaria

(a) A – (2), B – (1), C – (4), D – (3)
(b) A – (3), B – (1), C – (4), D – (2)
(c) A – (4), B – (3), C – (2), D – (1)
(d) A – (1), B – (4), C – (2), D – (3)

Critical Thinking Type Questions :

1. The IUPAC name of the compound shown below is



(a) 2-bromo-6-chlorocyclohex-1-ene
(b) 6-bromo-2-chlorocyclohexene
(c) 3-bromo-1-chlorocyclohexene
(d) 1-bromo-3-chlorocyclohexene

2. The number of structural and configurational isomers of a bromo compound, C_5H_9Br, formed by the addition of HBr to 2-pentyne respectively are

(a) 1 and 2 (b) 2 and 4
(c) 4 and 2 (d) 2 and 1

3. Hydrocarbon $(CH_3)_3CH$ undergoes reaction with Br_2 and Cl_2 in the presence of sunlight, if the reaction with Cl is highly reactive and that with Br is highly selective so no.of possible products respectively is (are)

(a) 2, 2 (b) 2, 1
(c) 1, 2 (d) 1, 1

4. Which chloride is least reactive with the hydrolysis point of view?

(a) CH_3Cl (b) CH_3CH_2Cl
(c) $(CH_3)_3CCl$ (d) $CH_2=CH-Cl$

5. In a S_N2 substitution reaction of the type

$$R-Br+Cl^- \xrightarrow{DMF} R-Cl+Br^-$$

which one of the following has the highest relative rate ?

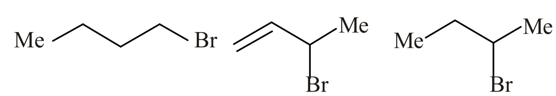
(a) $CH_3-CH_2-CH_2Br$

(b) $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2Br$

(c) $CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2Br$

(d) CH_3CH_2Br

6. Consider the following bromides :



(A) (B) (C)

The correct order of S_N1 reactivity is

(a) B > C > A (b) B > A > C
(c) C > B > A (d) A > B > C

7. Consider the reactions :

(i) $(CH_3)_2CH-CH_2Br \xrightarrow{C_2H_5OH} (CH_3)_2CH-CH_2OC_2H_5+HBr$

(ii) $(CH_3)_2CH-CH_2Br \xrightarrow{C_2H_5O^-} (CH_3)_2CH-CH_2OC_2H_5+Br^-$

The mechanisms of reactions (i) and (ii) are respectively :

(a) S_N1 and S_N2 (b) S_N1 and S_N1
(c) S_N2 and S_N2 (d) S_N2 and S_N1

8. Under certain conditions an alkyl halide reacts with base to give an alkene and HCl [Elimination Reaction] for example

$R - CH_2 - CH_2 - Cl \rightarrow R - CH = CH_2 + HCl$

The extent of these reactions depends on the structure of alkyl halides (e.g. primary, secondary or tertiary). The relative extent to which such reactions take place is in the order (of haloalkanes) :

(a) Primary < secondary < Tertiary
(b) Primary > Secondary > Tertiary
(c) Primary > Secondary < Tertiary
(d) Primary < Secondary > Tertiary

9. The replacement of chlorine of chlorobenzene to give phenol requires drastic conditions, but the chlorine of 2, 4-dinitrochlorobenzene is readily replaced since,

(a) nitro groups make the aromatic ring electron rich at ortho/para positions
(b) nitro groups withdraw electrons from the meta position of the aromatic ring
(c) nitro groups donate electrons at meta position
(d) nitro groups withdraw electrons from ortho/ para positions of the aromatic ring

10. Aryl halides are extremely less reactive towards nucleophilic substitution than alkylhalides. Which of the following accounts for this ?

(i) Due to resonance in aryl halides.
(ii) In alkyl halides carbon atom in C–X bond is sp^2 hybridised whereas in aryl halides carbon atom in C–X bond is sp^3 hybridized.
(iii) Due to stability of phenyl cation.
(iv) Due to possible repulsion there are less chances of nucleophile to approach electron rich arenes.

(a) (i), (ii) and (iv) (b) (i), (ii) and (iii)
(c) (i) and (iv) (d) (ii), (iii) and (iv)

25 Alcohols, Phenols and Ethers

Fill in the Blanks :

1. Ethanol vapour is passed over heated copper and the product is treated with aqueous NaOH. The final product is _______ .

2. The acidity of phenol is due to the _______ of its anion.

3. Formation of phenol from chlorobenzene is an example of _______ aromatic substitution.

4. Phenol is acidic because of resonance stabilization of its conjugate base, namely _______ .

5. Aliphatic ethers are purified by shaking with a solution of ferrous salt to remove _______ which are formed on prolonged standing in contact with air.

6. Glycerine contains one _______ hydroxy group.

7. _______ isomers of $C_5H_{11}OH$ will be primary alcohols.

8. IUPAC name of *m*-cresol is _______ .

9. Commercially carboxylic acids are reduced to alcohols by converting them to the _______ .

10. _______ is less acidic than *o*–nitrophenol

True/ False :

1. Sodium ethoxide is prepared by reacting ethanol with aqueous sodium hydroxide.

2. Alcohols react as electrophiles in the reactions involving cleavage of O–H bond.

3. Alcohols react as nucleophile in the reaction involving cleavage of C–O bond.

4. Acidic strength of alcohols follow the order 1° > 2° > 3°.

5. Alcohols also react as Bronsted base.

6. Ethanol on dehydration at 413 K gives diethyl ether

7. Secondary and tertiary alcohols on dehydration give ethers having 2° and 3° carbon attached with O atom.

8. In phenols, the —OH group is attached to sp^2 hybridised carbon of an aromatic ring

9. Ethanol mixed with methanol is called denatured alcohol.

10. A methanol poisoned patient is treated by giving intravenous injections of ethanoic acid.

Conceptual MCQs

1. The compound which reacts fastest with Lucas reagent at room temperature is
(a) butan-1-ol
(b) butan-2-ol
(c) 2-methylpropan-1-ol
(d) 2-methylpropan-2-ol

2. A compound that gives a positive iodoform test is
(a) 1-pentanol
(b) 2-pentanone
(c) 3-pentanone
(d) pentanal

3. $H_2COH \cdot CH_2OH$ on heating with periodic acid gives:
(a) 2 HCOOH
(b) $\begin{array}{c} CHO \\ | \\ CHO \end{array}$
(c) 2 $\begin{array}{l} H \diagdown \\ \quad C = O \\ H \diagup \end{array}$
(d) 2 CO_2

4. Which of the following compounds is oxidised to prepare methyl ethyl ketone?
(a) 2-Propanol (b) l-Butanol
(c) 2-Butanol (d) t-Butyl alcohol

5. An industrial method of preparation of methanol is :

(a) catalytic reduction of carbon monoxide in presence of $ZnO–Cr_2O_3$

(b) by reacting methane with steam at 900ºC with a nickel catalyst

(c) by reducing formaldehyde with lithium aluminium hydride

(d) by reacting formaldehyde with aqueous sodium hydroxide solution

6. Diethyl ether on heating with conc. HI gives two moles of

(a) ethanol (b) iodoform

(c) ethyl iodide (d) methyl iodide

7. Chlorination of toluene in the presence of light and heat followed by treatment with aqueous NaOH gives

(a) *o*-Cresol

(b) *p*-Cresol

(c) 2, 4-Dihydroxytoluene

(d) Benzoic acid

8. Among the following four compounds

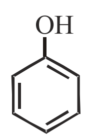
(i) phenol (ii) methylphenol

(iii) meta-nitrophenol (iv) para-nitrophenol

the acidity order is :

(a) ii > i > iii > iv (b) iv > iii > i > ii

(c) iii > iv > i > ii (d) i > iv > iii > ii

9.  $+ \ C_2H_5I \xrightarrow[\text{Anhydrous } (C_2H_5OH)]{^{-}OC_2H_5} ?$

(a) $C_6H_5OC_2H_5$ (b) $C_2H_5OC_2H_5$

(c) $C_6H_5OC_6H_5$ (d) C_6H_5I

10. Among the following ethers, which one will produce methyl alcohol on treatment with hot concentrated HI?

(a) $CH_3-CH_2-\underset{\underset{CH_3}{|}}{CH}-O-CH_3$

(b) $CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-O-CH_3$

(c) $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-O-CH_3$

(d) $CH_3-CH_2-CH_2-CH_2-O-CH_3$

11. Benzyl alcohol is obtained from benzaldehyde by

(a) Fitting's reaction

(b) Cannizzaro's reaction

(c) Kolbe's reaction

(d) Wurtz's reaction

12. Formation of Diethyl ether from ethanol is based on a :

(a) Dehydrogenation reaction

(b) Hydrogenation reaction

(c) Dehydration reaction

(d) Heterolytic fission reaction

13. Rectified spirit is a mixture of

(a) 95% ethyl alcohol + 5% water

(b) 94% ethyl alcohol + 4.53 water

(c) 94.4% ethyl alcohol + 5.43% water

(d) 95.87% ethyl alcohol + 4.13% water

14. In the reaction

$\text{Phenol} \xrightarrow{NaOH} (A) \xrightarrow[140°]{CO_2+HCl} (B)$, here B is

(a) benzaldehyde (b) chlorobenzene

(c) benzoic acid (d) salicylic acid

15. Consider the following reaction,

$\text{ethanol} \xrightarrow{PBr_3} X \xrightarrow{\text{alc.KOH}} Y$

$\xrightarrow[\text{(ii) } H_2O, \text{ heat}]{\text{(i) } H_2SO_4 \text{ room temperature}} Z;$

the product Z is:

(a) $CH_3CH_2-O-CH_2-CH_3$

(b) $CH_3-CH_2-O-SO_3H$

(c) CH_3CH_2OH

(d) $CH_2=CH_2$

16. Which statement is not correct about alcohol?

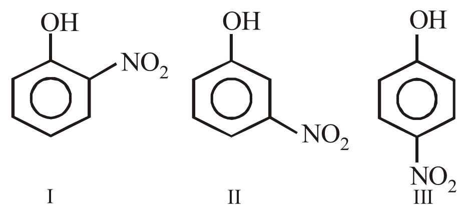
(a) molecular weight of alcohol is higher than water

(b) alcohol of less no. of carbon atoms is less soluble in water than alcohol of more no. of carbon atoms

(c) alcohol evaporates quickly

(d) all of these

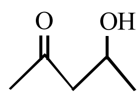
17. Arrange the following phenols in order of their increasing acidity.

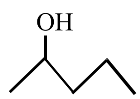


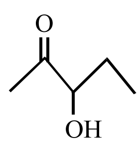
I II III

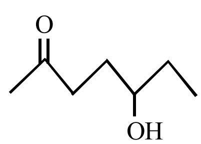
(a) I > III > II (b) I > II > III
(c) III > I > II (d) III > II > I

18. Which one of the following will most readily be dehydrated in acidic conditions ?

(a) 

(b) 

(c) 

(d) 

19. The compound which reacts fastest with Lucas reagent at room temperature is

(a) Butan-1-ol
(b) Butan-2-ol
(c) 2-Methyl propan-1-ol
(d) 2-Methylpropan-2-ol

20. Ethanol and dimethyl ether form a pair of functional isomers. The boiling point of ethanol is higher than that of dimethyl ether, due to the presence of

(a) H-bonding in ethanol
(b) H-bonding in dimethyl ether
(c) CH_3 group in ethanol
(d) CH_3 group in dimethyl ether

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The bond angle in alcohols is slightly less than the tetrahedral angle.
Reason : In alcohols, the oxygen of –OH group is attached to sp^3 hybridized carbon atom.

2. **Assertion :** In Lucas test, 3° alcohols react immediately.
Reason : An equimolar mixture of anhyd. $ZnCl_2$ and conc. HCl is called Lucas reagent.

3. **Assertion :** Reimer-Tiemann reaction of phenol with CCl_4 in NaOH at 340 K gives salicyclic acid as the major product.
Reason : The reaction occurs through intermediate formation of dichlorocarbene.

4. **Assertion :** Phenol is more reactive than benzene towards electrophilic substitution reaction.
Reason : In the case of phenol, the intermediate carbocation is more resonance stabilized.

5. **Assertion :** In case of phenol, bromination takes place even in absence of Lewis acid whereas bromination of benzene takes place in presence of Lewis acid like $FeBr_3$.
Reason : – OH group attached to benzene ring is highly deactivating.

6. **Assertion :** *ter* - Butyl methyl ether is not prepared by the reaction of *ter*-butyl bromide with sodium methoxide.
Reason : Sodium methoxide is a strong nucleophile.

7. **Assertion :** Ethers behave as bases in the presence of mineral acids.
Reason : Due to the presence of lone pairs of electrons on oxygen.

8. **Assertion :** With HI, anisole gives iodobenzene and methyl alcohol.

Reason : Iodide ion combines with smaller group to avoid steric hindrance.

9. **Assertion :** With HI at 373 K, *ter*-butyl methyl ether gives *ter*-butyl iodide and methanol.

Reason : The reaction occurs by S_N2 mechanism.

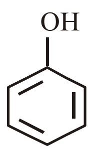
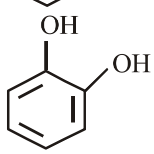
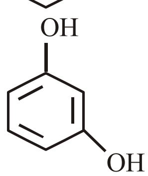
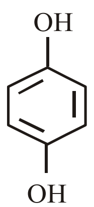
10. **Assertion :** Ethyl phenyl ether on reaction with HBr form phenol and ethyl bromide.

Reason : Cleavage of C–O bond takes place on ethyl-oxygen bond due to the more stable phenyl-oxygen bond.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I	Column-II
(A) 	(1) Quinol
(B) 	(2) Phenol
(C) 	(3) Catechol
(D) 	(4) Resorcinol

(a) A – (2), B – (1), C – (4), D – (3) (b) A – (3), B – (1), C – (4), D – (2)
(c) A – (4), B – (2), C – (1), D – (3) (d) A – (2), B – (3), C – (4), D – (1)

2. Match the columns

Column-I	Column-II
(A) Methanol	(1) Conversion of phenol to *o*-hydroxysalicylic acid
(B) Kolbe's reaction	(2) Wood spirit
(C) Williamson's synthesis	(3) Heated copper at 573 K
(D) Conversion of 2° alcohol to ketone	(4) Reaction of alkyl halide with sodium alkoxide

(a) A – (4), B – (3), C – (2), D – (1) (b) A – (2), B – (4), C – (1), D – (3)
(c) A – (2), B – (1), C – (4), D – (3) (d) A – (3), B – (2), C – (1), D – (4)

3. Match the columns

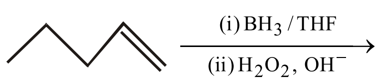
	Column-I		Column-II
(A)	Antifreeze used in car engine	(1)	Methanol
(B)	Solvent used in perfumes	(2)	Phenol
(C)	Starting material for picric acid	(3)	Ethleneglycol
(D)	Wood spirit	(4)	Ethanol

(a) A – (4), B – (2), C – (1), D – (3)
(b) A – (3), B – (4), C – (2), D – (1)
(c) A – (4), B – (2), C – (3), D – (1)
(d) A – (1), B – (3), C – (2), D – (4)

Critical Thinking Type Questions :

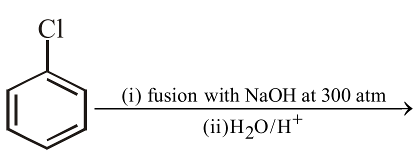
1. Propene, $CH_3CH = CH_2$ can be converted into 1-propanol by oxidation. Indicate which set of reagents amongst the following is ideal to effect the above conversion ?
(a) $KMnO_4$ (alkaline)
(b) Osmium tetraoxide (OsO_4/CH_2Cl_2)
(c) B_6H_6 and alk. H_2O_2
(d) O_3/Zn

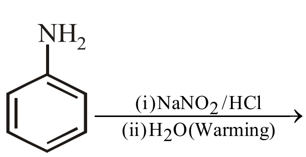
2. The product of the following reaction is

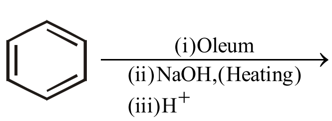


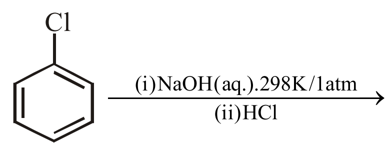
(a) 1-Pentanol
(b) 2-Pentanol
(c) Pentane
(d) 1,2-Pentanediol

3. Which of the following reactions will yield phenol?

(i) 

(ii) 

(iii) 

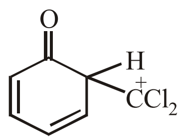
(iv) 

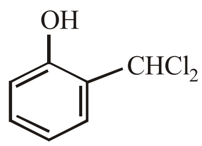
(a) (i), (ii) and (iii)
(b) (i) and (iii)
(c) (i), (iii) and (iv)
(d) (ii), (iii) and (iv)

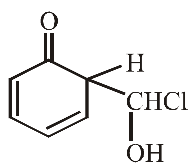
4. Which of the following reagents can be used for preparation of cumene ?
(i) C_6H_6, Cl_2, hv; Mg.THF; acetone.
(ii) C_6H_6, $CH_3CH_2CH_2Cl$, $AlCl_3$.
(iii) C_6H_6, $CH_3CHClCH_3$, $AlCl_3$.
(iv) C_6H_6, CH_3CH_2Cl, $AlCl_3$;
(a) (i) and (ii)
(b) (ii) and (iii)
(c) (i), (ii) and (iii)
(d) (ii) and (iv)

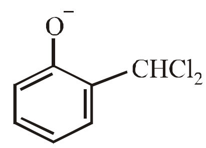
5. Which of the following shows structure of allylic alcohol?
(i) $CH_2=CH-CH_2OH$
(ii) $CH_2=CH-OH$
(iii) $CH_2=CH-CH(CH_3)OH$
(iv) $CH_2=CH-C(CH_3)_2OH$
(a) (i), (iii) and (iv)
(b) (i), (ii) and (iv)
(c) (ii), (iii) and (iv)
(d) (i), (ii), (iii) and (iv)

6. When phenol is reacted with $CHCl_3$ and NaOH followed by acidification, salicylaldehyde is obtained. Which of the following species are involved in the above mentioned reaction as intermediate?

(a) 

(b) 

(c) 

(d) 

7. In the following sequence of reactions,

$$CH_3CH_2OH \xrightarrow{P+I_2} A \xrightarrow[\text{ether}]{Mg} B \xrightarrow{HCHO}$$

$$C \xrightarrow{H_2O} D$$

the compound D is

(a) propanal
(b) butanal
(c) *n*-butyl alcohol
(d) *n*-propyl alcohol.

26 Aldehydes, Ketones and Carboxylic Acids

Fill in the Blanks :

1. Formic acid when heated with conc. H_2SO_4 produces _______ .

2. The structure of the intermediate product, formed by the oxidation of toluene with CrO_3 and acetic anhydride, whose hydrolysis gives benzaldehyde is _______ .

3. The structure of the enol form of CH_3–CO–CH_2–CO–CH_3 with intramolecular hydrogen bonding is _______ .

4. The IUPAC name of the compound having the molecular formula Cl_3C-CH_2CHO is _____.

5. The π-bond in carbonyl group is formed by _______ .

6. _______ on oxidation gives a ketone.

7. Benzaldehyde can be prepared by oxidation of toluene by _______ .

8. An aldehyde that cannot be obtained by Rosenmund's reaction _______ is _______ .

9. _______ is used to prepare ketone from acyl chloride ?

10. 2-pentanone and 3-pentanone can be distinguished by _______ .

True/ False :

1. Benzaldehyde undergoes aldol condensation in an alkaline medium.

2. Hydrolysis of an ester in presence of a dilute acid is known as saponification.

3. The yield of ketone when a secondary alcohol is oxidized is more than the yield of aldehyde when a primary alcohol is oxidized.

4. The reaction of methyl magnesium iodide with acetone followed by hydrolysis gives secondary butanol.

5. The boiling point of propionic acid is less than that of *n*-butyl alcohol, an alcohol of comparable molecular weight.

6. The carbonyl carbon is an electrophilic (Lewis acid) centre

7. The carbonyl oxygen is a nucleophilic (Lewis base) centre

8. Aldehydes having a boiling point less than 100°C can be prepared by the oxidation of primary alcohol with acidic dichromate.

9. Secondary alcohols on oxidation with PCC in dichloromethane give carboxylic acids having lesser number of carbon atoms

10. Alcohols show intermolecular hydrogen bonding whereas aldehydes and ketones do not show intermolecular hydrogen bonding.

11. The lower members of aldehydes and ketones are miscible with water in all proportions, because they form hydrogen bond with water.

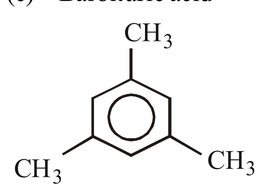
12. The solubility of aldehydes and ketones increases rapidly on increasing the length of alkyl chain

Conceptual MCQs

1. The compound formed when malonic ester is heated with urea is

(a) Cinnamic acid (b) Butyric acid
(c) Barbituric acid (d) Crotonic acid.

2.



The above compound describes a condensation polymer which can be obtained in two ways : either treating 3 molecules of acetone

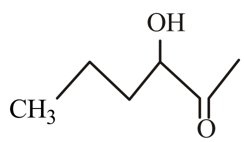
(CH_3COCH_3) with conc. H_2SO_4 or passing propyne ($CH_3C\equiv CH$) through a red hot tube. The polymer is

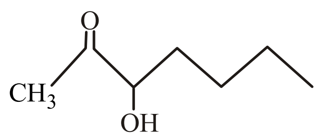
(a) Phorone (b) Mesityl oxide
(c) Deacetonyl alcohol (d) Mesitylene.

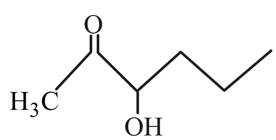
3. The reagent (s) which can be used to distinguish acetophenone from benzophenone is (are)

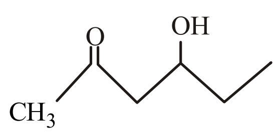
(a) 2,4- Dinitrophenylhydrazine
(b) Aqueous solution of $NaHSO_3$
(c) Benedict reagent
(d) I_2 and Na_2CO_3.

4. Which one of the following compounds will be most readily dehydrated?

(a) 

(b) 

(c) 

(d) 

5. Among acetic acid, phenol and n-hexanol, which of the following compounds well react with $NaHCO_3$ solution to give sodium salt and carbon dioxide ?

(a) Acetic acid
(b) n-Hexanol
(c) acetic acid and phenol
(d) Phenol

6. Which of the following compound will undergo self aldol condensation in the presence of cold dilute alkali

(a) $CH_2=CH-CHO$ (b) $CH\equiv C-CHO$
(c) C_6H_5CHO (d) CH_3CH_2CHO.

7. An ester is boiled with KOH. The product is cooled and acidified with concentrated HCl. A white crystalline acid separates. The ester is

(a) Methyl acetate
(b) Ethyl acetate
(c) Ethyl formate
(d) Ethyl benzoate

8. Clemmensen reduction of a ketone is carried out in the presence of which of the following ?

(a) Glycol with KOH
(b) Zn-Hg with HCl
(c) $LiAlH_4$
(d) H_2 and Pt as catalyst

9. Consider the following transformations :

$$CH_3COOH \xrightarrow{CaCO_3} \boxed{A} \xrightarrow{heat} \boxed{B} \xrightarrow[NaOH]{I_2} \boxed{C}$$

The molecular formula of $\boxed{C}$ is

(a) $CH_3-\underset{\displaystyle I}{\overset{\displaystyle OH}{C}}-CH_3$
(b) ICH_2-COCH_3
(c) CHI_3
(d) CH_3I

10. An ester (A) with molecular fomula, $C_9H_{10}O_2$ was treated with excess of CH_3MgBr and the complex so formed was treated with H_2SO_4 to give an olefin (B). Ozonolysis of (B) gave a ketone with molecular formula C_8H_8O which shows +ve iodoform test. The structure of (A) is

(a) $C_6H_5COOC_2H_5$
(b) $C_2H_5COOC_6H_5$
(c) $H_3COCH_2COC_6H_5$
(d) $p-H_3CO-C_6H_4-COCH_3$

11. Ketones

[$R-\underset{\displaystyle O}{\overset{}{\underset{\|}{C}}}-R_1$, where $R = R_1$ = alkyl groups]

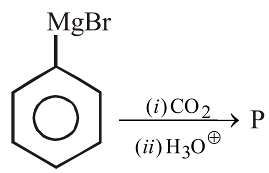
can be obtained in one step by

(a) oxidation of primary alcohols
(b) hydrolysis of esters
(c) oxidation of tertiary alcohols
(d) reaction of acid halides with alcohols

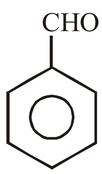
12. The cyanohydrin of a compound on hydrolysis gives an optically active α-hydroxy acid. The compound is

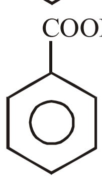
(a) Diethyl ketone (b) Formaldehyde
(c) Acetaldehyde (d) Acetone

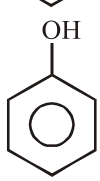
13.



In the above reaction product 'P' is

(a)


(b)


(c)


(d) $C_6H_5-\overset{\overset{\displaystyle O}{||}}{C}-C_6H_5$

14. The order of stability of the following tautomeric compounds is :

$$\underset{\text{I}}{CH_2=\overset{\overset{\displaystyle OH}{|}}{C}-CH_2-\overset{\overset{\displaystyle O}{||}}{C}-CH_3}$$

$$\rightleftharpoons \underset{\text{II}}{CH_3-\overset{\overset{\displaystyle O}{||}}{C}-CH_2-\overset{\overset{\displaystyle O}{||}}{C}-CH_3}$$

$$\rightleftharpoons \underset{\text{III}}{CH_3-\overset{\overset{\displaystyle OH}{|}}{C}=CH-\overset{\overset{\displaystyle O}{||}}{C}-CH_3}$$

(a) III > II > I (b) II > I > III
(c) II > III > I (d) I > II > III

15. A and B in the following reactions are

$$R-\underset{\underset{\displaystyle O}{||}}{C}-R' \xrightarrow[KCN]{HCN/} A \xrightarrow{B} R-\underset{R'}{C}\begin{matrix}OH\\CH_2NH_2\end{matrix}$$

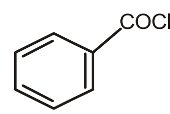
(a) $A = RR'C\begin{matrix}CN\\OH\end{matrix}$, $B = LiAlH_4$

(b) $A = RR'C\begin{matrix}OH\\COOH\end{matrix}$, $B = NH_3$

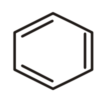
(c) $A = RR'C\begin{matrix}CN\\OH\end{matrix}$, $B = H_3O^{\oplus}$

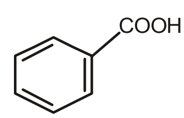
(d) $A = RR'CH_2CN$, $B = NaOH$

16. Reaction by which Benzaldehyde cannot be prepared :

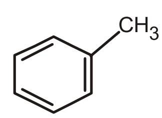
(a)


$+ H_2$ in presence of Pd - $BaSO_4$

(b)

+ CO + HCl in presence of anhydrous $AlCl_3$

(c)


+ Zn/Hg and conc. HCl

(d)


$+ CrO_2Cl_2$ in CS_2 followed by H_3O^+

17. Which of the following is the correct order of acidity?

(a) $HCOOH > CH_3COOH > ClCH_2COOH > C_2H_5COOH$
(b) $ClCH_2COOH > HCOOH > CH_3COOH > C_2H_5COOH$
(c) $CH_3COOH > HCOOH > ClCH_2COOH > C_2H_5COOH$
(d) $C_2H_5COOH > CH_3COOH > HCOOH > ClCH_2COOH$

18. Which one of the following on treatment with 50% aqueous sodium hydroxide yields the corresponding alcohol and acid?
(a) C_6H_5CHO
(b) $CH_3CH_2CH_2CHO$
(c) $CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$
(d) $C_6H_5CH_2CHO$

19. The product formed in Aldol condensation is
(a) a beta-hydroxy aldehyde or a beta-hydroxy ketone
(b) an alpha-hydroxy aldehyde or ketone
(c) an alpha, beta unsaturated ester
(d) a beta-hydroxy acid

20. Which one of the following can be oxidised to the corresponding carbonyl compound?
(a) 2-hydroxy-propane
(b) Ortho-nitro-phenol
(c) Phenol
(d) 2-methyl-2 hydroxy-propane

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The boiling points of aldehydes and ketones are higher than hydrocarbons and ethers of comparable molecular masses.
Reason : There is a weak molecular association in aldehydes and ketones arising out of the dipole-dipole interactions.

2. **Assertion :** Formaldehyde is a planar molecule.
Reason : It contains sp^2 hybridised carbon atom.

3. **Assertion :** Compounds containing –CHO group are easily oxidised to corresponding carboxylic acids.
Reason : Carboxylic acids can be reduced to alcohols by treatment with $LiAlH_4$.

4. **Assertion :** The molecular mass of acetic acid in benzene is 120 instead of 60.
Reason : The carboxylic acids exist as cyclic dimers in which the two molecules of the acid are held together by two strong hydrogen bonds.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I (Common names)	Column-II (IUPAC names)
(A) Cinnamaldehyde	(1) Pentanal
(B) Acetophenone	(2) Prop-2-enal
(C) Valeraldehyde	(3) 4-Methylpent-3-en-2-one
(D) Acrolein	(4) 3-Phenylprop-2-enal
(E) Mesityl oxide	(5) 1-Phenylethanone

(a) A – (4), B – (5), C – (1), D – (2), E – (3)
(b) A – (1), B – (2), C – (4), D – (5), E – (3)
(c) A – (5), B – (4), C – (1), D – (3), E – (2)
(d) A – (2), B – (5), C – (3), D – (4), E – (1)

2. Match the columns

Column-I	Column-II
(A) $R-CO-CH_3 \xrightarrow{Zn-Hg/HCl} R-CH_2-CH_3$	(1) Friedel-Craft's reaction
(B) $2C_6H_5CHO \xrightarrow{NaOH} C_6H_5COONa + C_6H_5CH_2OH$	(2) Kolbe's reaction
(C) $C_6H_6 + CH_3COCl \xrightarrow[AlCl_3]{Anhyd.} C_6H_5COCH_3$	(3) Clemmensen's reaction
(D) $C_6H_5OH + CO_2 + NaOH \rightarrow HOC_6H_4COONa$	(4) Cannizzaro's reaction

(a) A – (1), B – (2), C – (3), D – (4)
(b) A – (2), B – (1), C – (3), D – (4)
(c) A – (3), B – (4), C – (1), D – (2)
(d) A – (4), B – (3), C – (1), D – (2)

3. Match the columns

Column-I	Column-II
(A) Etard reaction	(1) Alcoholic KOH
(B) Hydroxylation	(2) Anhydrous $AlCl_3$
(C) Dehydrohalogenation	(3) Chromyl chloride
(D) Friedel-Crafts reaction	(4) Dilute alkaline $KMnO_4$

(a) A – (1), B – (2), C – (3), D – (2)
(b) A – (4), B – (3), C – (1), D – (2)
(c) A – (3), B – (4), C – (1), D – (2)
(d) A – (2), B – (1), C – (4), D – (3)

4. Match the columns

Column-I (Reactions)	Column-II (Reagents)
(A) Benzophenone $\rightarrow$ Diphenylmethane	(1) $LiAlH_4$
(B) Benzaldehyde $\rightarrow$ 1-Phenylethanol	(2) DIBAL–H
(C) Cyclohexanone $\rightarrow$ Cyclohexanol	(3) Zn(Hg)/Conc HCl
(D) Phenyl benzoate $\rightarrow$ Benzaldehyde	(4) CH_3MgBr

(a) A – (1), B – (4), C – (3), D – (2)
(b) A – (2), B – (4), C – (1), D – (3)
(c) A – (4), B – (3), C – (2), D – (1)
(d) A – (3), B – (4), C – (1), D – (2)

5. Match the columns

Column-I	Column-II
(A) $\genfrac{}{}{0pt}{}{R}{R}\!\!>C=NH$	(1) Oxime
(B) $\genfrac{}{}{0pt}{}{R}{R}\!\!>C=NOH$	(2) Semicarbazone
(C) $\genfrac{}{}{0pt}{}{R}{R}\!\!>C=N-NH_2$	(3) Imine

(D) $R_2C = N - NH - \overset{\overset{O}{\|}}{C} - NH_2$ (4) Hydrazone

(a) A – (2), B – (4), C – (1), D – (3) (b) A – (3), B – (1), C– (4), D– (2)

(c) A – (3), B – (4), C – (1), D– (2) (d) A – (4), B – (3), C – (2), D– (1)

6. Match the acids given in Column-I with their correct IUPAC names given in Column-II.

Column-I (Acids)	**Column-II (IUPAC names)**
(A) Phthalic acid	(1) Hexane-1, 6-dioic acid
(B) Oxalic acid	(2) Benzene-1, 2-dicarboxylic acid
(C) Succinic acid	(3) Pentane-1, 5-dioic acid
(D) Adipic acid	(4) Butane-1, 4-dioic acid
(E) Glutaric acid	(5) Ethane-1, 2-dioic acid

(a) A – (5), B – (2), C – (3), D – (1), E – (4) (b) A – (1), B – (4), C – (5), D – (2), E – (3)

(c) A – (2), B – (5), C – (4), D – (1), E – (3) (d) A – (3), B – (5), C – (1), D – (4), E – (2)

7. Match the columns

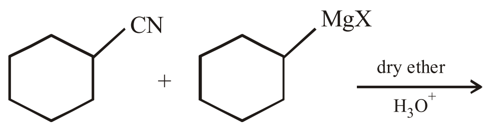
Column-I	**Column-II**
(A) $CH_2(COOH)_2$	(1) Glutaric acid
(B) $HOOC-CH_2-CH_2-COOH$	(2) Adipic acid
(C) $HOOC-CH_2-CH_2-CH_2-COOH$	(3) Succinic acid
(D) $HOOC-CH_2-CH_2-CH_2-CH_2-COOH$	(4) Malonic acid

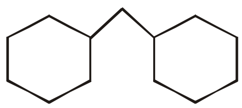
(a) A – (2), B – (1), C – (4), D – (3) (b) A – (3), B – (1), C – (4), D – (2)

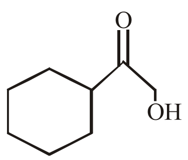
(c) A – (4), B – (3), C – (1), D – (2) (d) A – (3), B – (2), C – (4), D – (1)

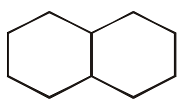
Critical Thinking Type Questions :

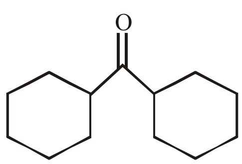
1. Product of the following reaction is



(a) 

(b) 

(c) 

(d) 

2. A new carbon - carbon bond is formed in

(i) Aldol condensation
(ii) Kolbe's reaction
(iii) Reimer-Tiemann reaction
(iv) Wurtz Fittig reaction

(a) (i) and (iii) (b) (ii) and (iii)
(c) (i), (ii) and (iiv) (d) All the four

3. Acetal formation is a reversible reaction

$$\begin{matrix}R\\H\end{matrix}\!\!>\!C=O + R'OH \overset{H^+}{\rightleftharpoons} \begin{matrix}R\\H\end{matrix}\!\!>\!C\!<\!\!\begin{matrix}OH\\OR'\end{matrix} \overset{R'OH,\ H^+}{\rightleftharpoons} \begin{matrix}R\\H\end{matrix}\!\!>\!C\!<\!\!\begin{matrix}OR'\\OR'\end{matrix} + H_2O$$

Under what conditions, the reaction can be forced to proceed only in right (forward) direction ?

(a) Using excess of alcohol
(b) Using high temperature
(c) Using dilute acid and excess of alcohol
(d) Using dry acid and excess of alcohol

4. Which of the following acts as a nucleophile in the aldol condensation of ethanal?

(i) OH^- (ii) $H_2\ddot{O}:$
(iii) $^-CH_2CHO$

(a) Only (i) (b) (i) and (ii)
(c) (i) and (iii) (d) All the three

5. Which of the following undergoes haloform reaction ?

(i) $CH_3CH_2COCH_2Cl$ (ii) $C_6H_5COCH_3$
(iii) $C_6H_5COCHCl_2$ (iv) $CH_3CH_2COCCl_3$

(a) Only (ii) (b) (ii) and (iv)
(c) (i), (ii) and (iv) (d) All the four

6. $$\begin{matrix}R\\R\end{matrix}\!\!>\!C=O \xrightarrow{HCN} (A) \xrightarrow{NH_3} (B) \xrightarrow{\text{Hydrolysis}} (C)$$

Compound (C) in above reaction is

(a) α-hydroxy acid
(b) α-amino acid
(c) α-amino alkanol
(d) α-amino β-hydroxy acid

7. Benzophenone can be obtained by__________.

(i) Benzoyl chloride + Benzene + $AlCl_3$
(ii) Benzoyl chloride + Diphenyl cadmium
(iii) Benzoyl chloride + Phenyl magnesium chloride
(iv) Benzene + Carbon monoxide + $ZnCl_2$

(a) (i), (ii) and (iii)
(b) (ii) and (iii)
(c) (iii) and (iv)
(d) (i), (ii) and (iv)

8. Benzaldehyde is less reactive than propanal because

(i) the carbon atom of the carbonyl group of benzaldehyde is less electrophilic as in propanal.
(ii) the carbon atom of the carbonyl group of benzaldehyde is more electrophilic as in propanal.
(iii) carbonyl group in benzaldehyde is more polar due to resonance
(iv) carbonyl group in benzaldehyde is less polar due to resonance

(a) (i) and (iii) (b) (i) and (iv)
(c) (i) only (d) (iv) only

9. Addition of alcohols to aldehydes and ketones takes place in presence of dry HCl gas because it

(i) Protonates the oxygen of the carbonyl compounds
(ii) Increases the electrophilicity of the carbonyl carbon
(iii) Removes the excess moisture from the reaction
(iv) Helps the reaction to move in the forward direction

(a) (i), (ii) and (iv) (b) (i), (ii), (iii) and (iv)
(c) (ii) ,(iii), and (iv) (d) (i), (iii) and (iv)

10. Nitration of the compound is carried out, this compound gives red–orange ppt. with 2,4–DNP, this compound undergoes Cannizzaro reaction but not aldol, than possible product due to nitration is

(a) 3–nitroacetophenone
(b) (2–nitro)–2–phenylethanal
(c) (2–nitro)–1–phenylpropan–2–one
(d) 3–nitrobezaldehyde

11. Ethanoic acid can't be obtained by which of the following reaction ?

(i) $C_2H_5Cl \xrightarrow[\text{(ii) } H_3O^+]{\text{(i) KCN}}$

(ii) $CH_3Cl \xrightarrow[\text{(ii) } H_3O^+]{\text{(i) AgCN}}$

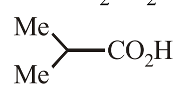
(iii) $CH_3CH = CH_2 \xrightarrow[\text{heat}]{KMnO_4 / OH^-}$

(iv) $CH_3Br \xrightarrow[\substack{\text{(ii) } CO_2 \\ \text{(iii) } H_3O^+}]{\text{(i) Mg}}$

(a) (iii) and (iv) (b) (i) and (ii)
(c) (ii) and (iii) (d) (i) and (iv)

12. The correct order of increasing acid strength of the compounds

(A) CH_3CO_2H (B) $MeOCH_2CO_2H$

(C) CF_3CO_2H (D) 

is

(a) D < A < B < C (b) A < D < B < C
(c) B < D < A < C (d) D < A < C < B

27

AMINES

Fill in the Blanks :

1. 1°R–NH_2 + RCHO followed by H_2/Pt Amongst the given set of reactants is the most appropriate for preparing _______ amine.

2. The best reagent for converting 2 – phenylpropanamide into 2-phenylpropanamine is _______ .

3. Aliphatic amines are _______ basic than NH_3 but aromatic amines are _______ basic than NH_3.
(a) more, less (b) less, more
(c) both (a) and (b) (d) None of these

4. The conjugate base of $(CH_3)_2NH_2^+$ is ______ .

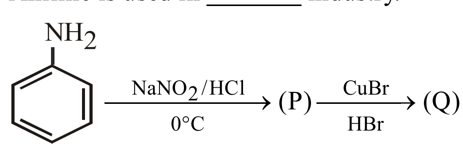
5. Aniline and other arylamines are usually colourless but get coloured on storage due to _______ .

6. The reaction $Ar\overset{+}{N_2}Cl^- \xrightarrow{Cu/HCl} ArCl + N_2$ + CuCl is named as _______ .

7. _______ can be used to convert benzenediazonium chloride into benzene.

8. Ethylamine reacts with HNO_2 giving ______ .

9. Aniline is used in _______ industry.

10. 

The compound Q is _______ .

True/ False :

1. Nitrogen atom in amines is sp^3-hybridised.

2. The angle C–N–C or C–N–H is slightly more than 109.5°.

3. Solubility increases with increase in molar mass of amines.

4. Amines are soluble in organic solvents.

5. Primary amines show more intermolecular association than secondary amines.

6. Tertiary amines do not show intermolecular association.

7. Boiling points of isomeric alkenes follow the order 3° > 2° > 1°

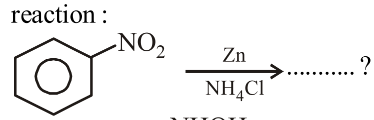
8. In Sandmeyer reaction nucleophiles like Cl^-, Br^- and CN^- are indroduced in benzene ring in the presence of Cu^+ ion

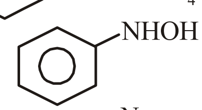
9. In Gattermann reaction nucleophiles are introduced in benzene ring in the presence of copper powder and HCl.

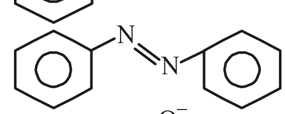
10. The yield in Gattermann reaction is found to be better than Sandmayer reaction.

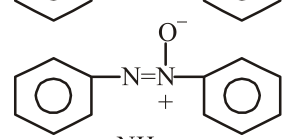
Conceptual MCQs

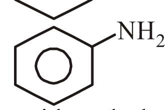
1. What is the product obtained in the following reaction :



(a) 

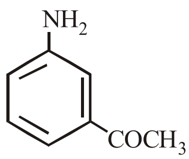
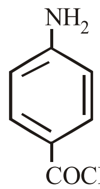
(b) 

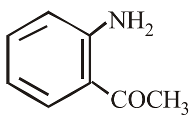
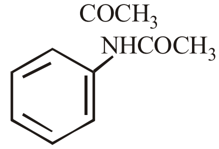
(c) 

(d) 

2. Acetamide and ethylamine can be distinguished by reacting with
(a) Aqueous HCl and heat
(b) Aqueous NaOH and heat
(c) Acidified $KMnO_4$
(d) Bromine water.

3. Aniline is an activated system for electrophilic substitution. The compound formed on heating aniline with acetic anhydride is

(a) 
(b) 

(c) 
(d) 

4. An organic compound (C_3H_9N) (A), when treated with nitrous acid, gave an alcohol and N_2 gas was evolved. (A) on warming with $CHCl_3$ and caustic potash gave (C) which on reduction gave isopropylmethylamine. Predict the structure of (A).

(a) $(CH_3)_2CH—NH_2$

(b) $CH_3CH_2—NH—CH_3$

(c) $CH_3—N(CH_3)—CH_3$

(d) $CH_3CH_2CH_2—NH_2$

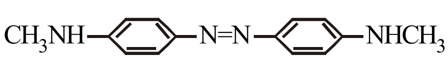
5. Which of the following reagents will convert p-methylbenzenediazonium chloride into p-cresol?

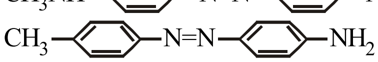
(a) Cu powder (b) H_2O
(c) H_3PO_2 (d) C_6H_5OH

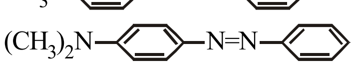
6. $[A] \xrightarrow{\text{reduction}} [B] \xrightarrow{CHCl_3 + KOH} [C] \xrightarrow{\text{reduction}}$ N – Methylaniline, A is

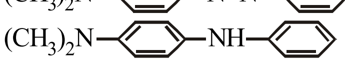
(a) Formaldehyde
(b) Trichloromethane
(c) Nitrobenzene
(d) Toluene

7. Aniline when diazotized in cold and when treated with dimethyl aniline gives a coloured product. Its structure would be

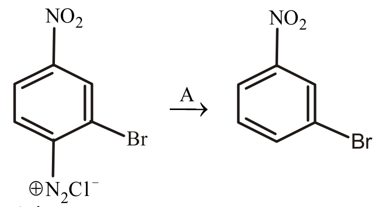
(a) 

(b) 

(c) 

(d) 

8. In the reaction



A is :
(a) Cu_2Cl_2 (b) H_3PO_2 and H_2O
(c) H^+/H_2O (d) $HgSO_4/H_2SO_4$

9. Which of the following is more basic than aniline?
(a) Triphenylamine (b) p-Nitroaniline
(c) Benzylamine (d) Diphenylamine

10. Nitrobenzene on reaction with conc. HNO_3/H_2SO_4 at 80 - 100°C forms which one of the following products ?
(a) 1, 3 - Dinitrobenzene
(b) 1, 4 - Dinitrobenzene
(c) 1, 2, 4 - Trinitrobenzene
(d) 1, 2 - Dinitrobenzene

11. On oxidation with sodium dichromate and sulphuric acid aniline gives aniline black. On controlled oxidation with the same reagent the product is
(a) Benzoic acid (b) Nitrobenzene
(c) p-Benzoquinone (d) Phenol

12. Among the following which one does not act as an intermediate in Hofmann rearrangement ?
(a) *R*NCO (b) $R\mathrm{CO}\ddot{\mathrm{N}}$
(c) $R\mathrm{CO}\ddot{\mathrm{N}}\mathrm{HBr}$ (d) *R*NC

13. Primary amines can be distinguished from secondary and tertiary amines by reacting with
(a) Chloroform and alcoholic KOH
(b) Methyl iodide
(c) Chloroform alone
(d) Zinc dust

14. Which of the following is not correct ?
(a) Ethyl amine and aniline both have – NH_2 group
(b) Ethyl amine and aniline dissolve in HCl
(c) Ethyl amine and aniline both react with $CHCl_3$ and KOH to form unpleasant smelling compound
(d) Ethyl amine and aniline both react with HNO_2 in cold to give hydroxy compounds

15. In the following reaction :

Acetamide $\xrightarrow[\Delta]{P_2O_5} Y \xrightarrow[\Delta]{H_2O/HCl} Z \xrightarrow[CaO]{NaOH} CH_4$, identify Z :

(a) $CH_3CH_2NH_2$ (b) CH_3COOH
(c) CH_3CONH_2 (d) CH_3CHO

16. In test for primary amines, the amine is treated with $CHCl_3$ and KOH and a bad smelling compound is formed. If the primary amine used is ethylamine, identify the bad smelling compound formed?
(a) CH_3CN (b) CH_3CNO
(c) CH_3CH_2NC (d) CH_3NCO

17. Which one of the following methods is neither meant for the synthesis nor for separation of amines?
(a) Curtius reaction (b) Wurtz reaction
(c) Hofmann method (d) Hinsberg method

18. Ethyl isocyanide on hydrolysis in acidic medium generates
(a) propanoic acid and ammonium salt
(b) ethanoic acid and ammonium salt
(c) methylamine salt and ethanoic acid
(d) ethylamine salt and methanoic acid

19. The correct order of increasing basic nature for the bases NH_3, CH_3NH_2 and $(CH_3)_2NH$ is
(a) $(CH_3)_2NH < NH_3 < CH_3NH_2$
(b) $NH_3 < CH_3NH_2 < (CH_3)_2NH$
(c) $CH_3NH_2 < (CH_3)_2NH < NH_3$
(d) $CH_3NH_2 < NH_3 < (CH_3)_2NH$

20. Which one of the following is the strongest base in aqueous solution ?
(a) Methylamine (b) Trimethylamine
(c) Aniline (d) Dimethylamine.

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Aromatic 1°amines can be prepared by Gabriel phthalimide synthesis.
Reason : Aryl halidses undergo nucleophilic substitution with anion formed by phthalimide.

2. **Assertion :** Only a small amount of HCl is required in the reduction of nitro compounds with iron scrap and HCl in the presence of steam.
Reason : $FeCl_2$ formed gets hydrolysed to release HCl during the reaction.

3. **Assertion :** Amines are basic in nature.
Reason : Amines have lone pair of electrons on nitrogen atom.

4. **Assertion :** Acetanilide is less basic than aniline.
Reason : Acetylation of aniline results in decrease of electron density on nitrogen.

5. **Assertion :** Nitration of aniline can be conveniently done by protecting the amino group by acetylation.
Reason : Acetylation increases the electron-density in the benzene ring.

6. **Assertoin :** Aniline does not undergo Friedel-Crafts reaction.
Reason : $-NH_2$ group of aniline reacts with $AlCl_3$ (Lewis acid) to give acid-base reaction.

7. **Assertion :** Acylation of amines gives a monosubstituted product whereas alkylation of amines gives polysubstituted product.
Reason : Acyl group sterically hinders the approach of further acyl groups

8. **Assertion :** Nitrating mixture used for carrying out nitration of benzene consists of conc. HNO_3 + conc. H_2SO_4.
Reason : In presence of H_2SO_4, HNO_3 acts as a base and produces NO_2^+ ions.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I		Column-II	
(A)	Gabriel phthalimide reaction	(1)	$C_6H_5CH_2NH_2$
(B)	Reduction with $LiAlH_4$	(2)	$C_6H_5NH_2$
(C)	Reaction with alc. $KOH + CHCl_3$	(3)	C_6H_5CN
(D)	1° Amide with $Br_2 + KOH$	(4)	$CH_3CH_2NH_2$

(a) A – (1,4); B – (1,4); C – (1,2,4); D – (1,2,4)
(b) A – (4); B – (1); C – (2); D – (1, 2)
(c) A – (1, 4); B – (3); C – (2); D – (4)
(d) A – (1, 2); B – (1); C – (1, 2); D – (4)

2. Match the columns

Column-I	Column-II
(A) Ammonolysis	(1) Amine with lesser number of carbon atoms
(B) Gabriel phthalimide synthesis	(2) Detection test for primary amines.
(C) Hoffmann bromamide reaction	(3) Reaction of Phthalimide with KOH and R–X
(D) Carbylamine reaction	(4) Reaction of alkylhalides with NH_3

(a) A – (4), B – (3), C – (1), D – (2)
(b) A – (3), B – (1), C – (3), D – (4)
(c) A – (2), B – (3), C – (4), D – (1)
(d) A – (4), B – (1), C – (2), D – (3)

3. Match the columns

Column-I	Column-II
(A) Benzene sulphonyl chloride	(1) Zwitter ion
(B) Sulphanilic acid	(2) Hinsberg reagent
(C) Alkyl diazonium salts	(3) Dyes
(D) Aryl diazonium salts	(4) Conversion to alcohols

(a) A – (4), B – (2), C – (3), D – (1)
(b) A – (2), B – (1), C – (4), D – (3)
(c) A – (3), B – (4), C – (1), D – (2)
(d) A – (4), B – (1), C – (3), D – (2)

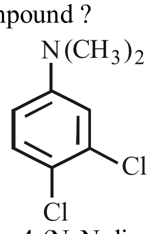
4. Match the columns

Column-I	Column-II
(A) $ArN_2^+Cl^- \longrightarrow ArOH$	(1) HBF_4 / $NaNO_2$
(B) $ArN_2^+Cl^- \longrightarrow ArNO_2$	(2) H_2O
(C) $ArN_2^+Cl^- \longrightarrow ArH$	(3) HBF_4
(D) $ArN_2^+Cl^- \longrightarrow ArF$	(4) CH_3CH_2OH

(a) A – (2), B – (1), C – (3), D – (3)
(b) A – (4), B – (1), C – (2), D – (3)
(c) A – (2), B – (4), C – (1), D – (3)
(d) A – (2), B – (4), C – (3), D – (1)

Critical Thinking Type Questions :

1. Which of the following is the correct IUPAC name of the compound ?

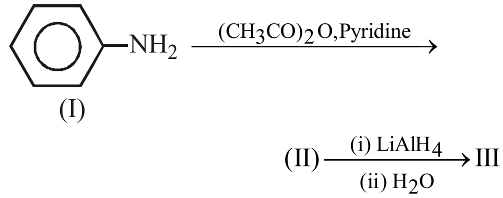


(a) 1, 2-dichloro-4-(N, N-dimethyl) aniline
(b) Dimethyl – (3, 4-dichlorophenyl) amine
(c) 3, 4-dichloro - N, N-dimethyl aniline
(d) N, N-dimethylamino - 3, 4 dichlorobenzene

2. What is the decreasing order of basicity of primary, secondary and tertiary ethylamines and NH_3 ?

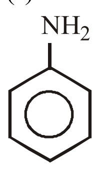
(a) $NH_3 > C_2H_5NH_2 > (C_2H_5)_2NH > (C_2H_5)_3N$
(b) $(C_2H_5)_3N > (C_2H_5)_2NH > C_2H_5NH_2 > NH_3$
(c) $(C_2H_5)_2NH > C_2H_5NH_2 > (C_2H_5)_3N > NH_3$
(d) $(C_2H_5)_2NH > C_2H_5NH_2 > (C_2H_5)_3NH > NH_3$

3.



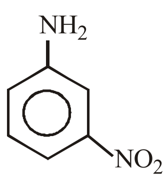
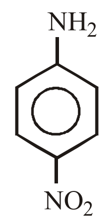
The basicity order of I, II and III is –

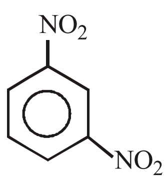
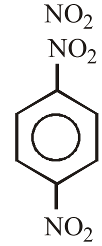
(a) III > I > II (b) I > II > III
(c) III > II > I (d) II > III > I

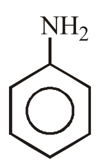
4. 

$\xrightarrow{(CH_3CO)_2O} (X) \xrightarrow[H_2SO_4]{HNO_3} (Y) \xrightarrow[H_2O]{H^+} (Z)$

Product Z of the reaction

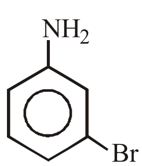
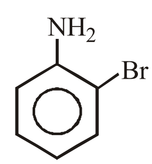
(a)  (b) 

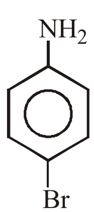
(c)  (d) 

5. 

$\xrightarrow{CH_3COCl} A \xrightarrow{Br_2-H_2O} B \xrightarrow{H_3O^+} C$

C (major product) is –

(a)  (b) 

(c)  (d) None of these

6. Nitration of nitrobenzence is carried out than obtained product is reduced with Fe/HCl, product so formed on reaction with HNO_2 and than with H_2O, forms

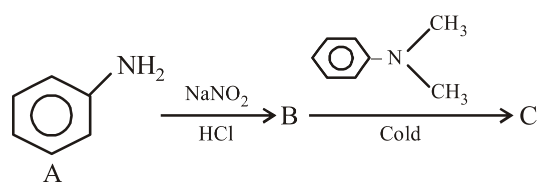
(a) 1,3–dihydroxybenzene
(b) 3–nitrophenol
(c) 2– nitrophenol
(d) 1,2–dihydroxybenzene

7. A compound of molecular formulae C_3H_6N shows following characteristics

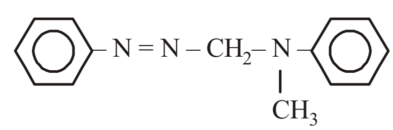
(i) Get dissolved in acidic medium.
(ii) Does not react with benzoylchloride
(iii) Does not give carbylamine test
(iv) Does not evolute nitrogen gas on reacting with HNO_2 than structure of the compound is

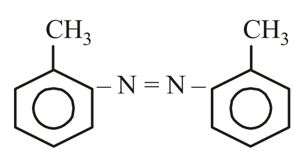
(a) trimethylamine
(b) isopropylamine
(c) propylamine
(d) None of these

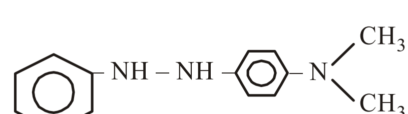
8. In a reaction of aniline a coloured product C was obtained.

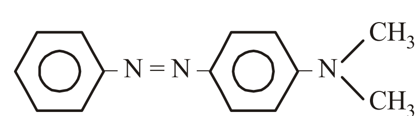


The structure of C would be :

(a) 

(b) 

(c) 

(d) 

28 Biomolecules

Fill in the Blanks :

1. A carbohydrate that cannot be hydrolysed into simpler units is called _______ .
2. Glucose gives silver mirror test with Tollen's reagent. It shows the presence of _______ .
3. Reduction of glucose by HI suggest that _______ carbon atoms are arranged in straight chain.
4. _______ is the least stable form of glucose.
5. The number of chiral carbon atoms present in cyclic structure α-D (+) glucose is _______ .
6. Glycogen is a branched chain polymer of α-D-glucose units in which chain is formed by C1–C4 glycosidic linkage whereas branching occurs by the formation of C1-C6 glycosidic linkage. Structure of glycogen is similar to _______ .
7. Chemically amylose is a _______ with 200–1000 α-D-(+)-glucose units held by _______ glycosidic linkage
8. Amylopectin is a _______ polymer of α-D-glucose units in which chain is formed by _______ glycosidic linkage whereas branching occurs by _______ glycosidic linkage.
9. A polypeptide with more than hundred amino acid residues, having molecular mass higher than 10,000 u is called _______ .
10. An insulin is a _______ which contains _______ amino acids.

True/ False :

1. In disaccharides if aldehydic or ketonic groups are bonded, these are non– reducing sugars.
2. Maltose is non reducing sugar
3. More than 25 monosaccharides occur naturally.
4. Sucrose on hydrolysis gives one molecule each of glucose and fructose.
5. The cyclic structure of glucose is correctly represented by Haworth strucure.
6. Linkage between two monosaccharide units through oxygen atom is called glycosidic linkage.
7. Lactose consists of linkage between C_1 of galactose and C_4 of glucose.
8. Glycogen is also known as animal starch because it is structurally similar to amylose a component of starch.
9. Starch consists of amylose and amylopectin.
10. Amino acids with equal number of amino and carboxyl groups are neutral.
11. Denaturation of proteins causes loss of secondary and tertiary structures of the protein.
12. Enzymes are highly specific both in binding chiral substrates and in catalysing their reactions
13. Vitamins A, D, E and K are stored in liver and adipose tissues.
14. In secondary structure of DNA adenine forms hydrogen bonds with guanine whereas cytosine forms hydrogen bonds with thymine.
15. Sugar moiety in DNA molecules is β-D-ribose whereas in RNA molecules it is β-D-2-deoxyribose.

Conceptual MCQs

1. The pair of compounds in which both the compounds give positive test with Tollen's reagent is
   (a) Glucose and Sucrose
   (b) Fructose and Sucrose
   (c) Acetophenone and Hexanal
   (d) Glucose and Fructose
2. The two forms of D–glucopyranose obtained from the solution of D–glucose are called
   (a) Isomers (b) Anomers
   (c) Epimers (d) Enantiomers

3. Which one of the following does not exhibit the phenomenon of mutarotation ?
(a) (+) – Sucrose (b) (+) – Lactose
(c) (+) – Maltose (d) (–) – Fructose

4. Complete hydrolysis of cellulose gives
(a) D-ribose (b) D-glucose
(c) L-glucose (d) D-fructose

5. The reason for double helical structure of DNA is operation of
(a) dipole-dipole interaction
(b) hydrogen bonding
(c) electrostatic attractions
(d) van der Waals' forces

6. Which of the statements about "Denaturation" given below are correct ?
(A) Denaturation of proteins causes loss of secondary and tertiary structures of the protein.
(B) Denturation leads to the conversion of double strand of DNA into single strand
(C) Denaturation affects primary strucrture which gets distorted
(a) (B) and (C) (b) (A) and (C)
(c) (A) and (B) (d) (A), (B) and (C)

7. Insulin production and its action in human body are responsible for the level of diabetes. This compound belongs to which of the following categories ?
(a) An enzyme (b) A hormone
(c) A co-enzyme (d) An antibiotic

8. In both DNA and RNA, heterocylic base and phosphate ester linkages are at –
(a) C_5' and C_1' respectively of the sugar molecule
(b) C_1' and C_5' respectively of the sugar molecule
(c) C_2' and C_5' respectively of the sugar molecule
(d) C_5' and C_2' respectively of the sugar molecule

9. The term anomers of glucose refers to
(a) enantiomers of glucose
(b) isomers of glucose that differ in configuration at carbon one (C-1)
(c) isomers of glucose that differ in configurations at carbons one and four (C-1 and C-4)
(d) a mixture of (D)-glucose and (L)-glucose

10. The pyrimidine bases present in DNA are
(a) cytosine and thymine
(b) cytosine and uracil
(c) cytosine and adenine
(d) cytosine and guanine

11. Which one of the following sets of monosaccharides forms sucrose?
(a) α–D-Galactopyranose and α–D-Glucopyranose
(b) α–D-Glucopyranose and β–D-Fructofuranose
(c) β–D-Glucopyranose and α–D- Fructofuranose
(d) α–D-Glucopyranose and β–D-Fructopyranose

12. α - D-(+)-glucose and β-D-(+)-glucose are
(a) conformers (b) epimers
(c) anomers (d) enatiomers

13. Glucose molecule reacts with X number of molecules of phenylhydrazine to yield osazone. The value of X is
(a) three (b) two
(c) one (d) four

14. Proteins when heated with conc. HNO_3 give a yellow colour. This is
(a) Oxidizing test
(b) Xanthoproteic test
(c) Hoppe's test
(d) Acid base test

15. Glucose gives silver mirror test with Tollen's reagent. It shows the presence of
(a) acidic group (b) alcoholic group
(c) ketonic group (d) aldehyde group

16. Which of the following reagent cannot distinguish between glucose and fructose?
(a) Fehling's solution (b) Tollen's reagent
(c) Benedict's solution (d) All of these

17. The linkage present in proteins and peptides is
(a) $-\overset{\overset{\displaystyle O}{\|}}{C}-NH-$ (b) $-\overset{\overset{\displaystyle O}{\|}}{C}-O$
(c) $-\overset{\overset{\displaystyle O}{\|}}{C}-O-\overset{\overset{\displaystyle O}{\|}}{C}-$ (d) $-NH-$

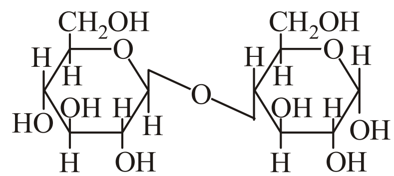
18. Which carbohydrate is essential constituent of plant cell?
    (a) starch (b) glucose
    (c) cellulose (d) sucrose
19. Amino acids are the building blocks of
    (a) fats (b) proteins
    (c) vitamins (d) carbohydrates
20. In an amino acid, the carboxyl group ionises at $pK_{a_1} = 2.34$ and ammonium ion at $pK_{a_2} = 9.60$. The isoelectric point of the amino acid is at pH
    (a) 5.97 (b) 2.34
    (c) 9.60 (d) 6.97

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** D(+)– Glucose is dextrorotatory in nature.
   Reason : 'D' represents its dextrorotatory nature.
2. **Assertion :** Sucrose is called an invert sugar.
   Reason : On hydrolysis, sucrose bring the change in the sign of rotation from dextro (+) to laevo(–).
3. **Assertion :** β-glycosidic linkage is present in maltose,



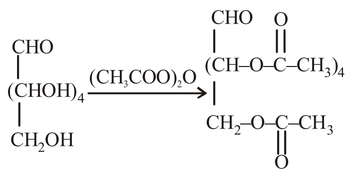
   Reason : Maltose is composed of two glucose units in which C–1 of one glucose unit is linked to C–4 of another glucose unit.
4. **Assertion :** At isoelectric point, the amino group does not migrate under the influence of electric field.
   Reason : At isoelectric point, amino acid exists as a zwitterion.
5. **Assertion :** Vitamin D cannot be stored in our body
   Reason : Vitamin D is fat soluble vitamin and is excreted from the body in urine.

Matching Based Questions :

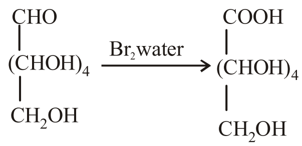
DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns.

Column - I (Reaction of glucose)	Column - II (Characteristic of glucose molecule)
(A) $CHO-(CHOH)_4-CH_2OH \xrightarrow{HI,\ \Delta} CH_3-(CH_2)_4-CH_3$	(1) Presence of $\rangle C=O$ group
(B) $CHO-(CHOH)_4-CH_2OH \xrightarrow[\text{(ii) HCN}]{\text{(i) } NH_2OH} H-C(CN)(OH)-(CHOH)_4-CH_2OH$	(2) Presence of aldehydic group

(C) 

(3) All six carbon atoms are linked in a straight

(D) 

(4) Presence of five —OH groups

(a) A – (1), B – (3), C – (4), D – (2)
(b) A – (3), B – (4), C – (1), D – (2)
(c) A – (3), B – (1), C – (4), D – (2)
(d) A – (3), B – (1), C – (2), D – (4)

2. Match the columns

Column-I (Enzymes)	**Column-II (Reactions)**
(A) Invertase	(1) Decomposition of urea into NH_3 and CO_2
(B) Maltase	(2) Conversion of glucose into ethyl alcohol
(C) Pepsin	(3) Hydrolysis of maltose into glucose
(D) Urease	(4) Hydrolysis of cane sugar
(E) Zymase	(5) Hydrolysis of proteins into peptides

(a) A – (4), B – (3), C – (5), D – (1), E – (2)
(b) A – (3), B – (2), C – (4), D – (1), E – (5)
(c) A – (2), B – (1), C – (3), D – (4), E – (5)
(d) A – (4), B – (1), C – (5), D – (2), E – (3)

3. Match the columns

Column - I	**Column - II**
(A) Vitamin B6	(1) Fat soluble
(B) Vitamin K	(2) Xerophthalmia
(C) Vitamin D	(3) Convulsions
(D) Vitamin A	(4) Delayed blood clotting

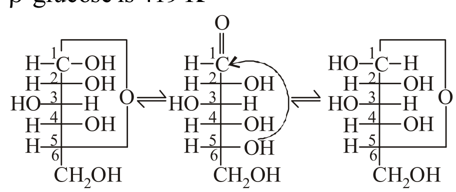
(a) A – (1,2), B – (1,4), C – (1), D – (1)
(b) A – (3), B – (1,4), C – (1), D – (1, 2)
(c) A – (1,4), B – (3), C – (1), D – (1,2)
(d) A – (3), B – (1,4), C – (1,2), D – (1)

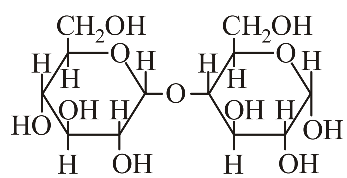
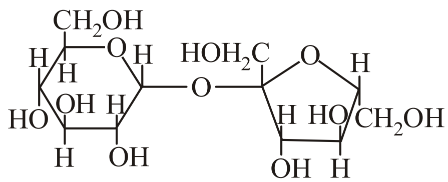
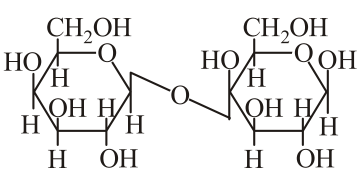
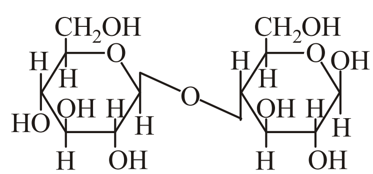
4. Match the columns

Column - I	**Column - II**
(A) Vitamin A	(1) Scurvy
(B) Vitamin B_{12}	(2) Hemorrhagic condition
(C) Vitamin C	(3) Sterility
(D) Vitamin E	(4) Xerophthalmia
(E) Vitamin K	(5) Pernicious anaemia

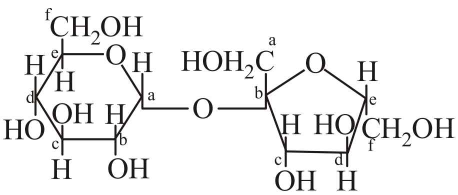
(a) A – (5), B – (4), C – (1), D – (3), E – (3)
(b) A – (4), B – (5), C – (1), D – (2), E – (3)
(c) A – (4), B – (5), C – (1), D – (3), E – (2)
(d) A – (5), B – (4), C – (1), D – (3), E – (2)

Critical Thinking Type Questions :

1. Select the false statement about the cyclic glucose.
   (a) If the OH group is added to CHO group it will form cyclic hemiacetal structure
   (b) Glucose form six-membered ring in which –OH is at C–5 position
   (c) Melting point of α-glucose is 423 K and of β-glucose is 419 K
   (d) 

2. In disaccharides, if the reducing groups of monosaccharides *i.e.*, aldehydic or ketonic groups are bonded, these are non-reducing sugars. Which of the following disaccharide is a non-reducing sugar?
   (a) 
   (b) 
   (c) 
   (d) 

3. Structure of a disaccharide formed by glucose and fructose is given below. Identify anomeric carbon atoms in monosaccharide units.



   (a) 'a' carbon of glucose and 'a' carbon of fructose.
   (b) 'a' carbon of glucose and 'e' carbon of fructose.
   (c) 'a' carbon of glucose and 'b' carbon of fructose.
   (d) 'f' carbon of glucose and 'f' carbon of fructose.

4. Which of the following statements is correct?
   (a) Only the compounds following general formula $C_x(H_2O)_y$ are carbohydrates.
   (b) Acetic acid (CH_3COOH) having general formula $C_2(H_2O)_2$ falls in this category.
   (c) Rhamnose having formula $C_6H_{12}O_5$ is a carbohydrate. Though this is not according to general formula of carbohydrates.
   (d) Chemically the carbohydrates may be defined as optically inactive polyhydroxy aldehydes or ketones.

5. For $-\overset{\overset{\displaystyle O}{||}}{C}-\ddot{N}H-$(peptide bond)
   Which statement is incorrect about peptide bond?
   (a) C — N bond length in proteins is longer than usual bond length of the C — N bond
   (b) Spectroscopic analysis shows planar structure of the $-\underset{\underset{\displaystyle O}{||}}{C}-NH-$ group
   (c) C — N bond length in proteins is smaller than usual bond length of the C—N bond
   (d) None of the above

6. Vitamin C must be supplied regularly in diet because
   (a) it is water soluble hence excreted in urine and can't be stored in the body
   (b) it is fat soluble hence stored in the body and cannot be used on regular basis
   (c) it is required in a large amount by the body hence supplied regularly
   (d) it is water soluble hence used by the body on daily basis and is to be supplied regularly.

29

Polymers

Fill in the Blanks :

1. _______ and _______ are semisynthetic polymers.
2. A polymer made from a polymerization reaction that produces small molecules (such as water) as well as the polymer is classified as a/an _______ polymer.
3. _______ density polythene is prepared by free radical polymerisation
4. The monomer(s) used in the preparation of Orlon, a substitute for wool is _______ .
5. Caprolactam polymerises to give _______ .
6. The plastic household crockery is prepared by using _______ and formaldehyde
7. The repeating unit present in _______ is — $[CO(CH_2)_5NH]$ —
8. Acetic acid is added in the preparation of _______ to avoid polymerisation at first step

True/ False :

1. Macromolecules have high molecular mass of order $10^3 - 10^7$u.
2. Monomeric units are joined together by ionic or covalent bond.
3. Condensation polymers can be obtained by condensation between two similar bi–functional monomeric units.
4. Buna–S and Buna–N consist of close packing of chains which impart them crystalline nature.
5. A polyamide nylon 6,6 prepared by the condensation polymerisation of hexamethylene diamine with adipic acid is used in the manufacture of tyre cords.
6. Terylene is crease resistant and is blended with cotton and wool fibres for various applications.
7. Melamine formaldehyde polymer is mainly used in the manufacture of electrical switches
8. Natural rubber is a cis –1, 4–polyisoprene having elastic properties due to coiled structure and weak van der Waal's forces.
9. Vulcanisation of natural rubber with sulphur and an appropriate additive is carried out above 415K.
10. In the manufacture of tyre rubber, 5% of sulphur is used as a cross-linking agent.
11. Buna–N being resistant to the action of petrol, lubricating oil and organic solvents is used in making oil seals.
12. PHBV is a copolymer used in the manufacture of orthopaedic devices.

Conceptual MCQs

1. Which of the following structures represents neoprene polymer?

(a) $\left(CH_2-\underset{\underset{Cl}{|}}{C}=CH-CH_2\right)_n$

(b) $\left(CH_2-\overset{\overset{CN}{|}}{CH}\right)_n$

(c) $\left(CH_2-\overset{\overset{Cl}{|}}{CH}\right)_n$

(d) $\left(\underset{\underset{C_6H_5}{|}}{CH}-CH_2\right)_n$

2. Which of the following monosaccharide is pentose ?

(a) Glucose (b) Fructose
(c) Arabinose (d) Galactose

3. Nylon – 66 is made by using
(a) succinic acid (b) benzaldehyde
(c) adipic acid (d) benzyl chloride

4. PVC is polymer of
(a) $CH_2=CH_2$
(b) $CH_2=CH\text{-}Cl$
(c) $CH_2=CH–CH_2Cl$
(d) $CH_3–CH=CH–Cl$

5. An example of biopolymer is
(a) Teflon (b) Neoprene
(c) Nylon-66 (d) DNA

6. Which one of the following is used to make "non-stick" cook-wares ?
(a) Polystyrene
(b) Poly (ethylene terephthalate)
(c) Polytetrafluoroethylene
(d) Poly (vinyl chloride)

7. Which of the following statements is false?
(a) Artificial silk is derived from cellulose.
(b) Nylon-66 is an example of elastomer.
(c) The repeat unit in natural rubber is isoprene.
(d) Both starch and cellulose are polymers of glucose.

8. Acrilan is a hard, horny and a high melting material. Which of the following represents its structure ?

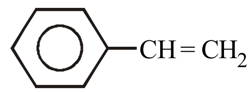
(a) $\left(—CH_2 — \underset{\displaystyle Cl}{\overset{}{C}}H—\right)_n$

(b) $\left(—CH_2 — \underset{\displaystyle CN}{CH}—\right)_n$

(c) $\left(—CH_2 — \underset{\displaystyle COOCH_3}{\overset{\displaystyle CH_3}{C}}—\right)_n$

(d) $\left(—CH_2 — \underset{\displaystyle COOC_2H_5}{CH}\right)_n$

9. Which one of the following sets forms the biodegradable polymer?
(a) $CH_2=CH–CN$ and $CH_2=CH–CH=CH_2$
(b) $H_2N–CH_2–COOH$ and $H_2N–(CH_2)_5–COOH$
(c) $HO–CH_2–CH_2–OH$ and

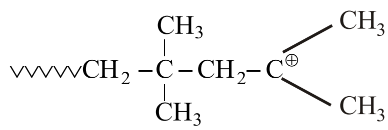
(d) 

and

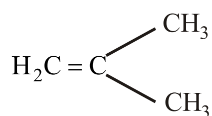
$CH_2=CH–CH=CH_2$

10. Which one of the following is a chain growth polymer?
(a) Starch
(b) Nucleic acid
(c) Polystyrene
(d) Protein

11. The monomer of the polymer;



is

(a) 

(b) $CH_3CH=CHCH_3$
(c) $CH_3CH=CH_2$
(d) $(CH_3)_2C=C(CH_3)_2$

12. $\sim\sim[NH(CH_2)NHCO(CH_2)_4CO]_n\sim\sim$ is a
(a) addition polymer
(b) thermosetting polymer
(c) homopolymer
(d) copolymer

13. Which one of the following polymers is prepared by condensation polymerisation?
(a) Teflon
(b) Natural rubber
(c) Styrene
(d) Nylon-66

14. Polymer formation from monomers starts by
(a) condensation reaction between monomers
(b) coordinate reaction between monomers
(c) conversion of monomer to monomer ions by protons
(d) hydrolysis of monomers.

15. Nylon threads are made of
(a) polyester polymer
(b) polyamide polymer
(c) polyethylene polymer
(d) polyvinyl polymer

16. Which of the following is a polyamide?
(a) Bakelite (b) Terylene
(c) Nylon-66 (d) Teflon

17. Buna-N synthetic rubber is a copolymer of :
(a) $H_2C=CH-CH=CH_2$ and $H_5C_6-CH=CH_2$
(b) $H_2C=CH-CN$ and $H_2C=CH-CHCH_2$
(c) $H_2C=CH-CN$ and $H_2C=CH-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH_2$
(d) $H_2C=CH-\overset{\displaystyle Cl}{\overset{|}{C}}=CH_2$ and $H_2C=CH-CH=CH_2$

18. The polymer of natural rubber is
(a) all *trans*-isoprene
(b) Buna - N
(c) all *cis*-isoprene
(d) None of these

19. Which of the following could act as a propellant for rockets?
(a) Liquid oxygen + liquid argon
(b) Liquid hydrogen + liquid oxygen
(c) Liquid nitrogen + liquid oxygen
(d) Liquid hydrogen + liquid nitrogen

20. The monomer of teflon is
(a) $CHF=CH_2$ (b) $CF_2=CF_2$
(c) $CHCl=CHCl$ (d) $CHF=CHCl$

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** Olefinic monomers undergo addition polymerisation.
Reason : Polymerisation of vinylchloride is initiated by peroxides/ persulphates.

2. **Assertion :** Teflon has high thermal stability and chemical inertness.
Reason : Teflon is a thermoplastic.

3. **Assertion :** Bakelite is a thermosetting polymer.
Reason : Bakelite can be melted again and again without any change.

4. **Assertion :** In vulcanisation of rubber, sulphur cross links are introduced.
Reason : Vulcanisation is a free radical initiated chain reaction.

5. **Assertion :** The time of vulcanisation and temperature is increased by adding accelerators.
Reason : By vulcanising, a material of high tensile strength can be obtained.

6. **Assertion :** Most of the Synthetic polymers are not biodegradable.
Reason : Polymerisation process induces toxic character in organic molecules.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns.

Column-I	Column-II
(A) Linear polymer	(1) Melamine
(B) Semisynthetic polymer	(2) Polyvinyl chloride
(C) Branched chain polymer	(3) LDPE
(D) Network polymer	(4) Cellulose nitrate

(a) A– (4), B – (2), C – (3), D – (1) (b) A– (2), B – (4), C – (3), D – (1)
(c) A– (2), B – (3), C – (4), D – (1) (d) A– (2), B – (4), C – (1), D – (3)

2. Match the columns.

Column-I	**Column-II**
(A) Highly branched chemically inert polymer used in the insulation of electric wires.	(1) Teflon
(B) Linear polymer prepared in presence of $Al(C_2H_5)_3$ and $TiCl_4$.	(2) Polyacrylonitrile
(C) Corrosion resistant polymer used in manufacture of non–stick surface coated utensils.	(3) HDPE
(D) Addition polymer used as a substitute for wool.	(4) LDPE

(a) A–(4), B–(3), C–(2), D–(1) (b) A–(4), B–(1), C–(3), D–(2)
(c) A–(4), B–(3), C–(1), D–(2) (d) A–(3), B–(4), C–(1), D–(2)

3. Match Column-I (Monomer) with Colum-II (Polymer) and select the correct answer using the codes given below the lists:

Column-I	**Column-II**
(A) Hexamethylenediamine	(1) Bakelite
(B) Phenol	(2) Dacron
(C) Phthalic acid	(3) Glyptal
(D) Terephthalic acid	(4) Melamine
	(5) Nylon

(a) A – (5), B – (1), C – (2), D – (3) (b) A – (5), B – (1), C – (3), D – (2)
(c) A – (4), B – (3), C – (1), D – (2) (d) A – (4), B – (3), C – (2), D – (1)

4. Match the columns

Column-I	**Column-II**
(A) Polyester of glycol and phtalic acid	(1) Novalac
(B) Copolymer of 1, 3-butadiene and styrene	(2) Glyptal
(C) Phenol and formaldehyde resin	(3) Buna-S
(D) Polyester of glycol and terephthalic acid	(4) Buna-N
(E) Copolymer of 1, 3-butadiene and acrylonitrile	(5) Dacron

(a) A – (1), B – (4), C – (1), D – (5), E – (3) (b) A – (1), B – (3), C – (1), D – (5), E – (4)
(c) A – (3), B – (1), C – (3), D – (4), E – (2) (d) A – (1), B – (4), C – (2), D – (5), E – (3)

5. Match the polymers given in Column-I with their chemical names given in Column-II

Column-I	**Column-II**
(A) Nylon 6	(1) Polyvinyl chloride
(B) PVC	(2) Polyacrylonitrile
(C) Acralin	(3) Polycaprolactum
(D) Natural rubber	(4) Low density polythene
(E) LDP	(5) cis-polyisoprene

(a) A – (3), B – (1), C – (2), D – (5), E – (4) (b) A – (4), B – (2), C – (5), D – (3), E – (1)
(c) A – (5), B – (4), C – (1), D – (2), E – (3) (d) A – (4), B – (5), C – (3), D – (2), E – (1)

6. Match the columns

Column-I (Polymers)	Column-II (Uses)
(A) Nylon 6,6	(1) Fabrics and ropes
(B) Nylon 6	(2) Electrical switches
(C) Dacron	(3) Bristles for brushes
(D) Bakelite	(4) As glass reinforcing materials in safety helmets.

(a) A – (2), B – (4), C – (3), D – (1)
(b) A – (3), B – (2), C – (4), D – (1)
(c) A – (3), B – (1), C – (4), D – (2)
(d) A – (3), B – (1), C – (2), D – (4)

7. Match the columns

Column-I	Column-II
(A) Polymer of styrene	(1) used in making handles of utensils and computer discs
(B) Polymer of ethylene glycol and phtalic acid	(2) used as an insulator
(C) Polymer of phenol	(3) used in making paints and formaldehyde and lacquers.
(D) Polymer of vinyl chloride	(4) used in manufacture of rain coats and flooring.

(a) A – (2), B – (3), C– (1), D – (4)
(b) A – (3), B – (2), C– (1), D – (4)
(c) A – (2), B – (1), C– (3), D – (4)
(d) A – (2), B – (3), C– (4), D – (1)

Critical Thinking Type Questions :

1. Among cellulose, poly (vinyl chloride), nylon and natural rubber, the polymer in which the intermolecular force of attraction is weakest is
(a) nylon
(b) poly (vinyl chloride)
(c) cellulose
(d) natural rubber

2. When condensation product of hexamethylenediamine and adipic acid is heated to 525K in an atmosphere of nitrogen for about 4-5 hours, the product obtained is
(a) solid polymer of nylon 66
(b) liquid polymer of nylon 66
(c) gaseous polymer of nylon 66
(d) liquid polymer of nylon 6

3. Identify A, B and C in the following sequence of reactions

$$C_6H_5-\overset{\overset{O}{\|}}{C}-O-O-\overset{\overset{O}{\|}}{C}-C_6H_5 \longrightarrow 2\,C_6H_5-\overset{\overset{O}{\|}}{C}-\dot{O} \longrightarrow 2A$$

$$A + CH_2 = CH_2 \longrightarrow B$$

$$B + nCH_2 = CH_2 \longrightarrow C$$

$$C + C \longrightarrow C_6H_5-(CH_2-CH_2)_n-CH_2-CH_2 -CH_2-(CH_2-CH_2)_n-C_6H_5$$

(a) $A = \dot{C}_6H_5$, $B = C_6H_5-CH_2-\dot{C}H_2$ and $C = \dot{C}_6H_5-(CH_2-CH_2)_n-CH_2-\dot{C}H_2$.

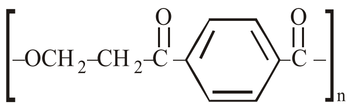
(b) $A = C_6H_5\dot{C}O$, $B = C_6H_5-CH_2-\dot{C}H_2$ and $C = C_6H_5-(CH_2-CH_2)_n-CH_2-\dot{C}H_2$

(c) $A = \dot{C}_6H_5$, $B = C_6H_5-\dot{C}H-CH_3$ and $C = C_6H_5-(CH_2-CH_2)_n-CH_2\dot{C}H_2$

(d) $A = \dot{C}_6H_5$, $B = C_6H_5-CH_2-\dot{C}H_2$ and $C = C_6H_5-(CH_2-CH_2)_n-C_6H_5$

4. Which one of the following monomers gives the polymer neoprene on polymerization ?
(a) $CF_2 = CF_2$
(b) $CH_2 = CHCl$
(c) $CCl_2 = CCl_2$
(d) $CH_2 = \overset{\overset{Cl}{|}}{C}-CH = CH_2$

5. Which of the following is not correctly matched?

(a) Terylene 

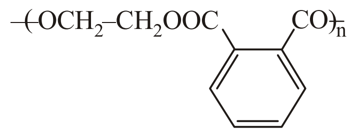
(b) Neoprene $\left[-CH_2-\underset{\underset{Cl}{|}}{C}=CH-CH_2-\right]_n$

(c) Nylon-66

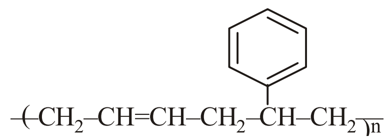
$\left[-NH-(CH_2)_6-NH-\overset{\overset{O}{||}}{C}-(CH_2)_4-\overset{\overset{O}{||}}{C}-O-\right]_n$

(d) PMMA $\left[-CH_2-\overset{\overset{CH_3}{|}}{\underset{\underset{COOCH_3}{|}}{C}}-\right]_n$

6. In which of the following polymers ethylene glycol is one of the monomer units?

(a) 

(b) $-(CH_2-CH_2)_n-$

(c) 

(d) $-(O-\underset{\underset{CH_3}{|}}{CH}-CH_2-\underset{\underset{O}{||}}{C}-O-\underset{\underset{CH_2CH_3}{|}}{CH}-CH_2-\underset{\underset{O}{||}}{C}-)_n$

7. Arrange the following in increasing order of their melting point. Nylon 2,2 (1); Nylon 2,4 (2), Nylon 2,6 (3), Nylon 2,10(4)

(a) 1, 2, 3, 4 (b) 3, 4, 2, 1

(c) 2, 1, 3, 4 (d) 4, 3, 2, 1

30 Chemistry in Everyday Life

Fill in the Blanks :

1. The function of enzymes in the living system is to _______ .
2. The drug used as an antidepressant is ______ .
3. _______ is used for inducing sleep.
4. Streptomycin is effective in the treatment of _______ .
5. Salol can be used as _______ .
6. Commonly used antiseptic 'Dettol' is a mixture of _______ and _______ .
7. Antibiotic that can be given orally in case of typhoid, acute fever, dysentery, meningitis and pneumonia is _______ .
8. _______ is added to soap. It functions to prevent rapid drying.

True/ False :

1. Chemical messengers are received at the binding sites of receptor proteins.
2. Before 1970 for treatment of stomach acidity $Al(OH)_3$ is a better antacid in comparison to $NaHCO_3$.
3. Terfenadine is a drug which competes with histamine for binding sites of receptor.
4. Veronal and luminal belongs to the class of tranquilizers called barbiturates.
5. 1% solution of iodine in alcohol–water mixture is known as tincture of iodine.
6. SO_2 in low concentrations are used as antiseptics whereas in higher concentration are used as disinfectants.
7. Bacteria can degrade the detergents containing highly branched chains.
8. Some synthetic detergents can give foam even in ice cold water.
9. Potassium soaps are soft to the skin than sodium soaps.
10. Builders like Na_2CO_3 and Na_3PO_4 make soaps act more rapidly.
11. Hard water contains Ca^{2+} and Mg^{2+} ions which forms insoluble Ca^{2+} and Mg^{2+} soaps separates out as scum.
12. Cationic detergents being inexpensive are extensively used as germicide.
13. Detergents with linear alkyl chains are more polluting as compared to detergents having branched alkyl chains.

Conceptual MCQs

1. Commonly used antiseptic 'Dettol' is a mixture of
   (a) o-chlorophenozylenol + terpeneol
   (b) o-cresol + terpeneol
   (c) phenol + terpeneol
   (d) chlorozylenol + terpeneol
2. Which one of the following can possibly be used as analgesic without causing addiction and mood modification ?
   (a) Diazepam
   (b) Morphine
   (c) N-Acetyl-para-aminophenol
   (d) Tetrahydrocannabinol
3. Substances which bring body temperature down are known as
   (a) Antipyretics (b) Analgesics
   (c) Antobiotics (d) None
4. Washing soap can be prepared by saponification with alkali of which of the following oil
   (a) Rose oil (b) Paraffin oil
   (c) Groundnut oil (d) Kerosene oil
5. Which of the following is not a fat soluble vitamin?
   (a) Vitamin B complex (b) Vitamin D
   (c) Vitamin E (d) VitaminA
6. Cobalt (60) isotope is used in the treatment of :
   (a) Heart diseases (b) Skin diseases
   (c) Diabetes (d) Cancer
7. Alkaline hydrolysis of esters is known as :
   (a) Esterification (b) Saponification
   (c) dehydration (d) alkalination

8. Saccharine contains
(a) C and H (b) C, H, N and O
(c) C, H, N, O & S (d) C, O and H

9. Chloroamphenicol is an :
(a) antifertility drug
(b) antihistaminic
(c) antiseptic and disinfectant
(d) antibiotic-broad spectrum

10. Enzymes take part in a reaction and
(a) decrease the rate of a chemical reaction
(b) increase the rate of a chemical reaction
(c) both (a) and (b)
(d) None of these

11. Antiseptics and disinfectants either kill or prevent growth of microorganisms. Identify which of the following statements is not true:
(a) Chlorine and iodine are used as strong disinfectants.
(b) Dilute solutions of boric acid and hydrogen Peroxide are strong antiseptics.
(c) Disinfectants harm the living tissues.
(d) A 0.2% solution of phenol is an antiseptic while 1% solution acts as a disinfectant.

12. Pheromones are chemicals
(a) formed by fermentation process of fungi
(b) secreted by endocrine glands of man
(c) secreted outside the body of insects
(d) plant growth hormones

13. Which of the following is not true ?
(a) Some disinfectants can be used as antispetics
(b) sulphadiazine is a synthetic antibacterial
(c) aspirin is analgesic as well as antipyretic
(d) polystyrene is used to make non-stick cookware

14. Structurally biodegrdable detergent should contain
(a) normal alkyl chain
(b) branched alkyl chain
(c) phenyl side chain
(d) cyclohexyl side chain

15. Which of the following is used for inducing sleep?
(a) Paracetamol
(b) Chloroquine
(c) Bithional
(d) Barbituric acid derivatives

16. Which of these is a hypnotic ?
(a) metaldehyde (b) acetaldehyde
(c) paraldehyde (d) none of these

17. Cetyltrimethyl ammonium bromide is a popular
(a) anionic detergent
(b) cationic detergent
(c) non-ionic detergent
(d) sweetener

18. Arsenic drugs are mainly used in the treatment of
(a) jaundice (b) typhod
(c) syphilis (d) cholera

19. An ester used as medicine is
(a) ethyl acetate (b) methyl acetate
(c) methyl salicylate (d) ethyl benzoate

20. Streptomycin, well known antibiotic, is a derivative of
(a) peptides (b) carbohydrates
(c) purines (d) terpenes

Assertion/ Reason :

DIRECTIONS : *Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

1. **Assertion :** The drugs which act on the central nervous system and help in reducing anxiety are called antibiotics.
Reason : Pencillin is an antibiotic.

2. **Assertion :** Equanil is a tranquilizer.
Reason : Equanil is used to cure depression and hypertension.

3. **Assertion :** Tetracycline is a broad spectrum antibiotic.
Reason : Tetracyclin is effective against a number of types of bacteria, large viruses and typhus fever.

4. **Assertion :** Antiseptics are applied to living tissues.
Reason : Iodine is a powerful antiseptic.

5. **Assertion :** Sedatives are given to patients who are mentally agitated and violent.
Reason : Sedatives are used to suppress the activities of central nervous system.

6. **Assertion :** Non-competitive inhibitor inhibits the catalyic activity of enzyme by binding with its active site.
Reason : Non-competitive inhibitor changes the shape of the active site in such a way that substrate can't recognise it.

7. **Assertion :** Sodium chloride is added to precipitate soap after saponification.
Reason : Hydrolysis of esters of long chain fatty acids by alkali produces soap in colloidal form.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and four or five statements (1, 2, 3, 4 or 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1. Match the columns

Column-I	**Column-II**
(A) Sodium Perborate	(1) Disinfectant
(B) Chlorine	(2) Antiseptic
(C) Bithional	(3) Milk bleaching agent
(D) Potassium stearate	(4) Soap

(a) A – (1), B – (2), C – (3), D – (4)
(b) A – (2), B – (3), C – (4), D – (1)
(c) A – (3), B – (1), C – (2), D – (4)
(d) A – (4), B – (1), C – (2), D – (3)

2. Match the columns

Column-I	**Column-II**
(A) Ranitidine	(1) Tranquilizer
(B) Furacine	(2) Antibiotic
(C) Phenelzine	(3) Antihistamine
(D) Chloramphenicol	(4) Antiseptic

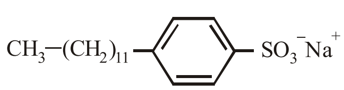
(a) A – (3), B – (4), C – (1), D – (2)
(b) A – (4), B – (1), C – (2), D – (3)
(c) A – (1), B – (2), C – (3), D – (4)
(d) A – (2), B – (3), C – (4), D – (1)

3. Match the columns

Column – I	**Column – II**
(A) First antibacterial drug	(1) Broad spectrum antibiotic
(B) Protosil	(2) Arsphenamine
(C) Chloramphenicol	(3) 1932
(D) Ofloxacin	(4) 1947

(a) A – (2), B – (3), C – (1, s), D – (1)
(b) A – (3), B – (2), C – (1, s), D – (1)
(c) A – (2), B – (1, 4), C – (3), D – (1)
(d) A – (1), B – (3), C – (1, 4), D – (2)

4. Match the columns

Column-I	**Column-II**
(A) $\left[CH_3(CH_2)_{15}-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{N}}-CH_3\right]^+ Br^-$	(1) Dishwashing powder
(B) 	(2) Laundry soap
(C) $C_{17}H_{35}COO^-Na^+ + Na_2CO_3$ + Rosin	(3) Hair conditioners
(D) $CH_3(CH_2)_{16}COO(CH_2CH_2O)_nCH_2CH_2OH$	(4) Toothpaste

(a) A – (1), B – (2), C – (3), D – (4)
(b) A – (2), B – (3), C – (1), D – (4)
(c) A – (3), B – (4), C – (2), D – (1)
(d) A – (1), B – (3), C – (2), D – (4)

5. Match the columns

Column -I		Column -II
(A) Toilet soap	(1)	Made by beating tiny air bubbles before their hardening.
(B) Transparent soap	(2)	Contain glycerol to prevent rapid drying.
(C) Shaving soaps	(3)	Prepared by using better grades of fats and oils.
(D) Soaps that float in water	(4)	Made by dissolving the soap in ethanol and then evaporating excess alkali.

(a) A – (4), B – (1), C – (2), D – (3)
(b) A – (3), B – (4), C – (2), D – (1)
(c) A – (3), B – (2), C – (1), D – (4)
(d) A – (2), B – (4), C – (1), D – (3)

Critical Thinking Type Questions :

1. Among the following antihistamines, which are antacids
   (i) Ranitidine (ii) Brompheniramine
   (iii) Terfenadine (iv) Cimetidine
   (a) (i) and (iii) (b) (i), (ii) and (iv)
   (c) (i) and (iv) (d) (ii) and (iii)
2. Select the incorrect statement.
   (a) Equanil is used to control depression and hypertension.
   (b) Mifepristone is a synthetic steroid used as "morning after pill".
   (c) 0.2 percent solution of phenol is an antiseptic while its 1.0 percent solution is a disinfectant.
   (d) A drug which kills the organism in the body is called bacteriostatic.
3. Which of the following is not correctly matched?
   (i) Proteins that are crucial to body's communication process. – Receptors
   (ii) Drugs that mimic the natural messenger by switching on the receptor. – Antagonists
   (iii) Drugs that binds to the receptor site and inhibit its natural function. – Agonists
   (a) (ii) only (b) (iii) only
   (c) (i) and (iii) (d) (ii) and (iii)
4. Which of the following drug inhibits the synthesis of chemicals known as prostaglandins which stimulate inflammation in tissue and cause pain?
   (a) Barbiturates (b) Aspirin
   (c) Seldane (d) Iproniazid
5. Which of the following antibiotics is not correctly classified?

	Bactericidal	Bacteriostatic
(A)	Penicillin	Erythromycin
(B)	Aminoglycosides	Tetracycline
(C)	Chloramphenicol	Ofloxacin

   (a) A and B (b) C only
   (c) B and C (d) B only
6. Antibiotics that are effective mainly against Gram-positive or Gram-negative bacteria X. Antibiotics that are effective against a single organism or disease are Y
   What is X and Y ?
   (a) X = Broad spectrum antibiotics.
   Y = Narrow spectrum antibiotics.
   (b) X = Broad spectrum antibiotics.
   Y = Limited spectrum antibiotics.
   (c) X = Narrow spectrum antibiotics.
   Y = Limited spectrum antibiotics.
   (d) X = Narrow spectrum antibiotics.
   Y = Broad spectrum antibiotics.
7. The artificial sweetener containing chlorine that has the appearance and taste as that of sugar and is stable at cooking temperature is
   (a) Aspartame (b) Saccharin
   (c) Sucrolose (d) Alitame
8. Which of the following statements is incorrect?
   (a) Saccharin is about 550 times as sweet as cane sugar.
   (b) Aspartame is used in the manufacture of baked sweets.
   (c) Alitame is more sweet than saccharin and aspartame.
   (d) Sodium benzoate is commonly used preservative.

Solutions

Free e-Book

Note: Detailed explanations to some of the selective problems are given separately in the form of e-book. To access this e-book for free refer to the Second Page of the book

Chapter - 1 Some Basic Concepts of Chemistry

Fill in the Blanks

1. **Carbon (C – 12)** 2. **6.02×10^{24}**
3. **0.4m** 4. **4.14 g**
5. A mixture may contain any number of components in any ratio.
e.g. air is a mixture of various gases.
6. **1.4×10^{-21}g** 7. **5L** 8. 8.6×10^{29}
9. equal 10. C_2H_4O

True/ False

1.	**True**	**2.**	**True**	**3.**	**False**	**4.**	**False**
5.	**False**	**6.**	**True**	**7.**	**False**	**8.**	**True**
9.	**False**	**10.**	**False**	**11.**	**False**	**12.**	**True**

Conceptual MCQs

1. **(b)**
2. **(b)** The number of atoms in 0.1 mole of a triatomic gas = $0.1 \times 3 \times 6.023 \times 10^{23} = 1.806 \times 10^{23}$
3. **(c)** 4. **(c)**
5. **(a)** Mass ratio of H : C = 1 : 12
However, given mass ratio of H : C = 1 : 3
Therefore, for every C atom, there are 4 H atoms, hence empirical formula = CH_4
6. **(c)** Each has three significant figures. When zero is used to locate the decimal point, it is not considered as significant figure.
7. **(a)**
8. **(c)** Meq of A = Meq of B.
Meq of $KMnO_4 = 20 \times 0.5 = 10$
Meq of 50 ml of 0.1
M $H_2C_2O_4 = 50 \times 0.2 = 10$
(0.1 M $H_2C_2O_4$ = 0.2 N $H_2C_2O_4$)
9. **(a)**
10. **(c)** Law of multiple proportions.
11. **(b)** Law of multiple proportion. As the ratio of oxygen which combine with fix weights of 1 g of nitrogen bears a simple whole number ratio
0.57 : 1 : 12 : 1.7031 : 2 : 3
12. **(a)** Molecular mass of HCl = 36.5
As 1 mole is the amount of the substance which has mass equal to gram molecular mass.
13. **(c)**
14. **(c)** Mol. of $O_2 = \frac{6}{32}$ & mol. of $SO_2 = \frac{6}{64}$. The number of molecules of SO_2 will be less than that of O_2.
15. **(b)** $N = \frac{N_1V_1 + N_2V_2 + N_3V_3}{\text{Total volume}}$
$= \frac{50\times10+25\times12+40\times5}{1000} = 1N$
16. **(b)** $\underset{1}{K_2Cr_2O_7} + \underset{1}{H_2SO_4} + \underset{3}{3SO_2} \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O$
17. **(d)** Let weight of O_2 in mixture = 1g, and weight of N_2 = 4g
1gm $O_2 = \frac{1}{32} \times 6.023 \times 10^{23}$ molecules
$\therefore$ Ratio of no. of molecules $= \frac{1}{32} : \frac{4}{28} = 7 : 32$
18. **(b)**
19. **(c)** $n = \frac{180}{\text{Molecular mass of } CH_2O} = \frac{180}{30}$
$n = 6$
20. **(b)**

Assertion/ Reason

1. **(c)**
2. **(d)** 1.231 has four significant figures all no. from left to right are counted, starting with the first digit that is not zero for calculating the no. of significant figure.
3. **(b)**
4. **(d)** We know that from the reaction $H_2 + Cl_2 \rightarrow 2HCl$ that the ratio of the volume of gaseous reactants and products is in agreement with their molar ratio.The ratio of $H_2 : Cl_2$: HCl volume is 1: 1: 2 which is the same as their molar ratio. Thus volume of gas is directly related to the number of moles. Therefore, the assertion is false but reason is true.
5. **(c)** Equal moles of different substances contain same number of constituent particles but equal weights of different substances do not contain the same number of consituent particles.
6. **(a)**
7. **(c)** Atoms can be created and can be destroyed.
At N.T.P., number of molecules or atoms contained in same volume remains equal.
8. **(c)** Assertion is true and reason is false.
0.3M H_3PO_3 = 0.6 N H_3PO_3
Eq. wt. of $H_3PO_3 = \frac{\text{mol.wt}}{2}$
[$\because$ Basicity of H_3PO_3 = 2]

Matching Based Questions

1. (a)
2. (b) Terminal zeros are not significant if there is no decimal i.e., 290 contains two significant figures whereas in 29900. there are 5 significant figures; 1.23 × 1.331 = 1.63713 but keeping the mind the 1.23 has only few significant figures i.e., only three significant figures, so result should also be reported in three significant figures only. Thus 1.6373 should be rounded off to 1.64. Value 1.783 is rounded off to 2, so has only one significant figure.
3. (a) 4. (b) 5. (a)
6. (d) A : 28 g of He = $\frac{28}{4}$ 7 mol

B : 46 g of Na = $\frac{46}{23}$ 2 mol

C : 60 g of Ca = $\frac{60}{40}$ 1.5 mol

D : 27 g of Al = $\frac{27}{27}$ 1 mol
7. (c)

Critical Thinking Type Questions

1. (b) For, 0.0 significant figure is zero. For 0.1 to 0.9 significant figure will be 1 whereas from 1.0 to 2.0 significant figures will be 2.
2. (c) Density = $\frac{\text{Mass}}{\text{Volume}}$; 1 gram cm^{-3} = $\frac{1\text{gram}}{\text{cm}^3}$

Volume = $\frac{\text{Mass}}{\text{Density}} = \frac{1\,\text{gram}}{1\,\text{gram}\,\text{cm}^{-3}} = 1\text{cm}^3$

∴ Volume occupied by 1 gram water = 1 cm^3

or Volume occupied by

$\frac{6.023\times10^{23}}{18}$ molecules of water = 1 cm^3

[∴ 1g water = $\frac{1}{18}$ moles of water]

Thus volume occupied by 1 molecule of water

$= \frac{1\times18}{6.023\times10^{23}}\text{cm}^3 = 3.0\times10^{-23}$ cm^3.
3. (a) Mass of 6.023 × 10^{23} atoms of oxygen = 16 g

Mass of one atom of oxygen

$= \frac{16}{6.023\times10^{23}} = 2.66\times10^{-23}\text{g}$

Mass of 6.023 × 10^{23} atoms of nitrogen = 14 g

Mass of one atom of nitrogen

$= \frac{14}{6.023\times10^{23}} = 2.32\times10^{-23}\text{g}$

Mass of 1 × 10^{-10} mole of oxygen

= 16 × 10^{-10}

Mass of 1 mole of copper = 63 g

Mass of 1 mole of oxygen = 16 g

Mass of 1 × 10^{-10} mole of copper

= 63 × 1 × 10^{-10} = 63 × 10^{-10}

So, the order of increasing mass is II < I < III < IV.
4. (c)

	Percentage	R.N.A	Simplest ratio
C	9	$\frac{9}{12} = \frac{3}{4}$	3
H	1	$\frac{1}{1} = 1$	4
N	3.5	$\frac{3.5}{14} = \frac{1}{4}$	1

Empirical formula = C_3H_4N

$(C_3H_4N)_n$ = 108

$(12 \times 3 + 4 \times 1 + 14)_n = 108$

$(54)_n = 108 \Rightarrow n = \frac{108}{54} = 2$

∴ molecular formula = $C_6H_8N_2$
5. (d) $\underset{2(78)}{2C_6H_6} + \underset{15(32)}{15O_2}(g) \rightarrow 12CO_2(g) + 6H_2O(g)$

∵ 156 gm of benzene required oxygen = 15 × 22.4 litre

∴ 1 gm of benzene required oxygen

$= \frac{15\times22.4}{156}$ litre

∴ 39 gm of Benzene required oxygen

$= \frac{15\times22.4\times39}{156} = 84.0$ litre
6. (a) Let 100 g of compound be there.

Number of moles of Nitrogen = $\frac{35}{14}$ = 2.5

Number of moles of Hydrogen = $\frac{5}{1.008}$ = 4.9

Number of moles of Carbon = $\frac{60}{12.01}$ = 4.9

Since 2.5 is the smallest value division by it give ratio

N : H : C

1 : 1.96 : 1.96 = 1 : 2 : 2

Empirical formula = C_2H_2N

Empirical formula weight

= 2 × 12 + 2 + 14 = 40

Molecular mass = 80

Molecular formulae = n (C_2H_2N)

= 2 (C_2H_2N)$\left(n = \frac{80}{40}\right)$ = $C_4H_4N_2$

7. **(a)** $C_{57}H_{110}O_6 + \frac{163}{2}O_2 \rightarrow 57CO_2 + 55H_2O$

890 gram of fat produces 990 gram of H_2O

450 gram fat produces $\left(\frac{990}{890}\times 450\right)$

$= 500.56$ g of H_2O

Moles of $H_2O = \frac{500.56\text{g}}{18\text{g/mol}} = 27.80$

8. **(a)** Molarity (M)

$= \frac{\text{No. of moles of solute}}{\text{Volume of solution in litres}}$

Molarity $\propto n_{solute}$

$n_{NaOH} = \frac{25}{40} = 0.625$; $n_{LiOH} = \frac{25}{24} = 1.04$

$n_{Al(OH)_3} = \frac{25}{(17+3\times17)} = 0.32$

$n_{KOH} = \frac{25}{(39+17)} = 0.45$

$n_{B(OH)_3} = \frac{25}{(11+17\times3)} = 0.403$

Chapter - 2 Structure of Atom

Fill in the Blanks

1. **1.66×10^{-27} kg**
2. **neutrons;**
3. **antiparallel; or opposite**
4. **isobars;**
5. **Heisenberg, de-Broglie;**
6. **photons**
7. **orbitals**
8. **orientation in space**
9. **$4s^1, 3d^5$;**
10. **911.7Å**

True/ False

1. **False** 2. **False** 3. **True** 4. **True**
5. **True** 6. **False** 7. **False** 8. **False**

Conceptual MCQs

1. **(d)**

2. **(a)** $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$ $[n = 6]$

3. **(a)**

4. **(a)** All positive ions are deposited at small part. (nucleus of atom).

5. **(b)** Number of p = number of e^- = 89 and neutrons 231 – 89 = 142.

6. **(c)** Energy of an electron at infinite distance from the nucleus is zero. As an electron approaches the nucleus, the electron attraction increases and hence the energy of electron decreases and thus becomes negative. Thus as the value of n decreases, i.e. lower the orbit is, more negative is the energy of the electron in it.

7. **(c)** Species having same number of electrons are isoelectronic calculating the number of electrons in each species given here, we get.

CN^- (6 + 7 + 1 = 14); N_2 (7 + 7 = 14);
O_2^{2-} (8 + 8 + 2 = 18); C_2^{2-} (6 + 6 + 2 = 14);
O_2^- (8 + 8 + 1 = 17); NO^+ (7 + 8 – 1 = 14)
CO (6 + 8 = 14); NO (7 + 8 = 15)

From the above calculation we find that all the species listed in choice (c) have 14 electrons each so it is the correct answer.

8. **(b)**

9. **(a)** Since, K.E. $= \frac{1}{2}mv^2$ and $\lambda = \frac{h}{mv}$.

$\therefore$ K.E. $= \frac{1}{2}m\frac{h^2}{m^2\lambda^2} = \frac{h^2}{2m\lambda^2}$.

As λ is the same.

$\therefore$ K.E. $\propto \frac{1}{m}$

10. **(b)**

11. **(d)** For Balmer $n_1 = 2$ and $n_2 = 3$; v

$= R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{36}\text{ cm}^{-1}$

12. **(b)** Heisenberg uncertainity principle can be explained by the relation

$\Delta x.\ \Delta P \Rightarrow \frac{h}{4\pi}$

where Δx = uncertainity in position
ΔP = uncertainity in momentum

13. **(d)** $E_1 = \frac{-13.6}{1}$; $E_3 - E_1 = -1.5 - (-13.6)$;

$= 12.1\text{ eV} = 12.1 \times 1.6 \times 10^{-12}$ ergs
$= 0.1936 \times 10^{-10}$ ergs

($1\text{ ev} = 1.6 \times 10^{-12}$ ergs).

14. **(a)** $r_n = \frac{a_0 \times n^2}{Z} = \frac{0.53\text{Å} \times n^2}{Z}$;

For $Li^{++} = \frac{0.53\text{Å}\times(1)^2}{3} = 0.17\text{Å}$

15. **(c)** $\Delta x = \frac{h}{4\pi \times \Delta p} = \frac{6.63\times10^{-34}}{4\times3.14\times10^{-5}}$

$= 5.27 \times 10^{-30}$ m

16. **(c)** For $4p$ electron $n = 4$, $l = 1$, $m = -1, 0 + 1$ and $s = +\frac{1}{2}$ or $-\frac{1}{2}$

17. **(a)** $(n + l)$ rule the higher the value of $(n + l)$, the higher is the energy. When $(n + l)$ value is the same see value of n.

	I	II	III	IV
$(n + l)$	(4 + 1)	(4 + 0)	(3 + 2)	(3 + 1)
	5	4	5	4

$\therefore$ IV < II < III < I

18. **(d)** ${}_7N^{14} + {}_1H^1 \longrightarrow {}_8O^{15} + \gamma$ ($\because$ γ is a neutral particle)

19. **(b)**

	5p	4f	6s	5d
(n + l)	5 + 1	4 + 3	6 + 0	5 + 2
	6	7	6	7

Hence the order is 5p < 6s < 4f < 5d

20. **(c)** Not more than two electrons can be present in same atomic orbital. This is Paulis exclusion principle.

Assertion/ Reason

1. **(d)** The statement-1 is false but the statement-2 is true exact position and exact momentum of an electron can never be determined according to Heisenberg's uncertainty principle. Even not with the help of electron microscope because when electron beam of electron microscope strikes the target electron of atom, the impact causes the change in velocity and position of electron .

2. **(a)** Both assertion and reason are true and reason is the correct explanation of assertion.

Radius, $r_n = \dfrac{n^2h^2}{4\pi e^2 mZ} = \dfrac{n^2}{Z} \times 0.529\text{Å}.r_n$

For first orbit of H-atom

$n = 1$

$r_1 = \dfrac{(1)^2}{1} \times 0.529\text{ Å} = 0.529\text{ Å}$

3. **(a)** **4.** **(b)** **5.** **(c)**

6. **(c)** Energy of a photon = $hv = h.\dfrac{c}{\lambda}$.

So, energy depends upon wavelength.

7. **(c)** The value of n for a line in Balmer series of hydrogen spectrum having the highest wave length will be $n_1 = 2$ and $n_2 = 3$ because this transition will have lowest energy and so highest wavelength.

8. **(d)** Absorption spectrum consists of dark lines separated by bright space and emission spectrum consists of bright lines.

Matching Based Questions

1. **(b)** Isotopes have same atomic number. Isobars have same mass number, whereas isoelectronic species have same number of electrons although the (A) has same number of electrons but the protons they carry are same while in case of isolelectronic species number of protons they carry are different.

2. **(a)** **3.** **(c)** **4.** **(a)**

5. **(a)** For d-subshell $\Rightarrow$ Number of orbitals = 5, $l = 2$

f-subshell $\Rightarrow$ Number of orbitals = 7, $l = 3$

s-subshell $\Rightarrow$ Number of orbitals = 1, $l = 0$

p-subshell $\Rightarrow$ Number of orbitals = 3, $l = 1$

6. **(b)** **7.** **(c)** **8.** **(b)**

Critical Thinking Type Questions

1. **(d)** $E = h\nu$ and $\nu = \left(\dfrac{c}{\lambda}\right)$

$\nu_a = 10^{15}$, $\nu_b = 10^{14}$,

$\nu_c = 10^{17}$, $\nu_d = 0.85 \times 10^{15}$

and $\nu_e = 10 \times 10^{15}$

2. **(d)** From the expression of Bohr's theory, we know that

$$m_e v_1 r_1 = n_1 \frac{h}{2\pi} \;\&\; m_e v_2 r_2 = n_2 \frac{h}{2\pi}$$

$$\frac{m_e v_1 r_1}{m_e v_2 r_2} = \frac{n_1}{n_2}\frac{h}{2\pi} \times \frac{2\pi}{h}$$

Given, $r_1 = 5\, r_2$, $n_1 = 5$, $n_2 = 4$

$$\frac{m_e \times v_1 \times 5r_2}{m_e \times v_2 \times r_2} = \frac{5}{4}$$

$$\Rightarrow \frac{v_1}{v_2} = \frac{5}{4 \times 5} = \frac{1}{4} = 1:4$$

3. **(d)** In S.I. units the $\text{P.E.} = \dfrac{-Ze^2}{4\pi\varepsilon_0 r}$.

For Li^{2+}, Z = 3. $\therefore$ $\text{P.E.} = \dfrac{-3e^2}{4\pi\varepsilon_0 r}$.

4. **(c)** Energy of a photon, $E = \dfrac{hc}{\lambda}$

$$= \frac{6.626 \times 10^{-34}(\text{Js}) \times 3 \times 10^8 (\text{ms}^{-1})}{331.3 \times 10^{-9}(\text{m})}$$

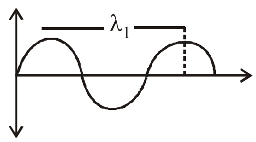
$= 6 \times 10^{-19}$ J

No. of photons emitted per second

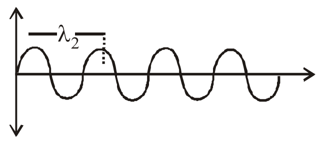
$$= \frac{600\ (\text{J})}{6 \times 10^{-9}(\text{J})} = 10^{21}$$

5. **(c)** e/m waves shown in figure A has higher wavelength in comparison to e/m waves shown in figure B.

Thus these waves also differ in frequency and energy. $\nu = \frac{c}{\lambda}$



(A) $\Rightarrow E_1 = \frac{hc}{\lambda_1}$



(B) $\Rightarrow$ $E_2 = \frac{hc}{\lambda_2}$ $\lambda_1 > \lambda_2 \Rightarrow E_1 < E_2$

6. **(a)** Considering the core of an atom, higher the positive charge concentrated in the nucleus, greater the repulsion for an alpha-particle.

Coulombic force of repulsion $= \frac{kq_1(z_e)}{r^2}$

q_1 = charge on α-particle

(z_e) = charge on nucleus of atom

7. **(d)** Given, $v_A = 0.1\ ms^{-1}$ and $v_B = 0.05\ ms^{-1}$ also, $m_B = 5m_A$

de-Broglie wavelength, $\lambda = \frac{h}{mv}$

$$\therefore \frac{\lambda_A}{\lambda_B} = \frac{h/m_A v_A}{h/m_B v_B} = \frac{m_B v_B}{m_A v_A}$$

$$= \frac{5m_A \times 0.05}{m_A \times 0.1} = 5 \times 0.5 = 2.5 = 5/2$$

$$\therefore \lambda_A : \lambda_B = 5:2$$

8. **(b)** According to Heisenberg uncertainty principle.

$$\Delta x . m \Delta v = \frac{h}{4\pi} \Rightarrow \quad \Delta x = \frac{h}{4\pi m \Delta v}$$

Here $\Delta v = \frac{600 \times 0.005}{100} = 0.03$

So, $\Delta x = \frac{6.6 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31} \times 0.03}$

$= 1.92 \times 10^{-3}$ meter

9. **(c)** Possible values of ℓ and m depend upon the value of n

$\ell = 0$ to $(n - 1)$

$m = -\ell$ to $+\ell$ through zero

$s = +\frac{1}{2}$ and $-\frac{1}{2}$

Thus for $n = 3$,

ℓ may be 0, 1 or 2; but not 3

m may be $-2, -1, 0, +1$ or $+2$

s may be $+\frac{1}{2}$ or $-\frac{1}{2}$

10. **(c)** First four orbitals contain four lobes, while fifth orbital consists of only two lobes. The lobes of d_{xy} orbital lie between x and y axis. Similarly in the case of d_{yz} and d_{zx}, their lobes lie between yz and zx axis respectively. Four lobes of $d_{x^2-y^2}$ orbital are lying along x and y axis while two lobes of d_{z^2} orbital are lying along z-axis.

Chapter - 3 Classification of Elements and Periodicity in Properties

Fill in the Blanks

1.	**Electron affinity**	**2.**	**Electronegativity**
3.	**31**	**4.**	**Boiling point**
5.	**120**	**6.**	**85**
7.	**s-block**	**8.**	**Negative**
9.	**p-block elements**	**10.**	**Group IB**

True/ False

1.	**True**	**2.**	**False**	**3.**	**False**	**4.**	**True**
5.	**True**	**6.**	**False**	**7.**	**False**	**8.**	**False**
9.	**True**	**10.**	**False**	**11.**	**False**	**12.**	**True**
13.	**False**	**14.**	**False**	**15.**	**False**		

Conceptual MCQs

1. **(a)** **2.** **(d)**

3. **(c)** Among the isoelectronic species, size increases with the increase in negative charge. Thus S^{2-} has the highest negative charge and hence largest in size followed by Cl^-, K^+ and Ca^{2+}.

4. **(b)**

5. **(a)** The screening effect follows the order $s > p > d > f$.

6. **(c)**

7. (c) $_{12}Mg$ (160p), $_{15}P$ (110), $_{17}Cl$ (99), $_{20}Ca$ (197) (pm)
$Cl < P < Mg < Ca$

8. (c) 9. (a) 10. (c)

11. (a) IE_1 of Na = – Electron gain enthalpy of Na^+ = – 5.1 Volt.

12. (a) IE_1 is always less than IE_2. 13. (c)

14. (b) The right sequence of $I.E_1$ of Li < B < Be < C.

15. (c) The element A is ns^2np^1 and B is ns^2np^4.
They can form compound of the type A_2B_3

16. (b) It is electronic configuration of alkali metal. Hence it will form basic oxide.

17. (d) There is a sudden jump in the value of IP when there is change of principal energy level.

18. (b)

19. (d) $\underset{\text{Acidic}}{SO_2 > P_2O_3} > \underset{\text{Weak acidic}}{SiO_2} > \underset{\text{Amphoteric}}{Al_2O_3}$

20. (b) The alkali metals are highly reactive because their first ionisation potential is very low and hence they have great tendency to lose electrons to form unipositive ions. On moving down a group from Li to Cs ionisation enthalpy decreases hence the reactivity increases.
The halogens are most reactive elements due to their low bond dissociation energy, high electron affinity and high enthalpy of hydration of halide ion however their reactivity decreases with increase in atomic number. As the size increases, the attraction for an additional electron by the nucleus becomes less. Thus reactivity decreases.

Assertion/ Reason

1. (d) In a triad, the atomic mass of the middle element is the mean of the atomic masses of the first and third elements.

2. (d) According to Mendeleev, periodic properties of elements is a function of their atomic masses.

3. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

4. (c) Number of elements in each period is twice the number of atomic orbitals available in the energy level that is being filled.

5. (c) He ($1s^2$) should be placed along with s-block elements because of its electronic configuration but it has a completely filled valence shell and as a result it exhibits properties of noble gases, thus it is placed along with noble gases (ns^2, np^6).

6. (b) Both the statements are correct but assertion is not correct explanation for reason.

7. (c) Atomic size generally decreases along a period.

8. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
It is difficult to remove an electron from a positively charged ion than a neutral atom.

9. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
Alkali metals belong to first group and have largest size in a period and hence low I.E.

Matching Based Questions

1. (d) A. 1800 → 31 elements were known
B. 1865 → 63 elements
C. At present → 118

2. (b) 3. (d) 4. (b) 5. (a)

6. (b) 7. (d) 8. (d) 9. (c)

10. (d) Helium (He) $1s^2$ → Highest ionisation energy due to noble gas in nature.
Fluorine (F) $1s^2$, $2s^22p^3$ → High electronegativity in nature due to small size and –1 oxidation state.
Rubidium (Rb) → Most electronegative element due to large atomic size.
Lithium (Li) → Strongest reducing agent due to small size and positive oxidation state (+1)

Critical Thinking Type Questions

1. (d) Oxides of Eka-Aluminium = Ga_2O_3
Oxides of Eka-Silicon = SiO_2
Melting point of Eka-Aluminium = Low (302 K)
Melting point of Eka-Silicon = High (1231 K)

2. (a) Iodine with lower atomic weight than that of tellurium (Group VI) was placed in Group VII along with fluorine, chlorine, bromine because of similarities in properties.

3. (b) These are characteristic properties of *d*-block elements.

4. (c)
5. (c) In a period the value of ionisation potential increases from left to right with breaks where the atoms have some what stable configuration. In this case N has half filled stable orbitals. Hence has highest ionisation energy. Thus the correct order is

$$B < C < O < N$$

and not as given in option (c)

Chapter - 4 Chemical Bonding and Molecular Structure

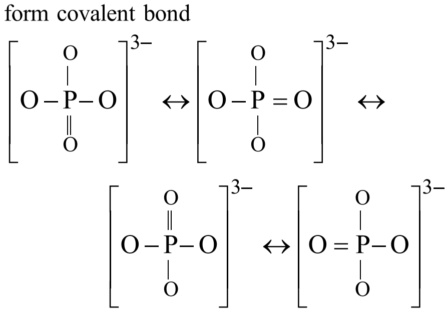
Fill in the Blanks

1. CO_2
2. $H-\underset{\underset{O}{\|}}{C}-OH$ and $CH_3-\overset{\overset{O}{\|}}{C}-OH$
3. 2 4. sp^3
5. Planar 6. banana bond;
7. Increases, decreases;
8. Low ionization enthalpy and electron gain enthalpy
9. Covalent radius
10. Increase, bond enthalpy, bond length, Bond order $\propto$ Bond enthalpy $\propto \dfrac{1}{\text{Bond length}}$

True/ False

1.	True	2.	False	3.	True	4.	False
5.	False	6.	False	7.	False	8.	False
9.	False	10.	False				

Conceptual MCQs

1. (c) At bond distance the attractive forces overweigh the repulsive forces.
2. (b) Hydrogen is non metal and non metal atoms form covalent bond
3. (c) 

Bond order

$$= \frac{\text{Number of bonds}}{\text{Number of Resonating structures}}$$

$$= \frac{5}{4} = 1.25$$

Three unit negative charge is being shared by four O atoms. Formal charge = –3/4

4. (b) $(O_2) = \sigma 1s^2\, \sigma^* 1s^2\, \sigma 2s^2 \sigma^* 2s^2\, \sigma 2p_z^2\, \pi 2p_x^2$

$$= \pi 2p_y^2\, \pi^* 2p_x^1 = \pi^* 2p_y^1$$

Bond order $= \dfrac{N_b - N_a}{2} = \dfrac{10-6}{2} = \dfrac{4}{2} = 2$

$\left(O_2^+ \text{ion}\right) = \sigma 1s^2\, \sigma^* 1s^2\, \sigma 2s^2\, \sigma^* 2s^2$

$\sigma 2p_z^2\, \pi 2p_x^2\; = \pi 2p_y^2\, \pi^* 2p_x^1$

Bond order $\dfrac{N_b - N_a}{2} = \dfrac{10-5}{2} = \dfrac{5}{2} = 2\dfrac{1}{2}$

$\left(O_2^-\right) = \sigma 1s^2\, \sigma^* 1s^2\, \sigma 2s^2\, \sigma^* 2s^2\, \sigma 2p_z^2$

$\pi 2p_x^2 = \pi 2p_y^2\, \pi^* 2p_x^2\, \pi^* 2p_y^1$

Bond order $= \dfrac{(N_b - N_a)}{2} = \dfrac{10-7}{2} = \dfrac{3}{2} = 1\dfrac{1}{2}$

$\left(O_2^{2-}\right) = \sigma 1s^2 \sigma^* 1s^2\, \sigma 2s^2\, \sigma^* 2s^2 \sigma 2p_z^2\, \pi 2p_x^2$

$$= \pi 2p_y^2\, \pi^* 2p_x^2 = \pi^* 2p_y^2$$

Bond order $\dfrac{N_b - N_a}{2} = \dfrac{10-8}{2} = \dfrac{2}{2} = 1$

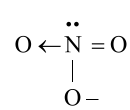
5. (b) B.O. $= \dfrac{1}{2}[N_b - N_a]$ $Li_2 = \dfrac{4-2}{2} = 1$; $N_2 = 3$; Be = 0, O_2= 2.
6. (a) O_2 = KK $(\sigma\ 2s)^2\ (\sigma^*\ 2s)^2\ (\sigma\ 2p_z)^2$ $(\pi\ 2p_x)^2\ (\pi\ 2p_y)^2\ (\pi^*\ 2p_x)^1\ (\pi^*\ 2p_y)^1$

O_2^- = KK $(\sigma\ 2s)^2\ (\sigma^*\ 2s)^2\ (\sigma\ 2p_z)^2$ $(\pi\ 2p_x)^2\ (\pi\ 2p_y)^2\ (\pi^*\ 2p_x)^2\ (\pi^*\ 2p_y)^1$

7. (c)

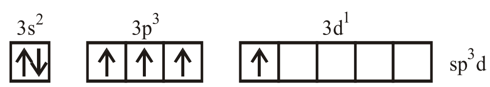
Species	N_2	O_2	N_2^-	O_2^-
Bond order	3	2	2.5	1.5

The O-O bond order in O_2^- decreases

8. (a) 

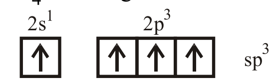
$\therefore$ 3 bp and 1 lp

9. (a) SF_4 – Configuration of excited S atom :



shape-square pyramidal, one lone pair

CF_4 – Configuration of excited C-atom :



shape-tetrahedral; no lone pair

XeF_4 – have square planar geometry with 2 lone pairs.

10. **(a)**

11. **(c)** Statement 1 is correct.

12. **(a)** **13.** **(c)** **14.** **(b)**

15. **(d)** BF_4^- hybridisation sp^3, tetrahedral structure.

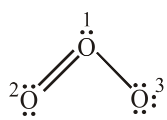
NH_4^+ hybridisation sp^3, tetrahedral structure.

16. (a) Both XeF_2 and CO_2 have a linear structure.

17. (a) **18.** (d) **19.** (b) **20.** (b)

Assertion/ Reason

1. **(a)**

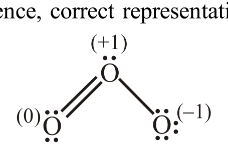


Formal charge on $O_1 = 6 - 2 - \frac{1}{2}(6) = +1$

Formal charge on $O_2 = 6 - 4 - \frac{1}{2}(4) = 0$

Formal charge on $O_3 = 6 - 6 - \frac{1}{2} \times 3 = -1$

Hence, correct representation of O_3 is



2. **(a)** Atoms combine either by transfer of valence electrons from one atom to another or by sharing of valence electrons to have an octet in their valence shell.

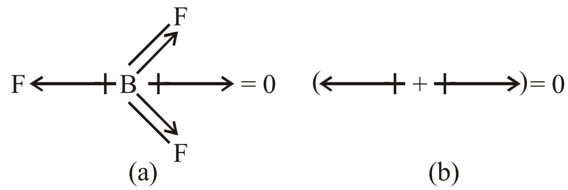
3. **(d)** Assertion is false but reason is true.

The greater the lattice enthalpy, more stable is the ionic compound.

4. **(c)** Sulphur forms many compounds in which the octet rule is obeyed. For example SCl_2 has an octet of electrons around it.

5. **(b)** Both assertion and reason are true but reason is not the correct explanation of assertion.

BF_3 is sp^2 hybridized. Dipole moment is a vector quantity. The three bond moments give a net sum of zero, as the resultant of any two is equal and opposite to the third.



6. **(d)** Assertion is false but reason is true.

CH_2Cl_2 is polar while CCl_4 is non-polar because in CCl_4 net dipole moment cancels.

7. **(a)** While the lone pairs are localised on the central atom, each bonded pair is shared between two atoms. As a result, the lone pair electrons in a molecule occupy more space as compared to the bonding pairs of electrons. This results in greater repulsion between lone pairs of electrons as compared to the lone pair -bond pair and bond pair - bond pair repulsions.

8. **(a)** Both assertion and reason are true and reason is the correct explanation of assertion.

lone pair – lone pair repulsion > lone pair – bond pair repulsion > bond pair – bond pair repulsion. In the ammonia molecule, NH_3 there are three bond pairs and one lone pair. The three N – H bond pairs are pushed closer because of the lone pair – bond pair repulsion, and HNH bond angle gets reduced from 109°23' (the tetrahedral angle) to 107°.

9. **(d)** Assertion is false but reason is true.

NH_3 molecule is pyramidal is shape, because out of four electron pairs, three are bonding pairs and one is lone pair.

10. **(a)** Both assertion and reason are true and reason is the correct explanation of assertion.

pi bonds are formed by the overlapping of p-p orbitals perpendicular to their axis i.e., sidewise overlap.

11. **(a)** Both assertion and reason are true and reason is the correct explanation of assertion.

Helium molecule is formed by linking two helium atoms. Both have 1s orbitals. These will combine to form two molecular orbitals σ (1s) and σ^* (1s). Four available electrons are accommodated as $\sigma (1s)^2$ and $\sigma^* (1s)^2$.

12. **(c)** The electron density in a bonding molecular orbital is located between the nuclei of the bonded atoms because of which the repulsion between the nuclei is very less while in case of an antibonding molecular orbital, most of the electron density is located away from the space between the nuclei.

Electrons placed in a bonding molecular orbital tend to hold the nuclei together and stabilise a molecule.

Matching Based Questions

1. (c) BeH_2 : Incomplete octet of central atom. Be has 2 valence electrons
SF_6 : Expanded octet
There are 12 electrons around the S atom in SF_6
NO_2 : Odd electron molecules.
In molecules with an odd number of electrons like NO_2, the octet rule is not satisfied.
2. (c)
3. (b) $NH_3 \rightarrow$ 1lp, 3bp $\rightarrow$ Trigonal pyramidal
$SO_2 \rightarrow$ 1lp, 2bp $\rightarrow$ Bent
$SF_4 \rightarrow$ 1lp, 4bp $\rightarrow$ See-saw
$ClF_3 \rightarrow$ 2lp, 3bp $\rightarrow$ T-shape
4. (c) Trigonal planar = BF_3; Tetrahedral = NH_4^+
Trigonal bipyramidal = PCl_5; Octahedral = SF_6
5. (c)
6. (a) $SF_6 \Rightarrow sp^3d^2$; $PF_5 \Rightarrow sp^3d$
$BCl_3 \Rightarrow sp^2$; $C_2H_6 \Rightarrow sp^3$
7. (c) Valence bond theory = Heitler and London
Octet rule = Kössel and Lewis
Molecular orbital theory = F. Hund and R.S. Mulliken
VSEPR theory = Nyholm and Gillespie
8. (b)

Critical Thinking Type Questions

1. (b) Covalent radius is half of the distance between atoms in bonding state, while van der Waal radius is half of the distance between atoms in its non bonding state.
2. (c) M.O. electronic configuration of CN^- is $\sigma 1s^2 \sigma^*1s^2\ \sigma 2s^2\ \sigma^*2s^2\pi 2p_x^2\ \pi 2p_y^2\ \sigma 2p_z^2$
$\therefore$ B.O. $= \frac{10-4}{2} = 3$
M.O. electronic configuration of O_2^- is
$\sigma 1s^2\ \sigma^*1s^2\sigma 2s^2\sigma^*2s^2\sigma 2p_z^2\pi 2p_x^2\ \pi 2p_y^2\ \pi^*2p_x^2\pi^*2p_y^1$
$\therefore$ B.O. $= \frac{10-7}{2} = 1.5$
M.O. electronic configuration of CN^+
$\sigma 1s^2\ \sigma^*1s^2\ \sigma 2s^2\ \sigma^*2s^2\pi 2p_x^2\ \pi 2p_y^2\ \sigma 2p_z^1$
$\therefore$ B.O. $= \frac{9-4}{2} = 2.5$
M.O. electronic configuration of NO^+ is
$\sigma 1s^2\ \sigma^*1s^2\ \sigma 2s^2\ \sigma^*2s^2\sigma 2p_z^2\ \pi 2p_x^2\ \pi 2p_y^2$
$\therefore$ B.O. $= \frac{10-4}{2} = 2$
$\therefore$ CN^- and NO^+ have bond order equal to 3
3. (c) B, C and D form intermolecular hydrogen bonding while A form intramolecular hydrogen bonding due to proximity of oxygen and hydrogen.
4. (a) XeF_4 having one lone pair of electron show distorted pentagonal bipyramidal shape and sp^3d^3 hybridisation.
5. (c) (a) $\underset{sp^2}{CH_2} = \underset{sp}{C} = \underset{sp^2}{CH_2}$
(b) $\underset{sp^3}{CH_3} - \underset{sp^2}{CH} = \underset{sp^2}{CH} - \underset{sp^2}{CH_2^+}$
(c) $\underset{sp^3}{CH_3} - \underset{sp}{C} \equiv \underset{sp}{C} - \underset{sp^2}{CH_2^+}$
(d) $\underset{sp^3}{CH_3} - \underset{sp^2}{CH} = \underset{sp^2}{CH} - \underset{sp^3}{CH_2^-}$
Note : Carbocations and carboanions are sp^2 and sp^3 hybridised respectively.

Chapter - 5 States of Matter

Fill in the Blanks

1. **R.** $[\because C_p - C_v = R]$
2. **Inversely, time;** $\left[\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \frac{t_2}{t_1} = \sqrt{\frac{M_2}{M_1}}\right]$.
3. **0.25**
4. **Robert Boyle**
5. **Absolute Zero**
6. **22.71098 L mol^{-1}**
7. **Aqueous Tension**
8. **Stop and settle down**
9. **Positive deviation and greater**
10. **Normal boiling point and standard boiling point**

True/ False

1. False	2. False	3. False	4. False
5. True	6. False	7. True	8. True
9. False	10. True	11. False	12. True

Conceptual MCQs

1. (c) 2. (c)
3. (a) Given
$P_1 = 1.5$ bar $T_1 = 273 + 15 = 288$ K $V_1 = V$
$P_2 = 1.0$ bar $T_1 = 273 + 25 = 298$K $V_2 = ?$
$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$; $\frac{1.5 \times V}{288} = \frac{1 \times V_2}{298}$
$V_2 = 1.55$ V i.e., volume of bubble will be almost 1.6 time to initial volume of bubble.
4. (b) Hot air is lighter due to less density (Charle's law) $\left(d = \frac{MP}{RT}\right)$.

5. **(b)** When P, V and T are same no. of particles will also be the same (Avogadro's law).

6. **(b)** $r \propto \sqrt{\frac{1}{M}} \Rightarrow \frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$

$\frac{3r_1}{r_1} = \sqrt{\frac{M_2}{4}} \Rightarrow 9 = \frac{M_2}{4}$

$M_2 = 36$ g/mole

7. **(b)** Charle's law $V \propto T$ at constant P.

8. **(N)** None

Molar mass $\uparrow$, 'a' increases

size of molecule $\uparrow$, 'b' increase

b(L/mol)	a(bar. L^2/mol^2)
$H_2 \rightarrow 0.02661$	$CH_4 \rightarrow 2.25$
$He \rightarrow 0.0237$	$O_2 \rightarrow 1.36$
$O_2 \rightarrow 0.03183$	$H_2 \rightarrow 0.244$
$CO_2 \rightarrow 0.04267$	

9. **(d)** $PV = \frac{1}{3}mnu^2 = \frac{1}{3} \times mu^2 = \frac{2}{3}KE = \frac{2}{3}KT$.

The product PV will have constant value at constant temperature. This is Boyle's law.

10. **(c)**

11. **(a)** At the same temperature KE is the same, as $KE \propto T$.

12. **(a)** Since for H_2 and He, $PV > nRT$ and

$z = \frac{PV}{nRT}$ Hence z is more than 1.

13. **(c)** $\frac{U_{H_2}}{U_{N_2}} = \sqrt{\frac{T_{H_2} \times 28}{T_{N_2} \times 2}} = \sqrt{7} \Rightarrow \frac{T_{H_2}}{T_{N_2}} = \frac{1}{2}$

$\Rightarrow T_{N_2} = 2T_{H_2} \quad \therefore T_{N_2} > T_{H_2}$

14. **(b)** Boyle's temperature,

$T_B = \frac{a}{Rb}$ and critical temperature,

$T_C = \frac{8a}{27Rb} \therefore \frac{T_B}{T_C} = \frac{27}{8}$

15. **(d)** **16.** **(a)**

17. **(d)** Suppose the solutions given are A and B respectively. Let the pressure and volume of A are P_1 and V_1 while that of B is P_2 and V_2. Total volume of the mixture is $(V_1 + V_2)$. In the mixture partial pressure of A and B are p_A and p_B respectively. Because temperature is constant then according to Boyle's law.

$p_A(V_1 + V_2) = P_1V_1$

Similarly, $p_B = \frac{P_2V_2}{(V_1 + V_2)}$

Then, $P_T = p_A + p_B = \frac{P_1V_1}{(V_1+V_2)} + \frac{P_2V_2}{(V_1+V_2)}$

$P_T = \frac{P_1V_1 + P_2V_2}{V_1 + V_2}$

Given $P_1 = P_2 = P$ and $V_1 = V_2 = V$

$P_T = \frac{2PV}{2V} = P$

18. **(c)**

19. **(b)** Liquid drops assume spherical shape because a sphere has minimum surface area.

20. **(a)** If n is the total number of moles of gas and n_1 moles are in the larger shpere and n_2 moles in the smaller shpere.

Then $n = n_1 + n_2$ and $pV = nRT$

$\frac{pV}{RT_1} = \frac{p'V}{RT_1} + \frac{p'V}{2RT_2}$

$p' = \frac{2pT_2}{2T_2 + T_1}$

Assertion/ Reason

1. **(a)**

2. **(a)** Gases expand and occupy all the space available to them because there is no force of attraction between the particles of a gas at ordinary temperature and pressure.

3. **(a)** **4.** **(a)**

5. **(c)** At high altitude atmospheric pressure is low.

6. **(d)**

Matching Based Questions

1. **(a)** **2.** **(b)** **3.** **(a)** **4.** **(b)**

5. **(c)**

Critical Thinking Type Questions

1. **(d)** Given, $P_1 = 15$ atm, $P_2 = 60$ atm

$V_1 = 76\ cm^3$, $V_2 = 20.5\ cm^3$.

If the gas is an ideal gas, then according to Boyle's law, it must follow the equation,

$P_1V_1 = P_2V_2$

$P_1 \times V_1 = 15 \times 76 = 1140$

$P_2 \times V_2 = 60 \times 20.5 = 1230$

$\therefore P_1V_1 \neq P_2V_2$

$\therefore$ The gas behaves non-ideally.

The given information is not sufficient to comment on other statements.

2. (d) All the gases occupy the available volume and will form homogeneous mixture.

3. (a) Since atmospheric pressure remain constant

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \Rightarrow \frac{V_1}{298K} = \frac{2800m^3}{372K}; V_1 = 2243\ m^3$$

2800 m^3 volume of inflated balloon.

Mass of air in inflated ballon

$= 2800\ m^3 \times 0.94\ kg\ m^{-3} = 2632$ kg

Keeping the volume same = 2800 m^3

The mass of air, which occupies it with density (1.2 kg/m^3) is $2800 \times 1.2 = 3360$ kg

Amount of air which had been escaped

$= 3360 - 2632 = 728$ kg

4. (c)

5. (d) By Ideal gas equation

$P_1V = n_1RT$

$n_1 \propto P_1$ and $n_2 \propto P_2$

$$\frac{n_1}{n_2} = \frac{P_1}{P_2} \Rightarrow \frac{n_1}{n_2} = \frac{170}{570} = 0.30$$

6. (c) Moles of A, $(n_A) = \frac{p_A v_A}{RT} = \frac{8 \times 12}{RT} = \frac{96}{RT}$

Moles of B, $(n_B) = \frac{p_B v_B}{RT} = \frac{8 \times 5}{RT} = \frac{40}{RT}$

Total pressure × total volume

$= (n_A + n_B) \times RT$

$$p \times (12+8) = \frac{1}{RT}(96+40)RT$$

$$p = 6.8$$

Partial pressure of A = p × mole fraction of A

$$= 6.8\left(\frac{96}{RT}\bigg/\frac{96+40}{RT}\right) = 4.8 \text{ atm}$$

Partial pressure of B = 6.8 – 4.8 = 2 atm.

7. (c) Due to small size of these species (H_2 and He) intermolecular interactions (van der Waal forces) are very low, therefore it is difficult to compress these.

Chapter - 6 Thermodynamics

Fill in the Blanks

1.	**isolated**	**2.**	**endothermic**
3.	**extensive**	**4.**	**System, surroundings**
5.	**Internal energy**	**6.**	**Positive, negative**
7.	**–608 J**	**8.**	**Positive, endothermic**
9.	**14.275 K**	**10.**	**Spontaneously**

True/ False

1.	**True**	**2.**	**False**	**3.**	**True**	**4.**	**True**
5.	**True**	**6.**	**True**	**7.**	**True**	**8.**	**False**
9.	**True**						

Conceptual MCQs

1. (d) $H_2O_{(\ell)} \xrightleftharpoons{1atm} H_2O_{(g)}$

$\Delta H = 40630\ J\ mol^{-1}$; $\Delta S = 108.8\ JK^{-1}\ mol^{-1}$

$\Delta S = 108.8\ JK^{-1}\ mol^{-1}$

$\Delta G = \Delta H - T\Delta S$ When $\Delta G = 0$,

$\Delta H - T\Delta S = 0$

$$T = \frac{\Delta H}{\Delta S} = \frac{40630\ J\ mol^{-1}}{108.8\ J\ mol^{-1}} = 373.4\ K.$$

$\therefore$ Correct choice : (d)

2. (d) $\frac{C_P}{C_V} = \frac{\frac{5}{2}R}{\frac{3}{2}R} = \frac{5}{3} = 1.67$

3. (a) Since, in the first reaction gaseous products are forming from solid carbon hence entropy will increase i.e. Δs = +ve.

C (gr.) + $\frac{1}{2}$ $O_2(g) \rightarrow CO(g)$; $\Delta S°$ = + ve

Since, $\Delta G° = \Delta H° - T\Delta S$ hence the value of ΔG decrease on increasing temperature.

4. (a)

5. (c) **Justification :** free expansion w = 0

adiabatic process q = 0

$\Delta U = q + w = 0$, this means that internal energy remains constant. Therefore,

$\Delta T = 0$.

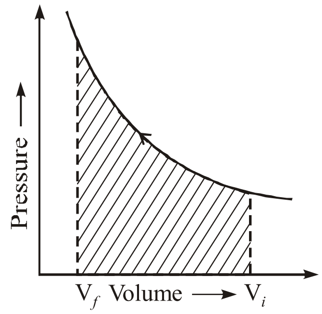
6. (d) It violate 2nd law of thermodynamics, not 1st.

7. (c) In a reversible process the work done is greater than in irreversible process. Hence the heat absorbed in reversible process would be greater than in the latter case. So,

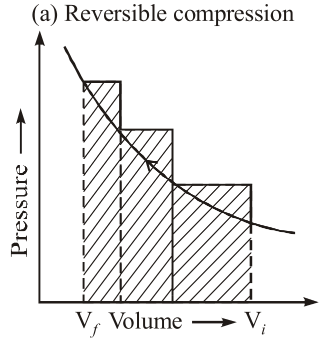
T_f(rev.) < T_f (irr.)

8. (b) w(reversible) < w(irreversible)

Justification : Area under the curve is always more in irreversible compression as can be seen from Fig. (a) and (b).



(a) Reversible compression



(b) Irreversible compression

9. **(b)** $\Delta n = -\frac{1}{2}$; $\Delta H = \Delta E - \frac{1}{2}RT$; $\Rightarrow \Delta E > \Delta H$

10. **(a)** Volume depends upon mass. Hence it is extensive property.

11. **(b)** $\Delta H = \Delta E + P\Delta V$, for solid and liquid, $\Delta V = 0$ or $\Delta H = \Delta E + \Delta n\, RT$, for solids and liquids $\Delta n = 0$.

12. **(d)** Entropy change at constant temperature

$= 2.303 nR \log\frac{V_2}{V_1}$

$= 2.303 \times 2 \times 2 \log\frac{20}{2} = 9.2 \text{ cal } K^{-1} mol^{-1}$

13. **(c)** **14.** **(c)**

15. **(a)** $I_2(s) + Cl_2(g) \longrightarrow 2ICl(g)$

$\Delta H = [\Delta H_{I_2(s) \longrightarrow I_2(g)} + \Delta H_{I-I} + \Delta H_{Cl-Cl}]$
$- [\Delta H_{I-Cl}]$

$= 151.0 + 242.3 + 62.76 - 2 \times 211.3 = 33.46$

$\Delta H^o_{f\,(ICl)} = \frac{33.46}{2} = 16.73 \text{ kJ/mol}$

16. **(c)** The energy involved in the conversion of $\frac{1}{2}Cl_2(g)$ to Cl^{-1} (aq) is given by

$\Delta H = \frac{1}{2}\Delta_{diss}H^{(-)}_{Cl_2} + \Delta_{eg}H^{(-)}_{Cl} + \Delta_{hyl}H^{(-)}_{Cl}$

Substituting various values from given data, we get

$\Delta H = \left(\frac{1}{2} \times 240\right) + (-349) + (-381) \text{ kJmol}^{-1}$

$= (120 - 349 - 381) \text{ kJ mol}^{-1}$

$= -610 \text{ kJ mol}^{-1}$

17. **(b)** Spontaneity of reaction depends on tendency to acquire minimum energy state and maximum randomness. For a spontaneous process in an isolated system the change in entropy is positive.

18. **(c)**

19. **(b)** Enthalpy of reaction

$= B.E_{(Reactant)} - B.E_{(Product)}$

$= \left[B.E_{(C=C)} + 4B.E._{(C-H)} + B.E._{(H-H)}\right]$
$- \left[B.E._{(C-C)} + 6B.E._{(C-H)}\right]$

$= [606.1 + (4 \times 410.5) + 431.37)]$
$- [336.49 + (6 \times 410.5)]$

$= -120.0 \text{ kJ mol}^{-1}$

20. **(c)** $\Delta S = \frac{\Delta H}{T} = \frac{1.435 \times 10^3}{273} = 5.260$ cal / mol K

Assertion/ Reason

1. **(c)** Values of state functions depend only on the state of the system and not on how it is reached.

2. **(a)** $Q = -W$ if $\Delta E = 0$

3. **(b)** In an isothermal process change in internal energy (ΔE) is zero (as it is a function of temperature).
∴ According to first law of thermodynamics
∵ $Q + W = \Delta E$. Hence $Q = -W$ (if $\Delta E = 0$)
If a system undergoes a change in which internal energy of the system remains constant (i.e. $\Delta E = 0$) then $-W = Q$. This means that work done by the system equals the heat absorbed by the system.

4. **(a)** It is fact that absolute values of internal energy of substances cannot be determined. It is also true that it is not possible to determine exact values of constitutent energies of a substance.

5. **(c)** It may involve increase or decrease in temperature of the system. Systems in which such processes occur, are thermally insulated from the surroundings.

6. **(a)** As internal energy is a state function so its value depends on intial and final states of the system. In case of cyclic system initial and final states are same. So $\Delta E = 0$, and similarly $\Delta H = 0$.

7. **(a)** The properties whose magnitude depends upon the quantity of matter present in the system are called extensive properties eg, internal energy.

8. **(b)** The mass and volume depend upon the quantity of matter so these are extensive properties while ratio of mass to its volume does not depend upon the quantity of matter so this ratio is an extensive property.

9. **(a)** In case of electric fan electrical energy is converted into mechanical energy and in case of heater, electrical energy is converted into heat energy. Therefore, these follow the first law of thermodynamics.

10. **(c)** The value of enthalpy of neutralisation of weak acid by strong base is less than 57.1 kJ. This is due to the reason that the part of energy liberated during combination of H^+ and OH^+ ions is utilised in the ionisation of weak acid.

11. **(d)** When a solid melts, increase in enthalpy is observed.

12. **(b)** The factor $T\Delta S$ increases with increase in temperature.

Matching Based Questions

1. **(b)** **2.** **(c)**

3. **(a)** A – (p), B – (s), C – (r), D – (q)

Expansion of a gas in vacuum ($p_{ext} = 0$) is called free expansion.

For isothermal irreversible change

$q = -W = p_{ext}(V_f - V_i)$

for isothermal reversible change

$q = -W = nRT \ln (V_f/V_i)$

$= 2.303\ nRT \log V_f/V_i$

For adiabatic change, $q = 0$, $\Delta U = W_{ad}$

4. **(b)** (A) $\Delta n_g = 2 - 2 = 0$ hence $\Delta H = \Delta U$

(B) $\Delta n_g = 2 - 1 = 1$ hence $\Delta H = \Delta U + RT$

(C) $\Delta n_g = 2 - 4 = -2$ hence $\Delta H = \Delta U - 2RT$

(D) $\Delta n_g = 5 - 2 = 3$ hence $\Delta H = \Delta U + 3RT$

5. **(c)** **6.** **(d)** **7.** **(b)**

Critical Thinking Type Questions

1. **(d)** Mathematical expression of first law of thermodynamics

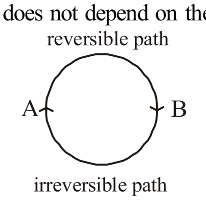
$\Delta E = q + w$, ΔE is a state function.

2. **(a)** $q = -W = 2.303 nRT \log \dfrac{V_2}{V_1}$

3. **(a)** Process is isothermal reversible expansion, hence $\Delta U = 0$, therefore $q = -W$.

Since $q = +208$ J, $W = -208$ J

4. **(c)** For a cyclic process the net change in the internal energy is zero because the change in internal energy does not depend on the path.



5. **(a)** $-W_{irreversible} = P_{ext}(V_2 - V_1)$

$= 10$ atm (2L – 1L)

$= 10$ atm – L

$$-W_{reversible} = \int_{V_1}^{V_2} P_{ex} dv = 2.303\ nRT \log \frac{V_2}{V_1}$$

$$= 1 \times 2.303 \times 0.0821 \text{ atm–L /K /mol} \times \log \frac{2}{1}$$

$= 16.96$ atm–L

$$\frac{W_{reversible}}{W_{irreversible}} = \frac{16.96}{10.00} = 1.69 \approx 1.7$$

6. **(d)** $4NO_2(g) + O_2(g) \rightarrow 2N_2O_5(g),\ \Delta_r H = -111$ kJ

$\Delta H'$ (to $2N_2O_5(s)$); $2N_2O_5(g) \xrightarrow{-54 \text{ kJ}} 2N_2O_5(s)$

$-111 - 54 = \Delta H' \Rightarrow \Delta H' = -165$ kJ

7. **(c)** Applying Hess's Law

$$\Delta_f H° = \Delta_{sub} H + \frac{1}{2}\Delta_{diss} H + \text{I.E.} + \text{E.A} + \Delta_{lattice} H$$

$$-617 = 161 + 520 + 77 + \text{E.A.} + (-1047)$$

E.A. $= -617 + 289 = -328$ kJ mol^{-1}

$\therefore$ electron affinity of fluorine $= -328$ kJ mol^{-1}

8. **(a)** $C_2H_5OH(\ell) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(\ell)$

Bomb calorimeter gives ΔU of the reaction

Given, $\Delta U = -1364.47$ kJ mol^{-1}; $\Delta n_g = -1$

$\Delta H = \Delta U + \Delta n_g RT$

$$= -1364.47 - \frac{1 \times 8.314 \times 298}{1000} = -1366.93 \text{ kJ mol}^{-1}$$

9. **(b)** For the equation

$B_2H_6(g) + 3O_2(g) \longrightarrow B_2O_3(g) + 3H_2O(g)$

Eqs. (i) + 3 (ii) + 3 (iii) – (iv)

$\Delta H = -1273 + 3(-286) + 3(44) - 36$

$= -1273 - 858 + 132 - 36 = -2035$ kJ/mol

10. **(a)** $I_2(s) + Cl_2(g) \longrightarrow 2ICl(g)$

$\Delta_r H = [\Delta H(I_2(s) \rightarrow I_2(g)) + \Delta H_{I-I} + \Delta H_{Cl-Cl}] - [\Delta H_{I-Cl}]$

$= 151.0 + 242.3 + 62.76 - 2 \times 211.3 = 33.46$

$_f H$ (ICl) $\dfrac{33.46}{2}$ 16.73 kJ/mol

11. **(a)** For spontaneous reaction, $dS > 0$ and dG should be negative i.e. < 0.

Chapter - 7 Equilibrium

Fill in the Blanks

1. SO_4^{2-} **2.** **amphoteric**

3. $k_p = k_c (RT)^{\Delta n}$; **4.** **no change**

5. I_2 **6.** 10^{-3} **to** 10^3

7. **Higher and lower** **8.** **decreases**

9. 6 10. $4\sqrt{\frac{1.6\times10^{-30}}{27}}$

True/ False

1. False 2. False 3. True 4. False
5. True 6. False 7. True 8. True
9. True 10. True 11. False 12. True
13. True, 14. True

Conceptual MCQs

1. (c)
2. (c) $A + B \rightleftharpoons C + D$

x x 2x 2x

At eqb.

$K_c = \frac{2x.2x}{x.x} = 4$

3. (d) $(CH_3)_3$ B - is an electron deficient, thus behave as a lewis acid.
4. (d) $2C_{(s)} + O_{2(g)} \rightleftharpoons 2CO_{2(g)}$; $\Delta n = 2 - 1 = +1$

$\therefore$ K_c and K_p are not equal.

5. (c) $K_p = \frac{P^2co}{Pco_2}; K_p = \frac{4\times4}{2} = 8$; C(s) = 1;

The concentration of solids and liquids are taken as unity.

6. (b) $Q > K_c$ will make the reaction to proceed from right to left.
7. (a) $\Delta G^0 = -2.303\ RT \log K$

$-4.606 \times 10^3 = -2.303 \times 2 \times 500 \log K_c$

$\therefore K_c = 100.$

8. (a) Lets take an example of an acidic buffer CH_3COOH and CH_3COONa.

$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$;

$CH_3COONa \rightleftharpoons CH_3COO^- + Na^+$

when few drops of HCl are added to this buffer, the H^+ of HCl immediatly combine with CH_3COO^- ions to form undissociated acetic acid molecules. Thus there will be no appreciable change in its pH value. Like wise if few drops of NaOH are added, the OH^- ions will combine with H^+ ions to form unionised water molecule. Thus pH of solution will remain constant.

9. (d) 10. (b)
11. (b) $3Fe(s) + 4H_2O\ (steam) \rightleftharpoons Fe_3O_4\ (s) + 4\ H_2\ (g)$

$K_p = \frac{(p_{H_2})^4}{(p_{H_2O})^4}$ only gaseous products and reactants.

12. (c) $H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$

$HCO_3^- \longrightarrow H^+ + CO_3^-$

$HCO_3^- + H^+ \longrightarrow H_2CO_3$

HCO_3^- can donate and accept H^+.

13. (d) $[Cu(H_2O)_4]^{2+} + 4NH_3 \rightleftharpoons [Cu(NH_3)_4]^{2+} + 4H_2O$

involves lose and gain of electrons. H_2O is coordinated to Cu by donating electrons (LHS). It is then removed by withdrawing electrons.

14. (d) 15. (a)
16. (d) In aqueous solution BA(salt) hydrolyses to give

$BA + H_2O \rightleftharpoons BOH + HA$

Base acid

Now pH is given by

$pH = \frac{1}{2}pK_w + \frac{1}{2}pKa - \frac{1}{2}pK_b$

substituting given values, we get

$pH = \frac{1}{2}(14 + 4.80 - 4.78) = 7.01$

17. (a)
18. (b) $[H^+] = \frac{K_a[ACID]}{[SALT]}; [H^+] = \frac{1.8\times10^{-6}\times0.1}{0.5}$

$= 0.36\times10^{-6}; \log[H^+] = -\log[0.13\times10^{-6}]$

$\therefore$ pH = 6.44

19. (c)
20. (c) Since k_{sp} of HgS is minimum among others, HgS will precipitate first.

Assertion/ Reason

1. (a) $K_p = K_c(RT)^{\Delta n}$
2. (a) If the volume is kept constant and an inert gas such as argon is added which does not take part in the reaction, the equilibrium remains undisturbed. It is because the addition of an inert gas at constant volume does not change the partial pressure or the molar concentration of the substance involved in the reaction. The reaction quotient changes only if the added gas is reactant or product involved in the reaction.
3. (d) In biological systems buffer system of carbonic acid and sodium bicarbonate is found in our blood. It maintains the pH of blood to a constant value of about 7.4.
4. (a) Ionic product of AgBr is greater than that of AgCl in comparison with there solubility product AgBr will precipitate first rather than

that of AgCl.

5. (c) K_{sp} of AgCl > K_{sp} of AgBr

6. (d) Presence of NH_4Cl suppresses the dissociation of NH_4OH, hence, concentration of OH^- is reduced to minimum. Further, $Ba(OH)_2$ is soluble in water.

7. (a) For the reaction

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$K_c = \frac{mole^2 \times L \times L^3}{L^2 \times mol \times mol^3} = L^2\ mol^{-2}$$

So, the units for K_c are $L^2\ mol^{-2}$

The assertion and reason, both are true and reason is correct explanation of assertion.

8. (c) $aA + bB \rightleftharpoons cC + dD,\ Q_c = \dfrac{[C]^c\,[D]^d}{[A]^a\,[B]^b}$

If $Q_c > K_c$, reaction will proceed in the direction of reactants

If $Q_c < K_c$, reaction will move in direction of products.

If $Q_c = K_c$, the reaction mixture is already at equilibrium.

Matching Based Questions

1. (d)

2. (b) (A) Liquid $\rightleftharpoons$ Vapour equilibrium exists at the boiling point.

(B) Solid $\rightleftharpoons$ Liquid equilibrium exists at the melting point.

(C) Solid $\rightleftharpoons$ Vapour equilibrium exists at the sublimation point.

(D) Solute $\rightleftharpoons$ Solute (solution) equilibrium exists in a saturated solution.

3. (a) In case of A no. of moles of product and reactant are same, in case of B no. of moles of reactant are greater so reaction go forward, in case of C the no. of moles of product are greater than no. of moles of reactant.

4. (a) (A) $K_P = K_C\ (RT)^{\Delta n}$

$$\frac{K_P}{K_C} = (RT)^{\Delta n} \text{ as } \Delta n = -ve \Rightarrow K_P < K_C$$

(B) $\Delta n > 0$

(C) $\Delta n = 2 - 1 = 1$

(D) As the reaction is not containing any gaseous component therefore K_P is not defined for this.

5. (b)

(A) As $\Delta n > 0$ therefore if P $\uparrow$, reaction will go in the backward direction.

(B) As $\Delta n < 0$ therefore if V $\uparrow$, P $\downarrow$ reaction will go in the direction in which more number of gaseous moles are formed i.e. backward direction.

(C) As $\Delta n = 0$ hence no effect.

(D) If concentration of reactant is increased reaction will go in the forward direction.

6. (d) 7. (b)

8. (b) $HClO_4$ is a strong acid

HNO_2 is a weak acid.

NH_2^- is a very good proton acceptor and thus, it is a base.

H_2SO_4 is a strong acid hence its conjugate base (HSO_4^-) will be a weak base.

Critical Thinking Type Questions

1. (d) To calculate the value of K_4 in the given equation we should apply :

eqn. (2) + eqn.(3) × 3 – eqn. (1)

hence $K_4 = \dfrac{K_2K_3^3}{K_1}$

2. (d) Given,

$$AB \xrightleftharpoons{K_1} A^+ + B^{-1}$$

$$K_1 = \frac{[A^+][B^-]}{[AB]}$$

$$AB + B^- \xrightleftharpoons{K_2} AB_2^-$$

$$K_2 = \frac{[AB_2^-]}{[AB][B^-]}$$

Dividing K_1 and K_2, we get

$$K = \frac{K_1}{K_2} = \frac{[A^+][B^-]^2}{[AB_2^-]}$$

$$\therefore \frac{[A^+]}{[AB_2^-]} = \frac{K}{[B^-]^2}$$

3. (d) $K_c = \dfrac{K_p}{(RT)^{\Delta n}} = \dfrac{1.44 \times 10^{-5}}{(0.082 \times 773)^{-2}}$

(R in L. atm. K^{-1} mole^{-1}).

4. (b) $NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$

$$K_P = \frac{(P_{NH_3})^2 \times (P_{CO_2})}{P_{NH_2COONH_4}(s)} = (P_{NH_3})^2 \times (P_{CO_2})$$

As evident by the reaction, NH_3 and CO_2 are formed in molar ratio of 2 : 1. Thus if P is the total pressure of the system at equilibrium, then

$$P_{NH_3} = \frac{2 \times P}{3} \qquad P_{CO_2} = \frac{1 \times P}{3}$$

$$K_P = \left(\frac{2P}{3}\right)^2 \times \frac{P}{3} = \frac{4P^3}{27}$$

Given $K_P = 2.9 \times 10^{-5}$

$\therefore\ 2.9\times10^{-5}=\frac{4P^3}{27}\Rightarrow P^3=\frac{2.9\times10^{-5}\times27}{4}$

$P=\left(\frac{2.9\times10^{-5}\times27}{4}\right)^{1/3}=5.82\times10^{-2}$ atm

5. **(a)** Justification : According to Le-Chatelier's principle, at constant temperature, the equilibrium composition will change but K will remain same.

6. **(a)**

7. **(b)** $[H_3O]^+$ for a solution having pH = 3 is given by $[H_3O]^+ = 1\times10^{-3}$ moles/litre
$[\because\ [H_3O]^+ = 10^{-pH}]$
Similarly for solution having pH = 4,
$[H_3O]^+ = 1\times10^{-4}$ moles/ litre and for pH = 5
$[H_3O^+] = 1\times10^{-5}$ moles/ litre
Let the volume of each solution in mixture be IL, then total volume of mixture solution L = (1 + 1 + 1) L = 3L
Total $[H_3O]^+$ ion present in mixture solution = $(10^{-3}+10^{-4}+10^{-5})$ moles
Then $[H_3O]^+$ ion concentration of mixture solution
$=\frac{10^{-3}+10^{-4}+10^{-5}}{3}M=\frac{0.00111}{3}M$
$= 0.00037\ M = 3.7\times10^{-4}$ M.

8. **(c)** Higher the value of K_a lower will be the value of pK_a i.e. higher will be the acidic nature. Further since CN^-, F^- and NO_2^- are conjugate base of the acids HCN, HF and HNO_2 respectively hence the correct order of base strength will be $F^- < NO_2^- < CN^-$
($\because$ stronger the acid weaker will be its conjugate base)

9. **(c)** $K_{sp} = [Ag^+][Cl^-]$
$1.8\times10^{-10} = [Ag^+][0.1]$
$[Ag^+] = 1.8\times10^{-9}$ M
$K_{sp} = [Pb^{+2}][Cl^-]^2$
$1.7\times10^{-5} = [Pb^{+2}][0.1]^2$
$[Pb^{+2}] = 1.7\times10^{-3}$ M

10. **(d)** The solubility equilibrium for AgI is
$AgI\,(aq) \rightleftharpoons Ag^+(aq) + I^-(aq)$;
$K_{sp} = [Ag^+][I^-]$
Let solubility of AgI be S moles per litre,
$[Ag^+] = S, [I^-] = S; K_{sp} = [Ag^+][I^-]$
$1\times10^{-16} = (S)\times(S) = S^2$
$S=\left(1\times10^{-16}\right)^{\frac{1}{2}}=1\times10^{-8}$
On calculating solubility of all given compounds

Compound	Solubility
AgCl	1×10^{-5}
AgI	1×10^{-8}
$PbCrO_4$	2×10^{-7}
Ag_2CO_3	1.26×10^{-4}

$\therefore$ Ag_2CO_3 is most soluble and AgI is least soluble.

Chapter - 8 Redox Reactions

Fill in the Blanks

1. **Oxidation** 2. **Sodium**
3. **Redox reaction** 4. **+1**
5. **NO_2** 6. **8**
7. **7** 8. **Decomposition reaction**
9. **Alkaline** 10. **4**
11. **3, 1 and 6** 12. **3 and 5**

True/ False

1. **True** 2. **True** 3. **True** 4. **True**
5. **True** 6. **True** 7. **True** 8. **False**
9. **True** 10. **True** 11. **True**

Conceptual MCQs

1. **(d)**

2. **(d)** In redox reactions oxidation and reduction take place side by side.
$$Cu_2S+2FeO\rightarrow2Cu+2Fe+SO_2.$$
O.N. of Cu changes from +1 to 0 (reduction) and O.N. of S changes from –2 to +4 (oxidation).

3. **(a)**

4. **(a)** Higher the value of reduction potential higher will be the oxidising power whereas the lower the value of reduction potential higher will be the reducing power.

5. **(c)** In $KMnO_4$ the O.N. of Mn is +7, in MnO_4^{-2} +6, in MnO_2 + 4 in Mn_2O_3 +3 and in Mn^{2+} is +2. The difference being 1, 3, 4 and 5 respectively.

6. **(c)** $N_2 + O_2 \rightarrow 2NO$
O.N. of N changes from 0 to +2 (oxidation) and O.N. of O changes from 0 to –2 (reduction).

7. **(d)** $$3Br_2+6CO_3^{2-}+3H_2O\rightarrow 5Br^-+BrO_3^-+6HCO_3^-$$
O.N. of Br_2 changes from 0 to –1 and +5 hence it is reduced as well as oxidised.

8. **(b)** During disproportionation same compound undergo simultaneous oxidation reduction.

Oxidation

$$3HO\overset{-\ +}{Cl} \longrightarrow 2H\overset{-1}{Cl} + H\overset{+5}{Cl}O_3$$

Reduction

9. **(c)** $4P + 3KOH + 3H_2O \rightarrow KH_2PO_2 + PH_3$

O.N of P = 0, In KH_2PO_2 it is + 1, In PH_3 it is –3. Hence P is oxidised and reduced.

10. **(a)** Since oxidation potential of Zn is highest hence strongest reducing agent.

11. **(b)** $Na_2S_4O_6$ Let O.N. of S be x then

2x (+1) + 4x (x) + 6x (–2) = 0

$\therefore$ x = 2.5. By chemical bonding method the two S atoms have O.N. + 5 and two S atoms have O.N. zero.

12. **(a)** 13. **(d)** 14. **(d)**

15. **(a)**

Fe	Al	Br	
0.77	–1.66	1.08	$E°_{Red}$
–0.77	1.66	–1.08	$E°_{Oxi}$

Hence, reducing power Al > Fe^{2+} > Br^-

16. **(c)**

17. **(a)** The balanced equation is

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

18. **(a)** $2MnO_4^- + 5H_2O_2 \rightarrow 2Mn^{2+} + 5H_2O + 13/2\,O_2 + 6\bar{e}$

$x = 2,\ y = 5$ and $z = 6$

19. **(c)** Acidified $KMnO_4$ is decolourized by H_2O_2 in following way.

$$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5O$$

$$5H_2O_2 + 5O \longrightarrow 5H_2O + 5O_2$$

$$2KMnO_4 + 3H_2SO_4 + 5H_2O_2 \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$$

20. **(d)** $2I^- \rightarrow I_2$ is oxidation (loss of electrons) ; Cr (+6) changes to Cr (+3) by gain of electrons. Hence Cr is reduced.

Assertion/ Reason

1. **(c)** In reaction $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$ sodium is oxidised by loss of electrons and acts as a reducing agent (donor of electrons).

2. **(b)** Both Assertion and Reason are true but reason is not the correct explanation of assertion. Greater the number of negative atoms present in the oxy-acid make the acid stronger. In general, the strengths of acids that have general formula $(HO)_m ZO_n$ can be related to the value of n. As the value of n increases, acidic character also increases. The negative atoms draw electrons away from the Z-atom and make it more positive. The Z-atom, therefore, becomes more effective in withdrawing electron density away from the oxygen atom that bonded to hydrogen. In turn, the electrons of H – O bond are drawn more strongly away from the H-atom. The net effect makes it easier from the proton release and increases the acid a strength.

3. **(b)** Decomposition of calcium carbonate is not a redox reaction.

4. **(a)**

Oxidation loss of $2e^-$

$$Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$$

Reduction gain of $2e^-$

5. **(d)** Here, assertion is false, because stannous chloride is a strong reducing agent and not strong oxidising agent. Stannous chlorides gives grey precipitate with mercuric chloride. Hence reason is true.

Matching Based Questions

1. **(b)** Oxidation is addition of electronegative or removal of electroposition element to a substance or removal of hydrogen from a substance.

Reduction is addition of electropositive or removal of electropositive element or removal of oxygen from a substance.

2. **(b)**

3. **(a)** $\underline{Cu}O \Rightarrow +2$

$\underline{Mn}O_2 \Rightarrow +4$

$H\underline{Au}Cl_4 \Rightarrow +3$

$\underline{Tl}_2O \Rightarrow +1$

4. **(b)**

Critical Thinking Type Questions

1. **(c)** Calculating the oxidation state of nitrogen in given molecules;

Oxidation state of N in NH_3 is

$x + 3 \times (+1) = 0$ or $x = -3$

Oxidation state on N in $NaNO_3$ is

$1 + x + 3 \times (-2) = 0$ or $x = +5$

Oxidation state of N in NaN_3 is

$+1 + 3x = 0$ or $x = -\frac{1}{3}$

Oxidation state of N in Mg_3N_2 is

$3 \times 2 + 2x = 0$ or $x = -3$

Thus 3 molecules (i.e. NH_3, NaN_3 and Mg_3N_2 have nitrogen in negative oxidation state.

2. **(d)** $PO_4^{3-} = x + 4(-2) = -3;\ x - 8 = -3;\ x = +5$

$SO_4^{2-} = x + 4(-2) = -2;\ x - 8 = -2;\ x = +6$

$Cr_2O_7^{2-} = 2x + 7(-2) = -2;\ 2x - 14 = -2;$
$2x = 12;\ x = +6$

3. **(b)** On reaction with hot and concentrated alkali a mixture of chloride and chlorate is formed

$$3Cl_2 + 3\ NaOH_{(excess)} \xrightarrow{\text{Hot}} 5Na\overset{-1}{Cl} + Na\overset{+5}{Cl}O_3 + 3H_2O$$

4. **(a)**

5. **(c)** The redox reaction involve loss or gain of electron(s) i.e. change in oxidation state. Given reaction is not a redox reaction as this reaction involves no change in oxidation state of reactant or product.

6. **(a)** $ClO_3^- \longrightarrow Cl_2^0$

$x - 6 = -1 \quad x = 0$

$x = +5 \quad x = 0\ (x = \text{oxidation number})$

Equivalent mass

$$= \frac{\text{Molecular mass}}{\text{Oxidation number}} = \frac{84.45}{5} = 16.89$$

7. **(a)** Given reaction is

$$IO_3^- + aI^- + bH^+ \longrightarrow cH_2O + dI_2$$

Ist half reaction

$I^- \longrightarrow I_2$ ...(i)

$-1 \qquad 0$ (oxidation)

IInd half reaction

$IO_3^- \longrightarrow I_2$ ...(ii)

$+5 \qquad 0$ (reduction)

On balancing equation (ii) we have

$10e^- + 2IO_3^- + 12H^+ \longrightarrow I_2 + 6H_2O$ ...(iii)

Now, balance equation (i)

$2I^- \longrightarrow I_2 + 2e^-$ ....(iv)

Multiply eqn (iv) by 5 and add it to eqn (iii), we get

$$2IO_3^- + 10I^- + 12H^+ \longrightarrow 6I_2 + 6H_2O$$

or, $IO_3^- + 5I^- + 6H^+ \longrightarrow 3I_2 + 3H_2O$

Hence a = 5, b = 6, c = 3, d = 3

8. **(d)** F_2 is strongest oxididing agent among halogens thus X^- can be possibly Br^-, Cl^- or I^-.

Chapter - 9 Hydrogen

Fill in the Blanks

1. **ortho hydrogen;** **2.** **0, 1 and 2**
3. **Non-metallic character**
4. **Sodium zincate, hydrogen**
5. **Hydrogen** **6.** **Cold water**
7. **bent, 104.5°, 95.7 pm** **8.** **Sodium**
9. Permanent hardness of water is due to chlorides and sulphates of calcium and magnesium.
10. **Chlorine** **11.** **8.4**
12. **Powdered metals**

True/ False

1.	**True**	**2.**	**True**	**3.**	**True**	**4.**	**True**
5.	**True**	**6.**	**False**	**7.**	**True**	**8.**	**True**
9.	**False**	**10.**	**True**	**11.**	**True**	**12.**	**True**
13.	**False**	**14.**	**True**				

Conceptual MCQs

1. **(b)** **2.** **(b)**

3. **(c)** The production of dihydrogen can be increased by reacting CO of syngas mixtures with $H_2O(g)$ in the presence of iron chromate as catalyst.

4. **(d)**

5. **(c)** Pure hydrogen is evolved by reacting absolute alcohol and Na

$$C_2H_5OH + Na \rightarrow C_2H_5ONa + \frac{1}{2}H_2$$

other statements are incorrect.

6. **(c)** In metal hydrides the O.S. of hydrogen –1 otherwise it is +1.

7. **(b)** Iron decomposes steam when red hot.

$$3Fe + 4\ H_2O \longrightarrow Fe_3O_4 + 4H_2$$

This is known as Lane’s process, and the reaction is termed as gassing reaction.

8. **(a)**

9. **(a)** Normality of 10V of H_2O_2

$$\frac{68 \times 10}{22.4} = 17 \times N \quad \therefore N = 1.78$$

10. **(b)** When water is heated from 0°C to 4°C , its density increases and volume decreases. $\left(d = \frac{m}{V}\right)$

11. **(a)** ice occupy more volume than liquid water (Ice $\rightleftharpoons$ water). Increase of pressure favours forward reaction (Le-Chatelier’s principle).

12. **(d)** Heavy water is D_2O (1 – C); Temporary hard water contains the bi-carbonates of Mg and Ca (2 – A); Soft water contains no foreign ions (3 –

B); Permanent hard water contains the sulphates and chlorides of Mg and Ca (4 – D) therefore the answer is D.

13. **(d)** In electrochemical series, H_2 is below from all these metals and we know reducing nature decreases from top to bottom in the electrochemical series.
14. **(b)**
15. **(c)** Heavy water (D_2O) is deuterium analogue of water H_2O
16. **(c)** 17. **(b)**
18. **(d)** Acetanilide, alcohol and H_3PO_4 are negative catalyst and retard decomposition of H_2O_2.
19. **(b)** D_2O is used in nuclear reactors as moderators.
20. **(d)**

Assertion / Reason

1. **(a)** Due to extremely small size of H^+ as compared to normal atomic and ionic size H^+ does not exist freely.
2. **(a)** 3. **(a)**
4. **(c)** Both assertion is correct reason is not true. Correct reason : Calgon forms soluble complexes with Ca^{2+} and Mg^{2+} in which properties of these ions are masked.
5. **(a)** $2C_{17}H_{35}COONa(aq) + M^{2+}(aq) \longrightarrow (C_{17}H_{35}COO)_2M\downarrow$ (M = Ca or Mg) $+ 2Na^+(aq)$
6. **(a)** Both assertion and reason are true and reason is the correct explanation of assertion.
7. **(a)**

Matching Based Questions

1. **(a)** 2. **(b)** 3. **(c)**
4. **(d)** Many salts can be crystallised as hydrated salts from an aqueous solutions such an association of water is of different types viz.,
   (i) Coordinated water e.g., $[Cr(H_2O)_6]^{3+}\ 3Cl^-$
   (ii) Interstitial water e.g., $BaCl_2 \cdot 2H_2O$
   (iii) Hydrogen-bonded water e.g., $[Cu(H_2O)_4]^{4+}\ SO_4^{2-}.H_2O$ in $CuSO_4.5H_2O$
5. **(d)** Heavy water is D_2O (1 – C); Temporary hard water contains the bi-carbonates of Mg and Ca (2 – A); Soft water contains no foreign ions (3 – B); Permanent hard water contains the sulphates and chlorides of Mg and Ca (4 – D) therefore the answer is D.
6. **(b)**

Critical Thinking Type Questions

1. **(d)** Heavy water is stable.
2. **(b)** $\underset{\text{base 1}}{H^-(aq)} + \underset{\text{acid 1}}{H_2O(l)} \longrightarrow \underset{\text{base 2}}{OH^-(aq)} + \underset{\text{acid 2}}{H_2(g)}$

   In this reaction H^- acts as bronsted base as it accepts one proton (H^+) from H_2O and for H_2.
3. **(a)** D_2O actually has higher freezing point (3.8°C) than water H_2O (0°C)
4. **(d)**
5. **(b)** $2HSO_4^-(aq) \xrightarrow{\text{electrolysis}} HO_3SOOSO_3H(aq) \xrightarrow{\text{Hydrolysis}} 2HSO_4^-(aq) + 2H^+(aq) + H_2O_2(aq)$
6. **(c)** (i) and (iii) are properties of hydrogen which shows its resemblance with alkali metals whereas (ii) , (iv) and (v) shows resemblance with halogens.

Chapter - 10 The s-Block Elements

Fill in the Blanks

1. **Anhydrous HCl**
2. **of solvated electrons.**
3. **higher effective nuclear charge.**
4. **Sodium**
5. **Rb**
6. paramagnetic, bronze and diamagnetic
7. **nothing**
8. **KI**
9. **barium**
10. **Chemical reactivity**

True/ False

1. **False**	2. **True**	3. **False**	4. **False**
5. **True**	6. **True**	7. **False**	8. **True**
9. **False**	10. **False**	11. **True**	12. **True**
13. **True**	14. **False**	15. **False**	16. **False**

Conceptual MCQs

1. **(d)**
2. **(c)** Li due to highest hydration energy among the alkali metals is the strongest reducing agent.
3. **(b)**
4. **(b)** (A) Plaster of paris = $CaSO_4.\frac{1}{2}H_2O$
   (B) Epsomite = $MgSO_4.7H_2O$
   (C) Kieserite = $MgSO_4.H_2O$
   (D) Gypsum = $CaSO_4.2H_2O$
5. **(b)** Na is basic in nature
6. **(c)** Tertiary halide can show ionic reaction with MF so, MF should be most ionic for reaction to proceed forward. Hence 'M' should be 'Rb'.

7. (c) $Na + NH_3 \longrightarrow \underset{\text{Sodium amide}}{NaNH_2} + 1/2\ H_2$

8. (a) 9. (d) 10. (c) 11. (a)

12. (a) As the size of the anion increases from F^- to I^-, the covalent character increase and hence the solubility in non-polar solvent increases.

$$LiI > LiBr > LiCl > LiF$$

13. (a)

14. (b) The basic character of oxides increases down the group.

15. (c)

$$\underset{\text{temp. hardness}}{Ca(HCO_3)_2} + Ca(OH)_2 \longrightarrow 2CaCO_3 \downarrow + 2H_2O$$

$$\underset{A}{Ca(OH)_2} + Na_2CO_3 \longrightarrow \underset{\text{Caustic soda}}{2NaOH} + CaCO_3$$

$$\underset{A}{Ca(OH)_2} + CO_2 \longrightarrow \underset{\text{milkiness}}{CaCO_3 \downarrow} + H_2O$$

16. (b) 17. (d) 18. (a)

19. (c) The IE of hydrogen is much higher than those of alkali metals and slightly higher than those of halogens. For example, IE of Cl is 1255 kJ/mole and IE of H is 1312 kJ/mole.

20. (a)

Assertion/ Reason

1. (a) Li^+ has maximum degree of hydration among other alkali metals.

2. (a) Lithium carbonate is unstable to heat; lithium being very small in size polarises a large CO_3^{2-} ion leading to the formation of more stable Li_2O and CO_2.

3. (a) Because of high value of ionisation enthalpy and small size it forms compound which are highly covalent in nature, hence, it get hydrolysed easily.

4. (d) Both assertion and reason are false. Radium is the rarest of all s-block elements comprising only 10^{-10} percent of igneous rocks. Francium (s-block member) is radioactive; its long lived isotope ^{223}Fr ahs a half life of only 21 minutes.

Matching Based Questions

1. (a)

2. (c) $Cs + O_2 \rightarrow CsO_2$ (Superoxide)
$4Li + O_2 \rightarrow 2Li_2O$ (Oxide)
$2Na + O_2 \rightarrow Na_2O_2$ (Peroxide)

3. (a) Lithium metal is used to make useful alloys, for example with lead to make 'white metal' bearings for motor engines, with aluminium to make aircraft parts, and with magnesium to make armour plates.

4. (a) 5. (c)

6. (b) Quick lime is used for the manufacture of dyestuffs.
Plaster of Paris is used for setting of fractured bones.
Slaked lime is used for the manufacture of bleaching powder.
Limestone is a constituent of chewing gum.

Critical Thinking Type Questions

1. (c) The atom becomes larger on descending the group, so the bonds becomes weaker (metallic bond), the cohesive force/energy decreases and accordingly melting point also decreases.

2. (b) During the dissolution of alkali metal hydrides energy is released in large amount, i.e., it is exothermic in nature.

3. (a) All the given elements react with oxygen to form oxides but only Li also react with nitrogen to form Li_3N.

4. (d) (a) and (b) forms corresponding hydroxides (NaOH and LiOH) in aqueous solution

$$M_2O + H_2O \longrightarrow 2M^+ + 2OH^- \ (M = \text{Na or Li})$$

Therefore reaction of HI with (a), (b) and (c) is simply a neutralization reaction, while aqueous solution of (d) form H_2O_2 which act as oxidizing agent, hence convert Iodide to Iodine(I_2).

$$Na_2O_2 + 2H_2O \longrightarrow 2Na^+ + 2OH^- + H_2O_2$$

5. (a) The ionisation potential value of lithium is maximum among alkali metals i.e., its tendency to ionise to give Li^+ ions should be the minimum i.e. Li should be the poorest reducing agent. But, lithium is the strongest reducing agent in aq. solution. This is due to the largest value of hydration energy of Li^+ ions.

6. (c) NaCl (brine), NH_3 and CO_2 are raw materials.
$CaCO_3$ is source of CO_2.

7. (d) Group1 carbonates are more soluble than group 2 which are sparingly soluble, and also in case of group 2, down the group the solubility of carbonates decreases.

8. (d) Because of larger size and smaller nuclear charge, alkali metals have low ionization potential relative to alkaline earth metals.

9. (b) Electrons in Mg due to its small size are tightly bound so they cannot be excited by the flame.

10. (d) $Be(OH)_2$ is amphoteric, but the hydroxides of other alkaline earth metals are basic. The basic strength increases gradually.

Chapter - 11 The p-Block Elements (Group 13 and 14)

Fill in the Blanks

1. **Sodium hydroxide**
2. **Silicones**
3. **Nitric oxide.**
4. **Trialkylchlorosilanol**
5. **Fullerene**
6. **inert-pair effect**
7. **Acidic/neutral, basic**
8. **boron**
9. **373 K**
10. **12 σ**
11. **Boron**
12. H_2CO_3/HCO_3^- buffer system help to maintain pH of blood between 7.26 to 7.42.

True/ False

1. False	2. True	3. True	4. True
5. True	6. True	7. True	8. False
9. True	10. True	11. False	12. True
13. True	14. True	15. True	

Conceptual MCQs

1. (c)
2. (b) *p-p* overlap between B and F is maximum due to identical size and energy of *p*- orbitals, so electron deficiency in boron of BF_3 is neutralized partially to the maximum extent by back donation.
   Hence BF_3 is least acidic.
3. (d) 4. (c)
5. (c) H_3BO_3 is monobasic acid.
6. (c)
7. (c) Fused alumina (Al_2O_3) is a bad conductor of electricity. Therefore, cryolite (Na_3AlF_6) and fluorspar (CaF_2) are added to purified alumina which not only make alumina a good conductor of electricity but also reduce the melting point of the mixture to around 1140 K.
8. (b)
9. (a) SiO_4^{4-} is basic structural unit of silicates.
10. (d)
11. (d) Pb^{2+} due to inert pair effect.
12. (b) 13. (d)
14. (b) In fullerene each carbon atom is bonded to three other carbon atoms and is sp^2 hybridised.
15. (b) 16. (c)
17. (a) Water gas is $CO + H_2$
18. (c) 19. (c)
20. (d) Ge(II) tends to acquire Ge (IV) state by loss of electrons. Hence it is reducing in nature. Pb (IV) tends to acquire Pb (II) O.S. by gain of electrons. Hence it is oxidising in nature. This is due to inert pair effect.

Assertion/ Reason

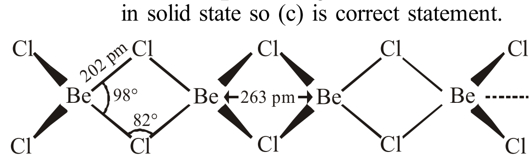
1. (c) Atomic radius of gallium is less than that of aluminium.
2. (c) Boron is metalloid. Thus assertion is correct. Metalloids possess, metallic as well as non-metallic nature. Hence, reason is false.
3. (a) The use of aluminium and its compounds for domestic purposes is now reduced considerably because of their toxic nature.
4. (c) Assertion is true because lower oxidation state becomes more & more stable for heavier elements in *p*-block due to inert pair effect. Hence Reason is false.
5. (a) PbI_4 does not exist because Pb–I bond initially formed during the reaction does not release enough energy to unpair $6s^2$ electrons and excite one of them to higher orbital to have four unpaired electrons around lead atom.
6. (a)

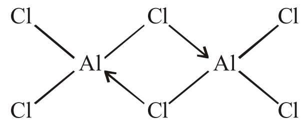
Matching Based Questions

1. (b)
2. (c) $$\underset{}{Na_2B_4O_7.10H_2O} \xrightarrow{\Delta} \underset{(i)}{Na_2B_4O_7} \xrightarrow{\Delta} \underset{(ii)}{2NaBO_2} + \underset{(iii)}{B_2O_3}$$
   $$Na_2B_4O_7 + 7H_2O \longrightarrow \underset{(iv)}{4H_3BO_3} + \underset{(v)}{2NaOH}$$
3. (d)
4. (a) Carbon and silicon are non-metals. Germanium is a metalloid. Tin and lead are metals.
5. (b) 6. (d)

Critical Thinking Type Questions

1. (c) The correct formula of inorganic benzene is $B_3N_3H_6$ so (d) is incorrect statement
   Boric acid (H_3BO_3 or $\begin{array}{c} OH \\ | \\ B-OH \\ | \\ OH \end{array}$) is a lewis acid so (a) is incorrect statement.
   The coordination number exhibited by beryllium is 4 and not 6 so statement (b) is incorrect.
   Both $BeCl_2$ and $AlCl_3$ exhibit bridged structures in solid state so (c) is correct statement.





2. **(d)** Al in its compounds forms covalent bonds.
3. **(a)**
4. **(b)** In fullerene a six membered ring can fuse with five as well as with six membered ring while a five membered ring can only fuse with a six membered ring.
5. **(c)** CO_2 forms carbonic acid H_2CO_3, when dissolved in water, CO is neutral, whereas other two GeO_2 and SnO_2 are solids.
6. **(d)**

Chapter - 12 Organic Chemistry-Some Basic Principles and Techniques

Fill in the Blanks

1. ***tert*-butyl carbonium ion**
2. **propadiene**
3. **cyclopropane**
4. sp^3
5. **vicinal, adjacent** (or stable, different).
6. **non-superimposable, enantiomers;**
7. *sp*;
8. **Hyperconjugation;**
9. **Butane-1, 4-dioic acid**
10. **ionic or polar**
11. **$CaCl_2$ and KOH**
12. **CO, I_2O_5, CO and CO_2**

True/ False

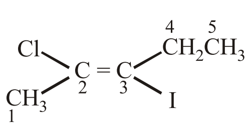
1. False	**2. False**	**3. False**	**4. False**
5. False	**6. True**	**7. True**	**8. False**
9. False	**10. True**	**11. True**	**12. True**

Conceptual MCQs

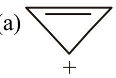
1. **(c)** 2. **(b)** 3. **(d)** 4. **(d)**
5. **(a)** Bond length order is

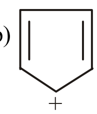
$$\underset{1.10A^\circ}{C-H} < \underset{1.34A^\circ}{C=C} < \underset{1.40A^\circ}{C-O} < \underset{1.54A^\circ}{C-C}$$

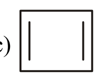
6. **(c)** 7. **(b)**
8. **(a)**

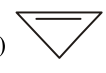


Correct IUPAC name of above compound is trans-2-chloro-3-iodo-2-pentene

9. **(a)**
10. **(a)** As (b) and (c) are not erythro and in (d) there is no intramolecular H-bonding.
11. **(d)** 12. **(b)**
13. **(b)** Structure (*b*) is a 3º carbocation, while (*a*) is 2º and (*c*) and (*d*) are 1º carbocations; thus (*b*) is the most stable.
14. **(a)**
15. **(b)** $C_6H_5CH_2^- > CH_3CH_2^- > (CH_3)_2CH^- > (CH_3)_3C^-$
Dispersal of –ve charge due to resonance and - I effect; Intensification of –ve charge due to + I effect of CH_3 gps.
16. **(b)** $C_6H_5\dot{C}HCH_3$ is a 2º benzylic free radical, hence stabilized most due to resonance.
17. **(a)** (a)  : 4n + 2 = 2, n = 0 (integer)

(b)  : 4n + 2 = 4, n = 0.5

(c)  : 4n + 2 = 4, n = 0.5

(d)  : 4n + 2 = 4, n = 0.5

Only (a) obeys Huckel's rule.

18. **(b)** 19. **(d)** 20. **(d)**

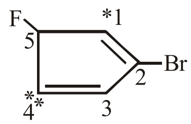
Assertion/ Reason

1. (c) – CN is a secondary suffix.
2. **(b)**
3. **(d)** The correct name of the given compound is 2, 5, 6 -trimethyloctane
4. **(c)** 5. **(d)**
6. **(c)** Benzene has a uniform C – C bond distance of 139 pm, a value intermediate between the C – C single. (154 pm) and C = C double (134 pm) bonds.
7. **(a)** It is fact that aniline is better nucleophile than anilium ion. Anilium ion contain +ve charge, which reduces the tendency to donate lone pair of electron $\underset{\text{Anilium ion}}{C_6H_5\overset{+}{N}H_3}$.
8. **(d)** Resonance structures contain the same number of unpaired electrons. However, they differ in the way of distribution of electrons.
9. **(d)** 10. **(a)** 11. **(a)** 12. **(c)**

Matching Based Questions

1. (b)	**2. (c)**	**3. (a)**	**4. (c)**
5. (a)	**6. (a)**	**7. (d)**	**8. (a)**
9. (b)	**10. (d)**		

Critical Thinking Type Questions

1. (d) 

The numbering of C-atom starts from $\overset{*}{C}$ or $\overset{**}{C}$.

But numbering from $\overset{*}{C}$ give minimum locant (2) to Br which is correct.

2. (d) The compound contains longest chain of 3 C - atoms and three -COOH groups and one -OH group attached to it (latest convention).

3. (d) $-NO_2$ group, being strong electron-withdrawing, disperses the –ve charge, hence stabilizes the concerned carbanion.

4. (d) $CH_3 - Br \rightarrow {}^{+}CH_3 + Br^{-}$

$CH_3 - Cl \rightarrow \dot{C}H_3 + \dot{C}l$

Chapter - 13 Hydrocarbons

Fill in the Blanks

1.	Ethyne	2.	2-butyne
3.	C_2H_2	4.	ethylene
5.	H_2SO_4, $HgSO_4$	6.	2
7.	4 and 3	8.	One carbon less
9.	3	10.	6

True/ False

1.	True	2.	False	3.	True	4.	True
5.	True	6.	False	7.	False	8.	True
9.	True	10.	True	11.	False	12.	True
13.	False	14.	False	15.	True		

Conceptual MCQs

1. (d) $C_6H_5CH_2Br + Mg \xrightarrow{\text{ether}}$

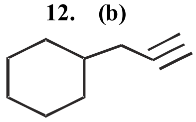
$C_6H_5CH_2MgBr$ (in ether as solution)

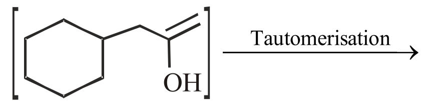
$\begin{array}{c|l} C_6H_5CH_2 & MgBr \\ H & OH \end{array} \xrightarrow{H^+}$

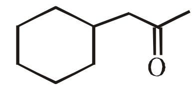
$C_6H_5CH_3 + MgBr(OH)$

2. (c) Other three methods can be used for the preparation of hydrocarbons having at least 2 carbon atoms.

3.	(d)	4.	(a)	5.	(c)	6.	(c)
7.	(a)	8.	(d)	9.	(a)	10.	(d)
11.	(a)	12.	(b)				

13. (b)  $\xrightarrow[H_2O]{HgSO_4\ H_2SO_4}$





14. (b) Reduction of alkynes with Na/liq. NH_3 gives trans-alkenes.

15. (c)

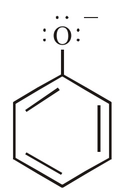
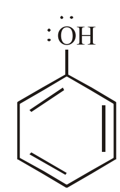
16. (c) Phenol as well as toluene have electron-releasing groups, however –OH group, in phenol, is more electron-releasing (due to +R effect) than the $-CH_3$ group in toluene, so phenol is more easily attacked by an electrophile.

17. (b) $CH_3C \equiv CCH_3$, being symmetrical, has the lowest dipole moment

18. (d) A doubly bonded carbon atom having an alkyl group is oxidised to aldehyde which is further oxidised to carboxylic acid.

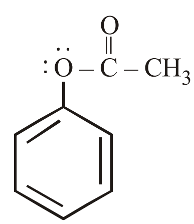
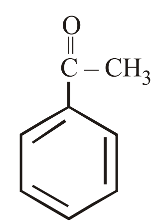
$CH_3CH_2CH = CHCH_3 \xrightarrow[\text{(ii)}H^+]{\text{(i)}KMnO_4, OH^-}$

$\begin{array}{ccc} CH_3CHO & + & CH_3CH_2CHO \\ \downarrow & & \downarrow \\ CH_2COOH & & CH_3CH_2COOH \end{array}$

19. (a)  > 

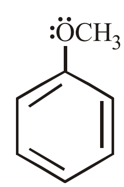
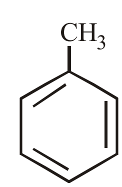
Most electron-releasing due to –ve charge on O

Electron releasing due to –OH group

>  > 

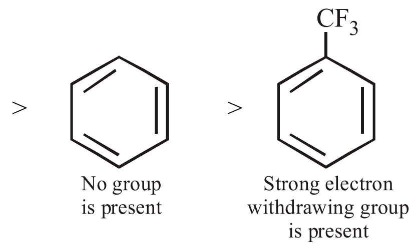
Less electron releasing due to presence of –CO grouping which shows resonance with the electrons on O

Electron-withdrawing group

20. (a)  > 

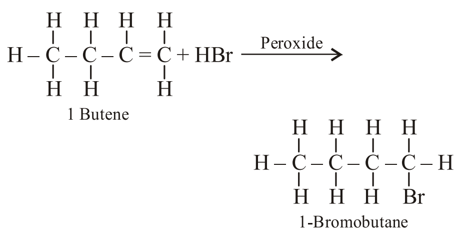
Strong electron-releasing group is present due to + R

Electron-releasing group is present



Assertion/ Reason

1. **(a)** This reaction is followed by anti Markownikoff rule



In this reaction anti Markownikoff's addition is explained on the basis of the fact that in the presence peroxides, addition takes place via free radical mechanism rather than the ionic mechanism.

2. **(b)** The assertion that chlorination of CH_4 does not take place in dark is correct because it is a free radical reaction and free radicals are obtained in presence of sun light.

3. **(b)** Iodination is reversible since formed HI is a strong reducing agent and reduces the alkyl iodide back to alkane.

$$CH_4 + I_2 \rightleftharpoons CH_3I + HI$$

Iodination can be done only in presence of strong oxidising agents like iodic acid which destroys the hydriodic acid.

4. **(d)** The two hydrogen atoms on first carbon and the two H-atoms on the third carbon atom lie in perpendicular planes. The central carbon atom is *sp*-hybridized while terminal carbon atoms are sp^2-hybridized

5. **(c)** $(4n + 2)\pi$ electrons and planar structure are the essential conditions for aromaticity.

Matching Based Questions

1. **(a)** Among the infinite number of conformations in the staggered conformation hydrogen atoms are as far as apart as possible. While in eclipse conformation hydrogen atoms are perfectly eclipsed.

In skew conformation, hydrogen atoms are closer than in staggered but away than in eclipsed conformation.

2. **(a)**

$$\underset{\text{Ethene}}{CH_2 = CH_2} + H_2 \xrightarrow{Pt/Pd/Ni} \underset{\text{Ethane}}{CH_3 - CH_3}$$

$$\underset{\text{Chloromethane}}{CH_3 - Cl} + H_2 \xrightarrow{Zn, H^+} \underset{\text{Methane}}{CH_4} + HCl$$

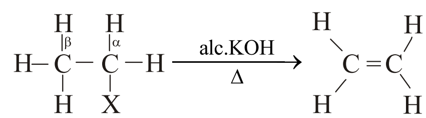
$$\underset{\text{Bromomethane}}{CH_3Br} + 2Na + BrCH_3 \xrightarrow{\text{dry ether}} \underset{\text{Ethane}}{CH_3 - CH_3} + 2NaBr$$

$$CH_3COO^-Na^+ + NaOH \xrightarrow[\Delta]{CaO} CH_4 + Na_2CO_3$$

3. **(c)**

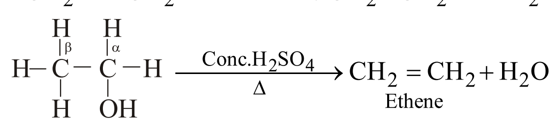
4. **(a)**

$$\underset{\text{Ethyne}}{CH \equiv CH} + H_2 \xrightarrow{Pd/C} \underset{\text{Ethene}}{CH_2 = CH_2}$$



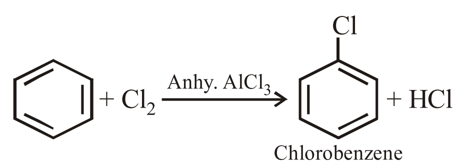
$(X = Cl, Br, I)$

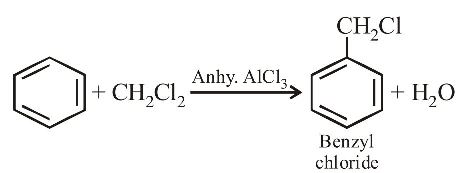
$$CH_2Br - CH_2Br + Zn \longrightarrow CH_2{=}CH_2 + ZnBr_2$$

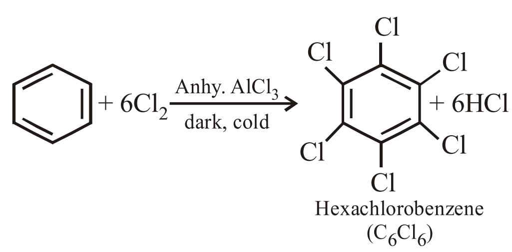


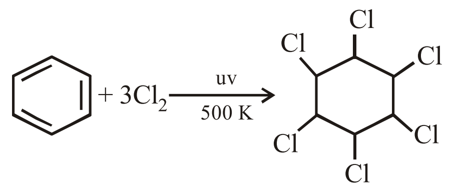
Ethanol

5. **(b)**









Benzene hexachloride.
(BHC)

6. (a)

(A) $\underset{\text{(Benzene)}}{C_6H_6} + Cl_2 \xrightarrow{AlCl_3} \underset{\text{(Chlorobenzene)}}{C_6H_5Cl}$

(B) $C_6H_6 + CH_3Cl \xrightarrow{AlCl_3} \underset{\text{(Toluene)}}{C_6H_5CH_3} + HCl$

(C) $C_6H_6 + CH_3COCl \longrightarrow \underset{\text{methyl phenyl ketone}}{C_6H_5COCH_3} + HCl$

(D) $\underset{\text{(Toulene)}}{C_6H_5-CH_3} \xrightarrow[NaOH]{KMnO_4} C_6H_5COOH$

7. (d) 8. (a) 9. (b)

Critical Thinking Type Questions

1. (c) The structure of neopentane is

$$H_3C-\underset{CH_3}{\overset{CH_3}{C}}-CH_3$$

It has 1 quaternary and 4 primary carbons.

2. (c)

$$\underset{\textit{neo}\text{-pentyl bromide}}{H_3C-\underset{CH_3}{\overset{CH_3}{C}}-CH_2Br} + 2Na + Br-CH_2-\underset{CH_3}{\overset{CH_3}{C}}-CH_3 \xrightarrow[-2NaBr]{ether}$$

$$\underset{\text{2,2,5,5-tetramethylhexane}}{H_3C-\underset{CH_3}{\overset{CH_3}{C}}-CH_2-CH_2-\underset{CH_3}{\overset{CH_3}{C}}-CH_3}$$

3. (a) Given

$$A \xrightarrow{Cl_2} B \xrightarrow{alc./KOH} \underset{\text{Hydrocarbon}}{C} \xrightarrow{O_3/H_2O} CH_2O$$

Since hydrocarbon C give only CH_2O, on ozonolysis, C should be $CH_2=CH_2$ hence going backward A should be ethane. Thus the reactions are

$$\underset{(A)}{CH_3CH_3} \xrightarrow{Cl_2/h\nu} \underset{(B)}{CH_3CH_2Cl} \xrightarrow[KOH]{alc.} ...$$

$$\underset{(C)}{CH_2=CH_2} \xrightarrow[\Delta]{O_3/H_2O} \underset{(D)}{HCHO}$$

4. (c) In compounds

I II

first has more dipole moment than second. Therefore its boiling point will be higher. Melting point depends on symmetry therefore I has higher melting point than II. Steric crowding in I is more than II therefore I is more stable than II.

5. (b) $CH_3-\overset{CH_3}{CH}-\underset{OH}{CH}-CH_3 \xrightarrow{H^+/Heat}$

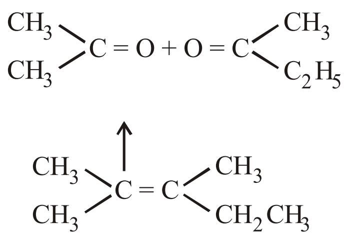
$$\underset{\substack{\text{2 methyl}\\\text{butene-2}\\(80\%)\\(A)}}{CH_3-\overset{CH_3}{C}=CH-CH_3} + \underset{\substack{\text{3 methyl}\\\text{butene-1 (20\%)}\\(B)}}{CH_3-\overset{CH_3}{CH}-CH=CH_2}$$

In this case dehydration is governed by Saytzeff's rule according to which hydrogen is preferentially eliminated from the carbon atom with fewer number of hydrogen atoms i.e., poor becomes poorer. Thus, 2-methyl butene-2 is the major product.

$$\underset{(A)}{CH_3-\overset{CH_3}{C}=CH-CH_3} \xrightarrow[\text{in absence of peroxide}]{HBr,\ dark}$$

$$\underset{\text{(Minor)}}{(CH_3)_2-CH-\underset{Br}{CH}-CH_3} + \underset{\text{(Major)}}{CH_3-\underset{Br}{\overset{CH_3}{C}}-CH_2-CH_3}$$

This reaction is governed by Markownikoff's rule according to which when an unsymmetrical reagent e.g. HBr adds to an unsymmetrical alkene, then the negative part of the reagent is added to that carbon atom of the double bond which bears the least number of hydrogen atom. Thus, in above case. 2-methyl 2-bromo butane will be the major product.

6. (d) 

2,3-Dimethyl-2-pentene

Chapter - 14 Environmental Chemistry

Fill in the Blanks

1. SO_2	**2. Pollutant**
3. H_2SO_4	**4. PAN**
5. non-viable	**6. Mercury**
7. COB and BOD	**8. Mn**
9. 0.005	**10. < 30 ppm**

True/ False

1. True	**2. False**	**3. False**	**4. True**
5. True	**6. True**	**7. True**	**8. True**
9. True	**10. False**		

Conceptual MCQs

1. (b) The ideal value of D.O for growth of fishes is 8 mg/ℓ. 7mg ℓ is desirable range, below this value fishes get susceptible to desease. A value of 2 mg/ ℓ or below is lethal for fishes.
2. (c)
3. (d) The mosquitoes will increase their population and spread malaria.
4. (a)
5. (d) Acid rain contains $H_2SO_4 > HNO_3 > HCl$.
6. (d) The oxidised hydrocarbons and ozone in presence of humidity cause photochemical smog. Hydrocarbons + O_2, NO_2, NO, O, O_3 $\rightarrow$ Peroxides, formaldehyde, peroxyace-tylnitrate (PAN), acrolein etc.
It is oxidising in nature and causes irritation to eyes, lungs, nose, asthamatic attack and damage plants.
7. (a) 8. (b) 9. (a)
10. (a) Based on the features given above the gas must be SO_2 .
11. (a) 12. (c)
13. (a) Phosphate pollution is caused by sewage and agricultural fertilizers.
14. (b) The oxidised hydrocarbons and ozone in presence of humidity cause photochemical smog. Hydrocarbons + O_2, NO_2, NO, O, O_3 $\rightarrow$ Peroxides
15. (a) Oil slick in sea water decreases D.O value.
16. (c) 17. (d)
18. (a) Excessive concentration of nitrate in drinking water is harmful and can cause methemoglobinemia (blue baby syndrome).
19. (c) water is often treated with Cl_2 to kill germs.
20. (d) Ozone layer acts as a shield and does not allow ultraviolet radiation from sun to reach earth. It does not prevent infra-red radiation from sun to reach earth, thus option (d) is wrong statement and so it is the correct answer.

Assertion/ Reason

1. (a) The presence of particulate matter in polluted a\ir catalyses the oxidation of SO_2 to SO_3
2. (b) At high altitudes when lightening strikes dinitrogen and dioxygen combine to form oxides of nitrogen.
3. (c) Other gases like CFCs, ozone, water vapour and nitrous oxide also show green house effect.
4. (c) 5. (b) 6. (a)
7. (b) SPM (Suspended Particulate Matter) is defined as particles floating in the air with a diameter below 10 μm. Studies have shown that high SPM concentrations in the air can have a detrimental impact on respiratory organs. SPM is generated from natural sources (e.g., volcanoes or dust storms) and human activities (vehicles, incinerators and industrial plants).

SPM	Other aerosols
Less than 10 μm	Less than 100 μm
Tend to float longer in air due to small size	Tend to settle fairly quickly due to comparative heaviness

Catalytic converters is a device designed to reduce the amount of emissions from automobiles. The current (so-called three-way) systems use a heated metal catalyst to reduce the emissions of carbon monoxide (CO), hydrocarbons, and nitric oxide (NO), all of which contribute to the formation of photochemical smog. In an automobile's exhaust system, a catalytic converter provides an environment for a chemical reaction where unburned hydrocarbons completely combust.

8. (b) 9. (d) 10. (a)

Matching Based Questions

1. (c) 2. (a) 3. (b)
4. (a) 5. (a) 6. (a)

Critical Thinking Type Questions

1. (a)

2. **(c)** The beauty of Taj Mahal is endangered due to air pollutants like SO_2 released from oil refinery.
3. **(b)** When SO_2 pollution in air is much higher. Sometimes, SO_2 mixes in the air with small particles of metals near the factories and gets oxidised into sulphur trioxide SO_3. These gases are harmful and they react with water to form sulphuric acid (H_2SO_4) or sulphurous acid (H_2SO_3) and come down to earth with rain water, it is called acid rain or acid precipitation.
4. **(b)**
5. **(a)** PSCs react with chlorine nitrate and HCl to give HOCl and Cl_2.
6. **(a)**

Chapter - 15 The Solid State

Fill in the Blanks

1. **Glass** is not crystalline solid.
2. **london forces**
3. **free valence electrons**
4. **Ionic solid**
5. **8**
6. **Cubic close packing**
7. **Frenkel defect**
8. **n-type semiconductor**
9. **5.188** $\rho = \dfrac{Z \times M}{N_A \times a^3}$

$$= \frac{2 \times 100}{6.023 \times 10^{23} \times (400 \times 10^{-10})^3}$$

$$= 5.188 \text{ g/cm}^3$$

True/ False

1.	**True**	**2.**	**False**	**3.**	**False**	**4.**	**True**
5.	**True**	**6.**	**False**	**7.**	**False**	**8.**	**True**
9.	**True**	**10.**	**False**	**11.**	**True**	**12.**	**False**
13.	**True**	**14.**	**True**	**15.**	**False**		

Conceptual MCQs

1. **(d)** Crystals show good cleavage because their constituent particles are arranged in planes.
2. **(a)** Number of octahedral voids in ccp, is equal to effective number of atoms.
   In ccp, effective number of atoms are 4 so, 4 octahedral voids.
   So, 1 octahedral voids per atom.
3. **(a)** For a cubic structure,

   No. of X atoms $= 8 \times \dfrac{1}{8} = 1$

   No. of Y atoms $= 6 \times \dfrac{1}{2} = 3$

   $\therefore$ Formula of the compound = XY_3
4. **(d)** Ionic compounds are dissociated in solution state and form ions. Ions are good carrier of charge. So it makes solution conducting.
5. **(a)** In stoichiometric Frenkel defects occurs in those compound which have
   (i) Low C.N.
   (ii) Large difference in size of cations and anions
6. **(c)** A body-centred cubic system consists of all eight corners plus one atom at the centre of cube.
7. **(d)** The appearance of colour in solid alkali metal halide is due to presence of F-centres found as defect in the crystal structure.
8. **(d)** In body centred cubic lattice one molecule of CsBr is within one unit cell.
   Atomic mass of unit cell
   = 133 + 80 = 213 a.m.u
   Volume of cell = $(436.6 \times 10^{-12})^3$

   $$\text{Density} \quad \frac{\text{n} \quad \text{at.wt.}}{\text{Av.no.} \quad \text{vol.of unit all cell}}$$

   $$\text{Density} = \frac{213}{6.02 \times 10^{23} \times (436.6 \times 10^{-12})^3}$$

   $$\left[\rho = \frac{ZM}{a^3 N_A}\right] = \frac{213 \times 10^7}{6.02 \times (436.6)^3} = 42.5 \text{ gm/cm}^3$$
9. **(c)**
10. **(c)** Pure silicon doped with phosphorus is a *n*-type semiconductor, as *n*-type extrinsic semiconductor (Si) is made by doping the semiconductor with pentavalent element.
11. **(d)** The statement (d) is correct
12. **(b)** In bcc structure,
    no. of atoms at corner = (1/8) × 8 = 1
    no. of atoms at body centre = 1
    $\therefore$ Total no. of atoms per unit cell = 1 + 1 = 2.
13. **(b)** To get *n*-type semi conductor the 14 group elements must be doped with 15 group elements (valence electrons 5).
14. **(d)** Zn^{2+} ion is too small to fit into the octahedral voids of S^{2-} ions. Hence, option (d) is incorrect statement.
15. **(a)** It is based on the definition of the cubic lattice.
16. **(d)** *d*-spacing

    $$= \frac{n\lambda}{2\sin\theta} = \frac{2 \times 100}{2 \times \sin 30^\circ} = 200\text{pm}$$
17. **(b)** Low co-ordination compound can be changed into high co-ordination compound by increasing pressure and decreasing temperature.

    $$\text{NaCl} \underset{\text{Temp.}}{\overset{\text{Pr.}}{\rightleftharpoons}} \text{CsCl}$$

(6, 6) (8, 8)

18. (a) The face centered cubic unit cell contains 4 atom.

$\therefore$ Total volume of atoms $= 4\times\frac{4}{3}\pi r^3 = \frac{16}{3}\pi r^3$

19. (d) The statement (d) is correct.

20. (b) The volume of the unit cell

$= (2.88\ \text{Å})^3 = 23.9 \times 10^{-24}\ \text{cm}^3$.

The volume of 100 g of the metal

$= \frac{m}{\rho} = \frac{100}{7.20} = 13.9\ \text{cm}^3$

Number of unit cells in this volume

$= \frac{13.9\ \text{cm}^3}{23.9\times10^{-24}\ \text{cm}^3} = 5.82 \times 10^{23}$

Assertion/ Reason

1. **(b)** In crystalline solids constituents are arranged in definite orderly arrangement. This regular arrangement of constituents extends throughout the three dimensional network of crystal. Thus crystalline substances said to have long range order. Whereas amorphous solids have no regular arrangement.
2. **(a)**
3. **(d)** Tetrahedral holes are smaller in size than octahedral holes. Cations usually occupy less space than anions.
4. **(c)** Tetrahedral void is so called because it is surrounded by four spheres tetrahedrally while octahedral void is so called because it is surrounded by six spheres octahedrally.
5. **(b)**
6. **(a)** Schottky defect is due to missing of equal number of cations and anions.
7. **(a)** In case of semiconductors, the gap between valence band and the conduction band is small and therefore some of the electrons may jump from valence band to conduction band and thus on increasing temperature conductivity is also increased.
8. **(a)** All magnetically ordered solids (ferromagnetic, ferrimagnetic and antiferromagnetic solids) transform to the paramagnetic state at high temperature due to the randomisation of spins.

Matching Based Questions

1. (d)	2. (b)	3. (c)	4. (a)
5. (a)	6. (a)	7. (c)	8. (c)
9. (d)			

Critical Thinking Type Questions

1. **(a)**
2. **(d)** The *bcc* cell consists of 8 atoms at the corners and one atom at centre. Contribution of each atom at each corner is equal to $\frac{1}{8}$.

$\therefore n = \left(8\times\frac{1}{8}\right)+1 = 2$

The *fcc* cell consists of 8 atoms at the eight corners and one atom at each of the six faces. This atom at the face is shared by two unit cells.

$\therefore n = 8\times\frac{1}{8}+\left(6\times\frac{1}{2}\right) = 4$

3. **(b)** $A : B : C = \frac{1}{8}\times8 : \frac{1}{2}\times2 : \frac{1}{2}\times4 = 1 : 1 : 2$
4. **(d)** In a unit cell, W atoms at the corner $= \frac{1}{8}\times8 = 1$

O-atoms at the centre of edges $= \frac{1}{4}\times12 = 3$

Na-atoms at the centre of the cube = 1

W : O : Na = 1 : 3 : 1

Hence, formula = $NaWO_3$

5. **(b)** No. of M atoms = $\frac{1}{4}\times 4 + 1 = 1 + 1 = 2$

No. of X atoms = $\frac{1}{2}\times 6 + \frac{1}{8}\times 8$
$= 3 + 1 = 4$

So, formula = $M_2X_4 = MX_2$

6. **(a)**
7. **(a)** Following generalization can be easily derived for various types of lattice arrangements in cubic cells between the edge length (a) of the cell and r the radius of the sphere.

For simple cubic : $a = 2r$ or $r = \frac{a}{2}$

For body centred cubic :

$a = \frac{4}{\sqrt{3}}r$ or $r = \frac{\sqrt{3}}{4}a$

For face centred cubic :

$a = 2\sqrt{2}r$ or $r = \frac{1}{2\sqrt{2}}a$

Thus the ratio of radii of spheres for these will be simple : bcc : fcc

$= \frac{a}{2} : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a$

i.e. option (a) is correct answer.

8. **(a)** $\rho = \frac{ZM}{N_A V}$

$Z = \frac{\rho N_A V}{M} = \frac{2\times6\times10^{23}\times(5\times10^{-8})^3}{75}$

Z = 2, which represents *bcc* structure

$\therefore\ r = \frac{\sqrt{3}}{4}a = \frac{\sqrt{3}}{4} \times 5 = 2.165Å = 216.5$ pm

≈ 217 pm

9. (d) $\rho = \frac{Z \times M}{N_o \times a^3}$,

$2.7 = \frac{Z \times 27}{6.02 \times 10^{23} \times (4.05)^3 \times 10^{-24}}$

$\therefore\ Z = 4$

Hence it is face centred cubic unit lattice.

Again $4r = a\sqrt{2} = 5.727$ Å

$\therefore\ r = 1.432$ Å

Chapter - 16 Solutions

Fill in the Blanks

1. **0.2 m** 2. **0.25**
3. **Dissolution, crystallization**
4. **Pressure** 5. **Crystallisation**
6. **Supersaturated** 7. **Pressure**
8. **Low atmospheric pressure**
9. **Increase** 10. **Bends, helium**
11. **Lower** 12. $i_A = i_B = i_C$

True/ False

1.	**True**	**2.**	**True**	**3.**	**True**	**4.**	**False**
5.	**True**	**6.**	**True**	**7.**	**True**	**8.**	**True**
9.	**True**	**10.**	**True**	**11.**	**True**	**12.**	**False**

Conceptual MCQs

1. (c) For ideal solution,

$\Delta V_{mixing} = 0$ and $\Delta H_{mixing} = 0$.

2. (b) For an ideal solution, $\Delta H_{mixing} = 0$
$\Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3$ (Accroding to Hess's law)
i.e., for ideal solutions there is no change in magnitude of the attractive forces in the two components present.

3. (a) Molecular masses of polymers are best determined by osmotic pressure method . Firstly because other colligative properties give so low values that they cannot be measured accurately and secondly, osmotic pressure measurements can be made at room temperature and do not require heating which may change the nature of the polymer.

4. (b) Concentration of

$Na_2CO_3 = \frac{25.3}{106} \times \frac{1000}{250} = 0.955$ M

$[Na^+] = 2 \times 0.955 = 1.91$ M

$\left[CO_3^{2-}\right] = 0.955$ M

5. (a) A solution of acetone in ethanol shows positive deviation from Raoult's law. It is because ethanol molecules are strongly hydrogen bonded. When acetone is added, these molecules break the hydrogen bonds and ethanol becomes more volatile. Therefore its vapour pressure is increased.

6. (b) As $\Delta T_f = K_f.\ m;\ \ \Delta T_b = K_b.\ m$

Hence, we have $m = \frac{\Delta T_f}{K_f} = \frac{\Delta T_b}{K_b}$

or $\Delta T_f = \Delta T_b \frac{K_f}{K_b}$

$\Rightarrow [\Delta T_b = 100.18 - 100 = 0.18°C]$

$= 0.18 \times \frac{1.86}{0.512} = 0.654°C$

As the Freezing Point of pure water is 0°C,
$\Delta T_f = 0 - T_f$; $0.654 = 0 - T_f$
$\therefore\ T_f = -0.654$
thus the freezing point of solution will be – 0.654°C.

7. (d) $P = P_AX_A + P_BX_B = P_AX_A + P_B(1 - X_A)$

$\Rightarrow P_AX_A + P_B - P_BX_A$
$\Rightarrow P_B + X_A(P_A - P_B)$

8. (a) $K_4[Fe(CN)_6]$ and $Al_2(SO_4)_3$ both dissociates to give 5 ions or i = 5

$K_4[Fe(CN)_6] \rightleftharpoons 4K^+ + [Fe(CN)_6]^-$

and

$Al_2(SO_4)_3 \rightleftharpoons 2Al^3 \quad 3SO_4$

9. (d) Molarity (M) = $\frac{wt \times 1000}{\text{mol. wt.} \times \text{vol (ml)}}$

$2 = \frac{wt.}{63} \times \frac{1000}{250} \Rightarrow wt. = \frac{63}{2}$ gm

wt. of 70% acid = $\frac{100}{70} \times 31.5 = 45$ gm

10. (c) Colligative properties of dilute solution containing non volatile solute depends upon the number of particles of the solute present in the solution.

11. (a) Colligative property is strictly true only for dilute solutions which behaves as nearly ideal solution. These properties are : lowering of vapour

pressure of the solvent, osmotic pressure of the solution, elevation in boiling point of the solvent, depression in freezing point of the solvent.
Hence, option (a) is not true.

12. **(c)** According to Raoult's law
Relative lowering of vapour pressure

$$= \frac{p^\circ - p}{p^\circ} = \frac{n_{solute}}{n_{solute} + N_{solvent}} = x_{solute}$$

13. **(d)** The number of mole particles of $BaCl_2$, NaCl and sucrose in the solution are 3, 2 and 1 respectively.

14. **(d)** $C = \frac{\pi}{RT} = \frac{2.5}{0.082 \times 297} = 0.1025 \text{ mol } \ell^{-1}$

15. **(b)** More than theoretical weight since impurity will not contribute.

16. **(a)** Weight of solute or non electrolyte (w) = 1.25 gm
Weight of solvent or water (W) = 20 gm.
Freezing point of solution T = 271.94 K
Molal depression constant or cryoscopic constant K_f = 1.86 K $mole^{-1}$

Molar mass of solute (m) = $\frac{1000 \times K_f \times w}{(T_0 - T) \times W}$

$$= \frac{1000 \times 1.86 \times 1.25}{(273 - 271.94) \times 20} = \frac{50 \times 1.86 \times 1.25}{1.06} = 109.67$$

17. **(a)** Given : In the Ist solution,
Weight of urea (w_u) = 12 g
M_u = 60; V_w = 1 litre, and
In second solution, w_c = 68.4 gm; M_c = 342
We know that according to Ist solution,
Number of the moles of urea (n_u)

$$= \frac{w_u}{M_u} = \frac{12}{60} = \frac{1}{5} = 0.2$$

According IInd solution,
Number of the moles of cane sugar n_c

$$= \frac{w_c}{M_c} = \frac{68.4}{342} = 0.2$$

We know that lowering in vapour pressure depends on the number of solute. Since both solutions have same number of moles, therefore, lowering in V. P. will be same.
Hence, option (a) is correct.

18. **(a)** Change in O.N. of N in HNO_3 is 3, hence one formula weight has 3 equivalents.

$$3Sn + 12HCl + 4H\overset{+5}{N}O_3 \xrightarrow{+3e^-} 3SnCl_4 + 4\overset{+2}{N}O + 8H_2O$$

Since change in O.N. = 3

19. **(c)** Applying the law of equivalence,

$$N_1V_1 + N_2V_2 + N_3V_3 = N_RV_R$$

$$\frac{N}{10} \times 50 + \frac{N}{3} \times 30 + \frac{N}{2} \times 10 = N_R \times 1000$$

$$5N + 10N + 5N = 1000 \times N_R$$

$$\Rightarrow N_R = \frac{N}{50}$$

20. **(b)** Molality = mol kg^{-1} = $\frac{5.85}{58.5} = 0.1$

Assertion/ Reason

1. **(a)**

2. **(c)** Both the solute and solvent will form the vapours but vapour phase will become richer in the more volatile component.

3. **(b)** **4. (b)** **5. (d)** **6. (a)**

7. **(b)**

Matching Based Questions

1. **(d)** **2. (c)** **3. (b)** **4. (a)**

5. **(a)**

Critical Thinking Type Questions

1. **(a)** k_H = 100 kbar = 10^5 bar, p = 1 bar
$p = k_H \times x_A$

$$x_A = \frac{p}{k_H} = \frac{1}{100 \times 10^3} = 10^{-5}$$

Moles of water = $\frac{1000}{18} = 55.5$

Weight of water = 1000 g
($\because$ 1000 mL = 1000 g)

Mole fraction = $10^{-5} = \frac{x}{55.5 + x}$

As 55.5 >>> x, thus neglecting x from denominator

$$10^{-5} = \frac{x}{55.5} \Rightarrow x = 55.5 \times 10^{-5} \text{ moles}$$

or 0.555 millimoles.

2. **(c)**

3. **(c)** Equivalent weight of orthophosphoric acid

$$(H_3PO_4) = \frac{3 + 31 + 64}{3} = \frac{98}{3}$$

Now 100 gm solution contains 70 gm H_3PO_4

$\frac{100}{1000 \times 1.54}$ litre of solution contains

$\frac{70}{98/3}$ gm equivalent of H_3PO_4

Normality of solution

$$= \frac{\frac{70 \times 3}{98}}{\frac{1}{10 \times 1.54}} = \frac{70 \times 3}{98} \times 10 \times 1.54 = 33 \text{ N}$$

4. **(a)** According to idea of Raoult's law "partial pressure of one of the component is proportional to mole fraction of that component in the solution."

$P \quad P_1 x_1 \quad P_2 x_2$

$600 = 450\, x_1 + 700\, x_2 \Rightarrow 4.5\, x_1 + 7x_2 = 6$

$\because$ $x_1 + x_2 = 1 \therefore \quad x_1 = 0.6\ x_2 = 0.4$

$\Rightarrow$ $x_1 = 0.4, x_2 = 0.6$

5. **(a)** According to Raoult's law,

$P_T = x_A p_A^\circ + x_B p_B^\circ$ Given, $= P_{T_1}$ 500 mm Hg

$n_A = 1$ and $n_B = 2 \therefore x_A = 1/3$ and $x_B = 2/3$

$$\Rightarrow 500 = \frac{1}{3} p_A^\circ + \frac{2}{3} p_B^\circ$$

$$\Rightarrow 1500 = p_A^\circ + 2p_B^\circ \qquad ...(i)$$

Also given Qn that one more mole of B is added to the solution, the pressure of the ideal solution increases by 25 mm Hg.

$\therefore\ P_{T_2} = 500 + 25 = 525$ mm Hg

Also, $n_B = 3 \therefore x_A = 1/4$ and $x_B = 3/4$

$$525 = \frac{1}{4} p_A^\circ = \frac{3}{4} p_B^\circ \qquad ...(ii)$$

$2100 = P_A^\circ + 3P_B^\circ$ Subtract (i) and (ii),

$p_B^\circ = 600$ mm Hg

$p_A^\circ + 2p_B^\circ = 1500 \Rightarrow p_A^\circ = 300$ mm Hg.

6. **(b)** According to Raoult's law

$$\frac{\Delta p}{p^\circ} = \frac{n}{n+N} \text{ (mole fraction of solute)}$$

$$\frac{10}{p^\circ} = 0.2 \therefore\ p^\circ = 50 \text{ mm of Hg}$$

For other solution of same solvent

$$\frac{20}{p^\circ} = \frac{n}{n+N} \text{ (Mole fraction of solute)}$$

$$\Rightarrow \frac{20}{50} = \text{Mole fraction of solute}$$

$\Rightarrow$ Mole fraction of solute = 0.4

As mole fraction of solute + mole fraction of solvent = 1

Hence, mole fraction of solvent = 1 – 0.4 = 0.6

7. **(d)** $(100 + \Delta T_b) - (0 - \Delta T_f) = 105$

$\Delta T_b + \Delta T_f = 5; \quad m\,(k_b + k_f) = 5$

$m = \frac{5}{2.37}$ i.e., $\frac{5}{2.37}$ moles in 1000 g water

(or) $\frac{5}{2.37 \times 10}$ moles in 100 g water

$\therefore$ Wt. of sucrose $= \frac{5}{2.37 \times 10} \times 342 = 72$g

8. **(d)** 1% solution contains 1 g of the solute in 100 g of solution.

Osmotic pressure, $\pi = CRT$

The value of R and T is same for all the solute however, all of them undergo 100% dissociation

$\therefore \quad \pi \propto i \times C$

$i_{KCl} = 2$, $i_{NaCl} = 2$, $i_{BaCl_2} = 3$ and $i_{urea} = 1$.

$n_{KCl} = 1/74.5$

$$C_{KCl} = \frac{1/74.5}{100} \times 1000 = 0.13$$

or $\pi_{KCl} = 2 \times 0.13 = 0.26$

$$n_{NaCl} = \frac{1}{58.5}$$

$$C_{NaCl} = \frac{1/58.5}{100} \times 1000 = 0.17$$

$\therefore \pi_{NaCl} = 2 \times 0.17 = 0.34$; $n_{BaCl_2} = \frac{1}{208.4}$

$$C_{BaCl_2} = \frac{1/208.4}{100} \times 1000 = 0.048$$

or $\pi_{BaCl_2} = 3 \times 0.048 = 0.14$

$$n_{urea} = \frac{1}{60}$$

$$C_{urea} = \frac{1/60}{100} \times 1000 = 0.16$$

$\therefore \quad \pi_{urea} = 1 \times 0.16 = 0.16$

$\therefore \quad \pi_{BaCl_2} < \pi_{urea} < \pi_{KCl} < \pi_{NaCl}$

or III < IV < I < II

9. **(b)** Given $k_b = x$ K kg mol^{-1}

$\Delta T_b = k_b \times m \therefore\ y = x \times m$

$m = \frac{y}{x}$

We know, $\Delta T_f = k_{f \times m}$

On substituting value of m,

$\Delta T_t = \frac{yz}{x}$

Chapter - 17 Electrochemistry

Fill in the Blanks

1. **Negative, greater** 2. **Increased**
3. **Cell emf** 4. **Reference**
5. **Increasing** 6. **1×10^{10}**
7. $ohm^{-1}\ cm^2\ (g\ eq)^{-1}$ 8. **Remains constant**
9. Platinum when platinum electrodes are dipped in dilute solution H_2SO_4 than H_2 is evolved at cathode.
10. **9650**

True/ False

1. **True** 2. **True** 3. **True** 4. **True**
5. **True** 6. **True** 7. **False** 8. **True**
9. **False** 10. **True**

Conceptual MCQs

1. **(c)** Equivalent conductance of an electrolyte at infinite dilution is given by the sum of equivalent conductances of the respective ions at infinite dilution.
2. **(a)** We know that according to Debye Huckel rule, on dilution the ionisation of strong acid increases due to increasing volume. Since ionic mobility also increases. Therefore the conductivity of strong electrolyte increases on dilution slightly.
3. **(b)** In an electrolytic cell reduction occurs at cathode.
4. **(c)** The compounds which when dissolved in water, do not produce ions, are called as non-electrolytes. Therefore, $C_{12}H_{22}O_{11}$ is non-electrolyte because it does not give ions with water.

   Hence, option (c) is correct.
5. **(c)** As the value of standard reduction potential decreases the reducing power increases i.e.,

$$\underset{(-3.0)}{Z} > \underset{(-1.2)}{X} > \underset{(+0.5)}{Y}$$

6. **(b)** The given statement explains that Al is placed above Cu in E.C.S. hence it can reduce Cu from its salt solution (reduction). Thus Al acts as a reducing agent now,

   Given : electrode potential of copper

   $(E^0{}_{cell}) = +\ 0.34\ V$

   e.m.f of cell = 2 V

   We know that,

   emf of a galvanic cell $(E^0{}_{cell})$

   = electrode potential of Cu (cathode) – electrode potential of Al (anode)

   $2.0 = 0.34 - E^0{}_{Al}$

   $E^0{}_{Al} = 0.34 - 2.00 = -\ 1.66\ V$

   Hence, electrode potential of Al is – 1.66 V.

   Option (b) is correct.
7. **(d)** The equivalent conductivity of a solution,

$$\Lambda_{eq} = \frac{1000}{C} \times \kappa$$

   Where,

   κ = specific conductance = Unit $ohm^{-1}\ cm^{-1}$

   C = normality of the solution unit gm eq/cm^3

   Hence, the unit of Λ_{eq} is $Ohm^{-1}.cm^2$ (gm equivalent)$^{-1}$.
8. **(d)** At cathodes : $Fe^+ + 2e^- \longrightarrow Fe;$

$$Fe^{3+} + 3e^- \longrightarrow Fe$$

$$(E_{Fe})_1 = \frac{At.\ wt.}{2}; \quad (E_{Fe})_2 = \frac{At.\ wt.}{3}$$

   Hence, $\frac{(E_{Fe})_1}{(E_{Fe})_2} = \frac{3}{2}$
9. **(a)** Standard electrode potential i.e. reduction potential of A is minimum (–3.05V) i.e. its oxidation potential is maximum which implies 'A' is maximum reactive chemically.
10. **(d)** Higher the reduction potential, stronger is the oxidizing agent.
11. **(d)** For a concentration cell having different concentrations of ions.

$$E \quad \frac{0.0591}{n} \log \frac{c_1}{c_2}$$

   If all the concentrations are identical then obviously the cell voltage is zero. But as the pH of 0.1 M HCl (strong acid) & pH of 0.1M CH_3 COOH is (weak acid) not same, therefore the cell voltage is not zero.
12. **(d)** Standard Gibbs free energy is given as

   $\Delta G° = -\ nE°\ F$

   If $E°_{cell} < 0$ i.e. – ve; $\Delta G° > 0$

Further $\Delta G^\circ = -RT\,\ell n\,K_{eq}$

$\Delta G^\circ > 0$ when $K_{eq} < 0$

13. (c) By Kohlraush's law, $\wedge^0_{eq}\,NaCl = 126.45$

$$\lambda^0_{Na^+} + \lambda^0_{Cl^-} = 126.45 \qquad ....(1)$$

$$\lambda^0_{H^+} + \lambda^0_{Cl^-} = 426.16 \qquad ...(2)$$

$$\lambda^0_{CH_3OO^-} + \lambda^0_{Na^+} = 91 \qquad ....(3)$$

on adding (2) and (3) then subtract (1) from it

$$\lambda^0_{CH_3COO^-} + \lambda^0_{Na^+} = 517.16 - 126.45$$

$$^0_{(CH_3COOH)} = 390.71\,ohm^{-1}\,cm^2$$

14. (d) Given for the reaction

$$Zn_{(s)} + Cu^{2+}_{(aq)} \rightleftharpoons Cu_{(s)} + Zn^{2+}_{(aq)},$$

$E^o = +1.10$ V.

At equilibrium

$$\therefore\ E^\circ_{cell} = \frac{0.0591}{n}\log_{10} K_{eq}$$

here (n $\rightarrow$ number of exchange of electrons)

$$\text{or } 1.10 = \frac{0.0591}{2}\log_{10} K_{eq}$$

$$\frac{2.20}{0.059} = \log_{10} k_{eq} = 37.22$$

or $K_{eq} = 1.66 \times 10^{37}$

15. (b) In elctrochemical series, Sn is above hydrogen and Hg below hydrogen. Elements above hyrogen are reducing in nature while below hydrogen are oxidising in nature.)

16. (d) $\overset{0}{\Lambda}_{m(NH_4Cl)} = \overset{0}{\Lambda}_{mNH_4^+} + \overset{0}{\Lambda}_{mCl^-}$

$\overset{0}{\Lambda}_{m(NaOH)} = \overset{0}{\Lambda}_{mNa^+} + \overset{0}{\Lambda}_{mOH^-}$

$\overset{0}{\Lambda}_{(NaCl)} = \overset{0}{\Lambda}_{mNa^+} + \overset{0}{\Lambda}_{mCl^-}$

$\therefore\ \overset{0}{\Lambda}_{m}\left(NH_4^+\right) + \overset{0}{\Lambda}_{m}\left(OH^-\right)$

$= \overset{0}{\Lambda}_{m}\left(NH_4^+\right) + \overset{0}{\Lambda}_{m}\left(Cl^-\right) + \overset{0}{\Lambda}_{m}\left(Na^+\right)$

$+ \overset{0}{\Lambda}_{m}\left(OH^-\right) - \left[\overset{0}{\Lambda}_{m}\left(Na^+\right) + \overset{0}{\Lambda}_{m}\left(Cl^-\right)\right]$

$\overset{0}{\Lambda}_{m(NH_4OH)} = \overset{0}{\Lambda}_{m(NH_4Cl)} + \overset{0}{\Lambda}_{m(NaOH)}$

$- \overset{0}{\Lambda}_{m(NaCl)}$

17. (d) In the silver plating of copper, $K[Ag(CN)_2]$ is used instead of $AgNO_3$. Copper being more electropositive readily precipitate silver from their salt solution

$$Cu \quad 2AgNO_3 \qquad Cu(NO_3)_2 \quad Ag$$

whereas in $K[Ag\,(CN)_2]$ solution a complex anion $[Ag(CN)_2]^-$ is formed and hence Ag^+ are less available in the solution and therefore copper cannot displace Ag from its complex ion.

18. (b) Cell reaction is,

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$$

$$E_{cell} = E^o_{cell} - \frac{RT}{nF}\,In\,\frac{[Zn^{2+}]}{[Cu^{2+}]}$$

Greater the factor $\left[\dfrac{(Zn^{2+})}{(Cu^{2+})}\right]$, less is the EMF

Hence $E_1 > E_2$

19. (b) $2AgCl_{(s)} + H_{2(g)} \rightarrow 2HCl_{(aq)} + 2Ag_{(s)}$

The activities of solids and liquids are taken as unity and at low concentrations, the activity of a solute is approximated to its molarity.

The cell reaction will be

$$Pt_{(s)}\,|\,H_{2(g)}, 1bar\,|\,H^+_{(aq)}1M\,|\,AgCl_{(aq)}$$

$$1M\,|\,Ag_{(s)}$$

20. (c) The cell reacton is as follows :

$$A \rightarrow A^+ + e$$

$$B^+ + e \rightarrow B$$

$$\text{Adding}\quad A + B^+ \rightarrow A^+ + B$$

(c) is correct answer.

Assertion/ Reason

1. (b) We know, $R \propto \dfrac{\ell}{A}$ or $R = \rho\left(\dfrac{\ell}{A}\right)$, where proportionality constant ρ is called resistivity. If ℓ = 1m and A = 1m^2, then R = ρ i.e., Resistance = Resistivity.

2. **(d)** The specific conductivity decreases while equivalent and molar conductivities increase with dilution.

3. **(a)** Zinc metal which has a more negative electrode potential than iron will provide electrons in preference of the iron, and therefore corrodes first. Only when all the zinc has been oxidised, the iron start to rust.

4. **(d)** Electrical conductivity of every metal decreases with increase in temperature due to increase in molecular motion which increases resistance.

5. **(a)** Water is a covalent compund, hence pure water is a weak electrolyte and feebly ionised and thus bad conductor of electricity. However, addition of a small amount of acid or alkali increases ionisation of water making at good conductor of electricity.

6. **(b)** $Zn(l) + HgO(s) \rightarrow Zn(s) + Hg(l)$
The cell potential remains constant during its life as the overall reaction does not involve any ion in solution whose concentration changes during its life time.

7. **(a)** According to Kohlrausch law, "limiting molar conductivity of an electrolyte can be represented as the sum of the individual contributions of the anion and cation of the electrolyte."

Matching Based Questions

1. **(b)** 2. **(a)** 3. **(b)** 4. **(d)**
5. **(b)**

Critical Thinking Type Questions

1. **(a)** Cell reaction
cathode :

$$H_2O(\ell)+\frac{1}{2}O_2(g)+2e^- \longrightarrow 2OH^-(aq)$$

anode : $$H_2(g)\longrightarrow 2H^+(aq)+2e^-$$

$$H_2O(\ell)+\frac{1}{2}O_2(g)+H_2(g) \longrightarrow 2H^+(aq)+2OH^-(aq)$$

Also we have

$$H_2(g)+\frac{1}{2}O_2(g)\longrightarrow H_2O(\ell);$$

$$\Delta G_f^\circ = -237.2 \text{ kJ/mole}$$

$$H_2O(\ell)\longrightarrow H^+(aq)+OH^-(aq);$$

$$\Delta G^\circ = 80 \text{ kJ/mole}$$

Hence for cell reaction

$$\Delta G^\circ = -237.2+(2\times 80) = -77.20 \text{ kJ/mole}$$

$$\therefore\ E^\circ = -\frac{\Delta G^\circ}{nF} = \frac{77200}{2\times 96500} = 0.40\text{V}$$

2. **(c)** $2Cu^+ \longrightarrow Cu^{+2} + Cu$

$2e^- + Cu^{+2} \longrightarrow Cu$; $E_1^o = 0.34$V; ... (i)

$e^- + Cu^{+2} \longrightarrow Cu^+$; $E_2^o = 0.15$V; ...(ii)

$Cu^+ + e^- \rightarrow Cu$; $E_3^o = ?$ ...(iii)

Now, $\Delta G_1^o = -nFE_1^o = -2\times 0.34F$

$\Delta G_2^o = -1\times 0.15F$, $\Delta G_3^o = -1\times E_3^o F$

Again, $\Delta G_1^o = \Delta G_2^o + \Delta G_3^o$

$\Rightarrow -0.68F = -0.15F - E_3^o F$

$\Rightarrow E_3^o = 0.68 - 0.15 = 0.53V$

$E_{cell}^o = E_{cathode}^o(Cu^+/Cu) - E_{anode}^o(Cu^{+2}/Cu^+)$
= 0.53 – 0.15 = 0.38 V.

3. **(d)** $E_{cell} = 0$; when cell is completely discharged.

$$E_{cell} = E_{cell}^\circ - \frac{0.059}{2}\log\left(\frac{[Zn^{2+}]}{[Cu^{2+}]}\right)$$

$$\text{or } 0 = 1.1 - \frac{0.059}{2}\log\left(\frac{[Zn^{2+}]}{[Cu^{2+}]}\right)$$

$$\log\left(\frac{[Zn^{2+}]}{[Cu^{2+}]}\right) = \frac{2\times 1.1}{0.059} = 37.3$$

$$\therefore \frac{[Zn^{2+}]}{[Cu^{2+}]} = 10^{37.3}$$

4. **(b)** According to Kohlrausch's law, molar conductivity of weak electrolyte acetic acid (CH_3COOH) can be calculated as follows:

$$\Lambda^\circ_{CH_3COOH} = \left(\Lambda^\circ_{CH_3COONa} + \Lambda^\circ_{HCl}\right) - \Lambda^\circ_{NaCl}$$

$\therefore$ Value of Λ°_{NaCl} should also be known for calculating value of $\Lambda^\circ_{CH_3COOH}$.

5. **(b)** Λ° for CH_3COOH

$= \overset{\circ}{\lambda}_{CH_3COO^-} + \overset{\circ}{\lambda}_{Na^+} + \overset{\circ}{\lambda}_{H^+} + \overset{\circ}{\lambda}_{Cl^-} - \overset{\circ}{\lambda}_{Na^+} - \overset{\circ}{\lambda}_{Cl^-}$

$= \overset{\circ}{\lambda}_{CH_3COO^-} + \overset{\circ}{\lambda}_{H^+}$

= 90 + 425 – 125 = 390 mho cm^2 mol^{-1}.

Degree of dissociation

$(\alpha) = \frac{\Lambda_m^c}{\overset{\circ}{\Lambda}_m} = \frac{7.8}{390} = 0.02$

6. **(d)** $\Lambda_C = \Lambda_0 \times \alpha = 8$; $\Lambda_C = \frac{1}{R} \times \frac{\ell}{A} \times \frac{1000}{N}$

$R = \frac{0.4 \times 1000}{8 \times 0.1} = 500$ Ohms

7. **(c)** Correct Nernst equation is

$$E = E^o + \frac{2.303\,RT}{nF} \log_a M^{n+}.$$

8. **(c)** Using Faraday's second law of electrolysis,

$$\frac{\text{Weight of Cu deposited}}{\text{Weight of Ag deposited}} = \frac{\text{Equ. wt. of Cu}}{\text{Equ. wt. of Ag}}$$

$\Rightarrow \frac{w_{Cu}}{0.18} = \frac{63.5}{2} \times \frac{1}{108}$

$\Rightarrow w_{Cu} = \frac{63.5 \times 18}{2 \times 108 \times 100} = 0.0529$ g.

Chapter - 18 Chemical Kinetics

Fill in the Blanks

1. **Product of active masses of reactants at that time**
2. **Acidic, first (or basic, second).**
3. **1.765×10^{-4} kg/hr;**
4. **Very high temperature** 5. **Decreases**
6. **Average rate** 7. **2** 8. **Reactants**

True/ False

1.	**True**	**2.**	**False**	**3.**	**False**	**4.**	**True**
5.	**False**	**6.**	**True**	**7.**	**True**	**8.**	**True**
9.	**True**	**10.**	**True**	**11.**	**True**	**12.**	**True**
13.	**True**						

Conceptual MCQs

1. **(b)** For a first reaction $\frac{dx}{dt}$ k(a x)

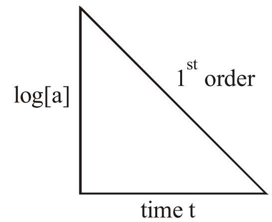
on intergration

$\{ \frac{dx}{(a \quad x)} \quad \{ k\,dt$

i.e – ℓn (a –x) = kt + c or kt = ℓn a – ℓn (a–x)

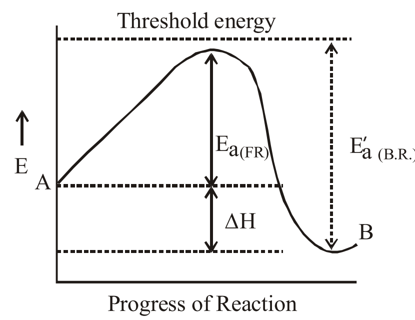
or kt = 2.303 [log a – log (a – x)]

Thus if we plot a graph between log a & t we get



2. **(a)** When concentration A is doubled, rate is doubled. Hence order with respect to A is one.
When concentrations of both A and B are doubled, rate increases by 8 times hence order with respect to B is 2. $\therefore$ rate = k $[A]^1$ $[B]^2$
Total order = 1 + 2 = 3

3. **(b)** $E_{a(Forward)} + \Delta H = E_{a(back\ word)}$
For Exothermic reaction, ΔH = –ve and
$\therefore$ activation energy of reactant is less than the energy of activation of products.



4. **(b)** $\Delta H = E_{a(f)} - E_{a(b)}$

Thus energy of activation for reverse reaction depend upon whether reaction is exothermic or endothermic

If reaction is exothermic,

$\Delta H = -ve \quad E_{a(b)} > E_{a(f)}$

If reaction is endothermic

$\Delta H = +ve \quad E_{a(b)} < E_{a(f)}$

5. **(d)** Rate of reaction

$-\frac{1}{5}\frac{d[Br^-]}{dt} = +\frac{1}{3}\frac{d[Br_2]}{dt}$

$\frac{d[Br_2]}{dt} = -\frac{3}{5}\frac{d[Br^-]}{dt}$

6. **(c)** For the reaction

$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ ...(i)

$K_1 = \frac{[NO_2]^2}{[N_2][O_2]}$

For the reaction

$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$ ...(ii)

$K_2 = \frac{[NO_2]^2}{[NO]^2[O_2]}$

For the reaction

$$NO_2(g) \rightleftharpoons \frac{1}{2}N_2(g) + O_2(g) \qquad ...(iii)$$

$$K = \frac{[N_2]^{\frac{1}{2}}[O_2]}{[NO_2]}$$

$$\text{Hence, } K = \sqrt{\frac{1}{K_1} \times \frac{1}{K_2}}$$

$$K = \frac{[N_2]^{\frac{1}{2}}[O_2]^{\frac{1}{2}}}{[NO]} \times \frac{[NO][O_2]^{\frac{1}{2}}}{[NO_2]}$$

$$= \frac{[N_2]^{\frac{1}{2}}[O_2]}{[NO_2]}$$

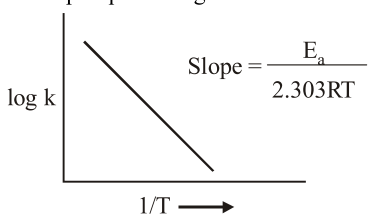
7. **(d)** $k = Ae^{-Ea/RT}$

or $\log k \quad \log A \quad \dfrac{E_a}{2.303\ RT}$

Comparing the above equation with
$y = mx + c$

$$y = \log k,\ x = \frac{1}{T}$$

Thus A plot of $\log_{10}k$ vs 1/T should be a straight line, with slope equal to – Ea/2.303 RT and intercept equal to log A



$$\therefore \quad \text{Slope} = \frac{-Ea}{2.303R} \text{ or } E_a = -2.303R \times \text{Slope}$$

8. **(d)** In the given options $-\dfrac{d[C]}{3.dt}$ will not represent the reaction rate. It should not have –ve sign as it is product.

since $\dfrac{1}{3}\dfrac{dC}{dt}$ show the rate of formation of product C which will be positive.

9. **(b,d)** According to Arrhenius equation

$$\ln\frac{K_2}{K_1} = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$= -\frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln\frac{K_1}{K_2} = -\frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

10. **(b)** $\text{Rate}_I = k\,[A]^x[B]^y \qquad ...(1)$

$$\frac{\text{Rate}_I}{4} = k\,[A]^x\,[2B]^y \qquad ...(2)$$

or $\text{Rate}_I = 4k[A]^x[2B]^y$
From (1) and (2) we get

$$\frac{k[A]^x[B]^y}{4} = k[A]^x[2B]^y$$

$$\frac{[B]^y}{4} = [2B]^y$$

$$\text{or } \frac{1}{4} = \left(\frac{2B}{B}\right)^y \Rightarrow \frac{1}{4} = 2^y \text{ or } 2^{-2} = 2^y$$

or $y = -2$.

11. **(d)** As the slowest step is the rate determining step thus the mechanism B will be more consistent with the given information also because it involve one molecule of H_2 and one molecule of ICl it can expressed as
$r = k\,[H_2][ICl]$
Which shows that the reaction is first order w.r.t. both H_2 & ICl.

12. **(d)** $(\text{Rate})_1 = K[A]^l[B]^m$;

$$(\text{Rate})_2 = K(10[Al])^l[B]^m$$

$$\text{Hence, } \frac{(\text{Rate})_2}{(\text{Rate})_1} = 100 = 10^l$$

or $10^2 = 10^l \Rightarrow l = 2$

13. **(d)** $H_{2(g)} + Br_{2(g)} \rightleftharpoons 2HBr_{(g)}$

Rate law, $R = k[H_2]\,[Br_2]^{1/2}$
Order of reaction = 1 + ½ = 3/2
Molecularity of reaction = 2

$$\text{The unit of } k = \frac{R}{[H_2][Br_2]^{1/2}}$$

$$= \frac{\text{mole. lit}^{-1}\text{s}^{-1}}{[\text{mole. lit}^{-1}][\text{mole. lit}^{-1}]^{1/2}}$$

$= \text{mole}^{-1/2}\ .\ \text{lit}^{1/2}\ .\ \text{s}^{-1}$

14. **(a)** It is a constant of a particular reaction at a given temperature. It does not depend upon initial concentration of the reactants, time of reaction and extent of reaction.

15. **(d)** Order of a reaction can be fractional. Rest of all are true.
Order of a reaction can be determined experimentally]

16. **(d)** Overall order = sum of orders w.r.t each reactant.
Let the order be *x* and *y* for G and H respectively

Exp.No.	[G]mole $litre^{-1}$	[H]mole $litre^{-1}$	rate(mole $litre^{-}time^{-1}$)
1	a	b	r
2	$2a$	$2b$	$8r$
3	$2a$	b	$2r$

Applying $r = k\,[G]^x\,[H]^y$ we get,
$x = 1, y = 2$
$\because$ For (1) and (3), the rate is doubled when conc. of G is doubled keeping that of H constant i.e., rate $\propto [G]$ $\therefore x = 1$
From (2) and (3), y = 2
$\therefore$ Overall order is 3.

17. **(a)** For a zero order reaction

$$t_{1/2} = \frac{a}{2k}$$

18. **(b)** $O_3 \xrightarrow{\text{Fast}} O_2 + O;\ O + O_3 \xrightarrow{\text{Slow}} 2O_2$

$k = \frac{[O_2][O]}{[O_3]}$ (I) Rate = k' $[O_3][O]$ put [O]

from (I) $r = \frac{k'[O_3]K[O_3]}{[O_2]} = k[O_3]^2[O_2]^{-1}$

Note intermediates are never represented in rate law equation.

19. **(c)** Order is the sum of the powers to which the concentration terms are raised in the rate equation.

20. **(a)**

Assertion/ Reason

1. **(b)** For a zero order reaction, $t_{1/2} = [A_0] / 2k$
2. **(b)** According to Arrhenius equation, $k = Ae^{-E_a / RT}$
   When $E_a = 0$, k = A.
3. **(a)**
4. **(a)** A calalyst is more effective in finely divided form because of more surface area.
5. **(b)** The formation of an activated complex takes place when vibrational degree of freedom convert into a translational degree of freedom. This statement is given by transition statement theory. Also the energy of activated complex is higher than the energy of reactant molecule is true but it is not the correct explanation of the assertion.
6. **(a)** Rate expression for the given reaction suggests that order of reaction with respect to C is zero. Hence it does not depend upon the concentration of C. Hence assertion and reason both are true and reason is the correct explanation of assertion.
7. **(b)** The order of a reaction can have fractional value. Assertion is true.
   The order of a reaction can not be written from balanced equation of a reaction because its value changes with pressure, temperature and concentration. It can only be determined experimentally. Thus the reason is also correct, but the reason is not the correct explanation of assertion.

Matching Based Questions

1. **(a)** 2. **(b)** 3. **(a)** 4. **(c)**
5. **(b)** 6. **(a)** 7. **(d)**

Critical Thinking Type Questions

1. **(b)** Rate law has to be determined experimentally as Cl_2 is raised to power $\frac{1}{2}$ in rate law whereas its stichiometric coefficient in balanced chemical equation is 1.
2. **(d)** From 1st and 2nd sets of data - no change in rate is observed with the change in concentration of 'C'. So the order with respect to 'C' is zero.
   From 1st and 4th sets of data
   Dividing eq. (4) by eq. (1)
   $$\frac{1.25\times10^{-3}}{5.0\times10^{-3}} = \left[\frac{0.005}{0.010}\right]^x$$
   or $0.25 = (0.5)^x$ or $(0.5)^2 = (0.5)^x$ $\therefore$ x = 2
   The order with respect to 'A' is 2 from the 1st and 3rd sets of data dividing eq. (1) by eq. (3)
   $$\frac{5.0\times10^{-3}}{1.0\times10^{-2}} = \left[\frac{0.005}{0.010}\right]^y$$
   or $(0.5)^1 = (0.5)^y \Rightarrow y = 1$
   The order with respect to 'B' is 1
   So the order with respective the reactants A, B and C is 2, 1 and 0.
3. **(a)** Rewriting the given data for the reaction
   $$CH_3COCH_3(aq) + Br_2(aq) \xrightarrow{H^+} CH_3COCH_2Br(aq) + H^+(aq) + Br^-(aq)$$

S. No.	Initial concent -ration of CH_3COCH_3 in M	Initial concentr -ation of Br_2 in M	Initial concentr -ation of H^+ in M	Rate of disappearance of Br_2 in Ms^{-1} i.e. $-\frac{d}{dt}[Br_2]$ or $\frac{dx}{dt}$
1	0.30	0.05	0.05	5.7×10^{-5}
2	0.30	0.10	0.05	5.7×10^{-5}
3	0.30	0.10	0.10	1.2×10^{-4}
4	0.40	0.05	0.20	3.1×10^{-4}

Actually this reaction is autocatalyzed and involves complex calculation for concentration terms.

We can look at the above results in a simple way to find the dependence of reaction rate (i.e., rate of disappearance of Br_2).

From data (1) and (2) in which concentration of CH_3COCH_3 and H^+ remain unchanged and only the concentration of Br_2 is doubled, there is no change in rate of reaction. It means the rate of reaction is **independent of concentration of Br_2.**

Again from (2) and (3) in which ($CH_3CO\ CH_3$) and (Br_2) remain constant but H^+ increases from 0.05 M to 0.10 i.e. doubled, the rate of reaction changes from 5.7×10^{-5} to 1.2×10^{-4} (or 12×10^{-5}), thus it also becomes almost doubled. It shows that rate of reaction is directly proportional to $[H^+]$. From (3) and (4), the rate should have doubled due to increase in conc of $[H^+]$ from 0.10 M to 0.20 M but the rate has changed from 1.2×10^{-4} to 3.1×10^{-4}. This is due to change in concentration of CH_3COCH_3 from 0.30 M to 0.40 M. Thus the rate is directly proportional to $[CH_3\ COCH_3]$. We now get

rate $= k\,[CH_3COCH_3]^1[Br_2]^0[H^+]^1$

$= k\,[CH_3COCH_3][H^+]$.

4. **(a)**

5. **(c)** Rate law : $-\dfrac{d[A]}{dt} = k[A]^x[B]^y$

Doubling $[A]$, rate is doubled. Hence $2^x = 2, x = 1$

Similarly $y = 1$; $-\dfrac{d[A]}{dt} = k[A][B]$

$$k = \frac{\text{rate}}{[A][B]} = \frac{2.0\times10^{-4}}{1\times10^{-2}\times2\times10^{-2}} = 1$$

$$\frac{(\text{rate})_2}{(\text{rate})_1} = \frac{k(2[A])(2[b])}{k[A][B]} = 4$$

6. **(d)** $\log k = \log A - \dfrac{E_a}{2.303RT}$ ...(1)

Also given $\log k = 6.0 - (2000)\dfrac{1}{T}$ ...(2)

On comparing equations, (1) and (2)

$\log A = 6.0 \Rightarrow A = 10^6\ s^{-1}$

and $\dfrac{E_a}{2.303\,R} = 2000$;

7. **(b)** $T_2 = T$ (say), $T_1 = 25°C = 298K$,

$E_a = 104.4\ kJ\ mol^{-1} = 104.4 \times 10^3\ J\ mol^{-1}$

$k_1 = 3 \times 10^{-4}$, $k_2 = ?$,

$$\log\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$\log\frac{k_2}{3\times10^{-4}} = \frac{104.4\times10^3\ J\ mol^{-1}}{2.303\times(8.314\ J\ K^{-1}mol^{-1})}\left[\frac{1}{298} - \frac{1}{T}\right]$$

As $T \to \infty, \dfrac{1}{T} \to 0$

$$\therefore \log\frac{k_2}{3\times10^{-4}} = \frac{104.4\times10^3\ J\ mol^{-1}}{2.303\times8.314\times298}$$

$$\log\frac{k_2}{3\times10^{-4}} = 18.297, \frac{k_2}{3\times10^{-4}} = 1.98\times10^{18}$$

$$k_2 = (1.98\times10^{18})\times(3\times10^{-4}) = 6\times10^{14}s^{-1}$$

8. **(b)**

Chapter - 19 Surface Chemistry

Fill in the Blanks

1. **Both absorption and adsorption**
2. **Decrease**
3. **Increase**
4. **Increase**
5. **Vander Waal's**
6. **1**
7. **Equilibrium**
8. **Biochemical catalysis**
9. Milk is a emulsion in which liquid is dispersed in liquid.
10. **Kraft temperatue**

True/ False

1.	**True**	2.	**True**	3.	**False**	4.	**False**
5.	**True**	6.	**True**	7.	**False**	8.	**True**
9.	**True**	10.	**True**	11.	**False**		

Conceptual MCQs

1. **(d)**
2. **(b)** The stability of a lyophilic sol is due to both the charge and solvation of particles, but largely to the latter factor.
3. **(b)** Cloud consists of fine droplets of water suspended in air.
4. **(b)** Crystalloids. can easily be obtained in the crystalline form and their solution can diffuse rapidly through a vegetable or animal membrane [i.e., parchment membrane]; e.g. sugar, urea, salts, acids, etc.
5. **(d)** Air is a homogeneous mixture of gases, mainly nitrogen and oxygen.
6. **(c)** The theory of heterogeneous catalysis is based upon the phenomenon of adsorption. The activity of catalyst is due to the presence of free valencies on its sufrace due to which surface of catalyst has force of attraction.
7. **(a)** Wood charcoal is used to decolourise sugar because it has a highly porous structure, providing a large surface area for adsorption. Therefore it adsorbs coloured material from sugar.

Option (a) is correct.

8. (c) Liquid-liquid system is known as emulsion.

9. (a) The colloidal particles have diameter 1-100 nm.

10. (d) Adsorption is accompanied by evolution of heat as the residual forces acting along the surface of adsorbent decrease i.e., adsorption is accompanied by decrease in enthalpy.

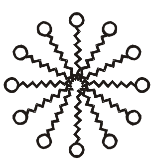
11. (d) The use of membrane for separating colloidal particles is termed as dialysis. Hence it is clear that colloidal particle cannot pass through animal membrane. Hence only solvent molecules and ions (in case of electrodialysis) can diffuse.

12. (d) According to the Hardy schulze rule the coagulating effect of an ion on dispersed phase of opposite charge increases with the valency of the ion. Therefore more the charge on oppositely charged ion higher is the coagulation value

13. (c) According to this law the coagulating effect of an ion on dispersed phase of opposite charge increases with the valency of the ion. The precipitating power of Al^{3+} , Ba^{++}, Na^{+} ions is in order $Al^{3+} > Ba^{2+} > Na^{+}$.

14. (a) On increasing temperature adsorption of a gas on surface of solid decreases. Solid adsorb greater amount of substances at lower temperature.

15. (a)



o- Polarhead
n- Non-polar tail
(micelle)

16. (a) According to the adsorption theory of catalysis, the activity of catalysis is due to the presence of free valencies on its surface due to which surface of catalyst has chemical force of altraction. When a gas comes in contact with this surface molecules get attached attached through these valencies. Further the rate of reaction is always increases by decreases in activation energy
When any of the reactants is strongly adsorbed on the surface of catalyst, the rate becomes inversely proportional to the concentration of that reaction. The reaction is then said to be inhibited by such reactant. The lowering of activation energy always leads to the increase in speed of reaction.

17. (a) Langmuir adsorption isotherm is based on the assumption that every adsorption site is equivalent and the ability of a particle to bind there is independent of whether or not nearby sites are occupied.

18. (c) For a protective colloid μ lesser the value of gold number better is the protective power.
Thus the correct order of protective power of A, B, C and D is

	(A)	< (C)	< (B)	< (D)
⇒				
Gold number	0.50	0.10	0.01	0.005

Hence (c) is the correct answer

19. (d)

20. (b) The lyophobic sols are less stable than lyophilic sols. The lyophilic sols are thus used to protect the lyophobic sols. This property of lyophilic sols is known as protective action of lyophilic sols.
Which can be represented by gold number.

Assertion/ Reason

1. (c) Assertion is true, reason is false. When several lines have the same value of $\frac{1}{n}$, then the lines by which their adsorption isotherms can be represented will be parallel and will not meet at a point.

2. (d) Assertion is false but Reason is true. The enthalpy of chemisorption is of the order of 40 - 400 $kJmol^{-1}$ while for physical adsorption it is of the order of 20 - 40 $kJmol^{-1}$.

3. (c) Assertion is true but Reason is false.
Freundlich adsorption isotherm gives an empirical relationship between the quantity of gas adsorbed by unit mass of solid adsorbent and pressure at a particular temperature.

4. (a) **5. (c)**

6. (a) Colligative properties depend upon number of particles.

Matching Based Questions

1. (a) **2. (a)**

3. (a) (A) V_2O_5 is used as a catalyst during the preparation of H_2SO_4
(B) Ziegler-Natta is used as a catalyst during the preparation of HDPE.
(C) Peroxide is used as a catalyst during the preparation of polyacrylonitrile.
(D) Finely divided Fe is used as a catalyst during the preparation of ammonia.

4. (a) **5. (d)** **6. (a)** **7. (a)**

8. (c) **9. (a)** **10. (b)**

11. (d) Argyrol is used as an eye lotion.
Antimony is used in Kalazar.
Collidal gold is used in intramuscular injection.
Milk of magnesia is used in the stomach disorder.

Critical Thinking Type Question

1. (c) Adsorption is an exothermic process, hence ΔH will always be negative.

2. (b) The adsorption of methylene blue on activated charcoal is an example of physiosorption which is exothermic, multilayer and does not have energy barrier.

3. (c) Homogenous catalysis does not involves adsorption.

4. (a)
5. (b) Given reactions shows that the selectivity of different catalysts for same reactants is different.
6. (a) Colloid of liquid in liquid is called emulsion. Colloid of liquid in solid is gel.
7. (b) When oppositely charged sols are mixed their charges
are neutralised. Both sols may be partially or completely precipitated.
8. (d) Tannin used in leather industry contains negatively charged colloidal particles.

Chapter - 20 General Principles and Processes for Isolation of Elements

Fill in the Blanks

1. **Tin** **2.** **Aluminium**
3. **Magnesia and lime; calcium silicate**
4. **sintering, smelting.**
5. **Tin** **6.** **Sulphide ores**
7. **Electromagnetic separation**
8. **Roasting** **9.** **Calcination**
10. **CO** $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
11. **Si** **12.** **Na**

True/ False

1.	**False**	**2.**	**True**	**3.**	**False**	**4.**	**True**
5.	**True**	**6.**	**True**	**7.**	**True**	**8.**	**True**
9.	**False**	**10.**	**True**				

Conceptual MCQs

1. (c) NOTE : Galena is PbS and thus purified by froth floatation method.
Froath floatation method is used to concentrate sulphide ores. This method is based on the preferential wetting properties with the froathing agent and water.
2. (b) During the process of electrolytic refining Ag and Au are obtained as anode mud.
3. (d)
4. (b) Argentite (Ag_2S) is a sulphide ore. It is not an acidic ore.
5. (b) NOTE : During the extraction of copper, iron is present in the ore as impurity (FeS).
The ore together with a little coke and silica is smelted; FeS present as impurity in the ore is oxidized to iron oxide, which then reacts with silica to form fusible ferrous silicate which is removed as slag.

$$2FeS + 3O_2 \longrightarrow 2FeO + 2SO_2\uparrow\ ;$$
$$FeO + SiO_2 \longrightarrow \underset{\text{(Slag)}}{FeSiO_3}$$

6. (d) Leaching is the selective dissolution of the desired mineral leaving behind the impurities in a suitable dissolving agent eg
Argentitie or Silver glance, Ag_2S is an ore of silver. Silver is extracted from argentite by the mac-Arthur and Forest process (leaching process).

$$Ag_2S + 4NaCN \rightarrow 2Na[Ag(CN)_2] + Na_2S$$
$$4Au + 8KCN + 2H_2O + O_2 \rightarrow 4K[Au(CN)_2] + 4KOH$$

7. (b) Cyanide process is for gold (I-D); floatation process - pine oil (II-B); Electrolytic reduction - Al (III-C); Zone refining -Ge (IV-A).
8. (b) Zr and Ti are purified by van Arkel method.

$$Zr(s) + 2I_2(g) \longrightarrow ZrI_4(g)$$
$$ZrI_4(g) \xrightarrow[\text{filament}]{\text{On the hot}} Zr(s) + 2I_2(g)$$

9. (d)
10. (a) Most metals occur in their combined state. They have to be reduced to become free metals. The choice of reducing agent is decided by the factors of energetics and economics. In this regard C is the most common reducing agent used. Carbon can be used in the form of coal, coke, charcoal and carbon monoxide. e.g :-

$$SnO_2 + 2C \xrightarrow{1473-1573K} Sn + 2CO$$
$$ZnO + CO \xrightarrow{1600K} Zn + CO_2$$
$$Fe_2O_3 + CO \xrightarrow{823K} 2FeO + CO_2$$
$$FeO + CO \xrightarrow{1123K} Fe + CO_2$$

11. (a) Silver ores are Ag_2S (argentite) and AgCl (horn silver). Haematite is ore of iron, bauxite of Aluminium and stibnite (Sb_2S_3) is an ore of antimony.
12. (a) Cuprous oxide formed during roasting of cuprous sulphide is mixed with few amount of cuprous sulphide and heated in a reverberatory furnace to get metallic copper.

$$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2(g)$$

13. (c) SiO_2 is an acidic flux.
14. (b) In froth floatation process, ore particles float because their surface is hydrophobic i.e., not easily wetted by oil.
15. (b) Highly electropositive element Na is extracted by electrolytic reduction.
16. (d) Basic flux is used to remove the impurities in the metallurgy of Al.
17. (b) Aluminium has the power of displacing elements less electropositive than itself from their oxides as it has great affinity for oxygen at high temperature. The reaction being so strongly exothermic that the metal set free is obtained in the molten condition and it is protected from oxidation by a layer of fluid slag consisting of Al_2O_3.

$$Oxide + Al \longrightarrow \underbrace{Al_2O_3 + metal}_{\text{Molten state}} + \text{heat energy}$$

18. **(b)** Mg is highly electropositive.

19. **(b)** In the Bassemer converter the molten matter (Cu_2S and little FeS) is heated in blast of air. A part of cuprous sulphide is oxidised into cuprous oxide which combines with remaining Cu_2S to form copper metal.

$$2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 3SO_2$$
$$2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$$

Option (b) is correct.

20. **(a)** Refractory metals are used in the construction of furnaces because they can withstand high temperature e.g. silica, flint, lime, etc.
Option (a) is correct.

Assertion/ Reason

1. **(c)** Assertion is true but reason is false.
Oxide ores being heavier than the earthy or rocky gangue particles, settle down while lighter impurities are washed away.

2. **(a)**

3. **(d)** Assertion is false but reason is true. Leaching is a process of concentration.

4. **(b)** Both assertion and reason are true but reason is not the correct explanation of assertion. Non fusible mass present in ore in mixing with suitable flux are fused which are then reduced by coke to give free metal.

5. **(a)** Both assertion and reason are correct and reason is the correct explanation of assertion.

6. **(a)**

Matching Based Questions

1. **(a)** **2.** **(c)** **3.** **(a)** **4.** **(b)**

5. **(a)**

6. **(b)** Cyanide process is for gold (A - s); floatation process - pine oil (B - q); Electrolytic reduction - Al (C - r); Zone refining -Ge (D - p).

7. **(b)** **8.** **(a)**

Critical Thinking Type Questions

1. **(b)** The reactions involved in cyanide extraction process are :

$$\underset{\text{(argentite)}}{Ag_2S} + 4NaCN \rightarrow 2Na[Ag(CN)_2] + Na_2S$$

$$4Na_2S + \underset{\text{Oxiding agent}}{5O_2} + 2H_2O \rightarrow 2Na_2SO_4 + 4NaOH + 2S$$

$$2Na[Ag(CN)_2] + \underset{\text{(reducing agent)}}{Zn} \rightarrow Na_2[Zn(CN)_4] + 2Ag\downarrow$$

2. **(d)** The sulphide ore is roasted to oxide before reduction because the ΔG_f^o of most of the sulphides are greater than those of CS_2 and H_2S, therefore neither C nor H can reduce metal sulphide to metal. Further, the standard free energies of formation of oxide are much less than those of SO_2. Hence oxidation of metal sulphides to metal oxide is thermodynamically favourable.

3. **(d)** Ellingham diagrams are based on thermodynamic concepts. It does not tell anything about the kinetics of the reduction process.

4. **(a)** FeO is capable forming slag with SiO_2

$$SiO_2 + FeO \rightarrow FeSiO_3$$

5. **(c)**

6. **(c)** The iron obtained from blast furnace is pig iron with 4% carbon and impurities like S, P, Mn etc., in small amount.

7. **(a)** (iii) and (iv) reactions occur in the temperature range of 900 – 1500K in blast furnace.

8. **(d)** Na reacts vigorously with water (exothermic process)

9. **(b)** During electrolytic refining of copper electrolyte used is acidified solution of copper sulphate.

Chapter - 21 The p-Block Elements (Group 15, 16, 17 and 18)

Fill in the Blanks

1. **–3;** **2.** **$NaIO_3$** **3.** **HF** **4.** **KI_3**

5. **white/ yellow** **6.** **Hypobromous; bromite.**

7. **cross-linking;** **8.** **two**

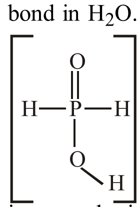
9. **four** **10.** **I_3^- complex ion**

True/ False

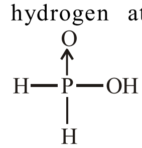
1.	False	2.	False	3.	True	4.	True
5.	False	6.	False	7.	True	8.	False
9.	False	10.	True	11.	False	12.	True
13.	True	14.	False	15.	True		

Conceptual MCQs

1. **(b)** H - S bond is weaker than H—O bond due to large size of S. Moreover due to high electronegativity of oxygen it forms hydrogen bond in H_2O.

2. **(b)**  Hypophosphorous acid (H_3PO_2)

is a monobasic acid. i.e., it has only one ionisable hydrogen atom or one OH is present



3\. (b) If acidic nature is high, K_a is high and pk_a is low

	H_2O	H_2S
K_a	1.8×10^{-6}	1.3×10^{-7}
	H_2Se	H_2Te
K_a	1.3×10^{-4}	2.3×10^{-3}

since $pk_a = -\log k_a$

Hence the order of pk_a will be

$H_2O > H_2S > H_2Se > H_2Te$

4\. (b) The structure of NO is $\overset{\cdots}{N} = O$. It is an odd electron molecule and is paramagnetic. It contains a three electron bond.

5\. (b) The basic character decreases from NH_3 to BiH_3. The basic nature is due to the presence of lone pair of electrons on the central atom. NH_3 is the strongest electron pair donor due to its small size as the electron density of the electron pair is concentrated over a small region. As the size increases the electron density gets diffused over a large region and hence the ability to donate the electron pair (basic nature) decreases.

6\. (d) Out of N, S and C, nitrogen has the highest electronegativity and it decrease in the order N > S > C. Thus the oxide of nitrogen in its highest (+5) oxidation state will the most acidic.

Next to N_2O_5 in the decreasing order of acidity will be SO_2 then CO_2 and finally CO which is neutral.

7\. (a) Nitric acid attacks proteins forming a yellow nitro compound called xanthoprotein. It therefore, stains skin and renders wool yellow. This property is utilised for the test of proteins.

8\. (a) The size of anion is always larger than corresponding neutral atom. So S^{2-} has larger radii and larger size than S.

9\. (a) NCl_5 in not possible because N does not contain d orbitals.

Only nitrogen has a tendency to form $p\pi - p\pi$ multiple bonds. Other forms $d\pi - p\pi$ multiple bonds easily.

10\. (a) Boiling point of NH_3 is high due to intermolecular hydrogen bonding. In others it varies directly with molecular weight of molecule due to increased vander wall's force. This force is least in PH_3 & highest in SbH_3. So (a) is the correct option.

11\. (b) $Xe + F_2 \xrightarrow{673K} XeF_2$

2 : 1

$Xe + 2F_2 \xrightarrow[5-6Alm]{673K} XeF_4$

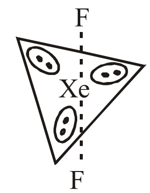
1 : 5

$Xe + 3F_2 \xrightarrow[50-60\ Atm]{573K} XeF_6$

1 : 20

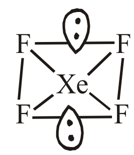
Structures of Xenon fluorides

Xe F_2 : Hybridization sp^3d



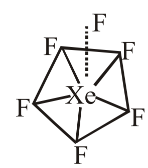
Linear

Xe F_4 : Hybridization sp^3d^2



Square planar

XeF_6 : Hybribisation sp^3d^3



Pentagonal pyramidal or distorted octahedral

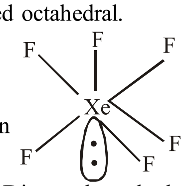
12\. (a) HI is most acidic due to weak bonding between H and I. It breaks into H^+ and I^+. HF is weakest acid because of extensive hydrogen bonding H^+ does not ionise freely.

13\. (c) $\underset{\text{Acidic}}{P_4O_{10}} + 2H_2O \longrightarrow \underset{\text{meta phosphoric acid}}{4HPO_3}$

$\xrightarrow[\text{basic}]{NH_3} \underset{\text{meta ammonium phosphate}}{NH_4PO_3}$

14\. (a) sp^3d^3 hybridization will give pentagonal bipyramid geometry with one trans position occupied by a lone pair and shape of the molecule will be distorted octahedral.

XeF_6 sp^3d^3 hybridisation



Distorted octahedral

15\. (d) Fluorine does not form oxyacids because in oxyacids halogen has positive oxidation state. Fluorine is most electronegative element. It can not have positive oxidation state. So it does not form oxyacids.

16\. (b) In halogens electron affinity decreases in group

except chlorine
$Cl > F > Br > I$
The electron gain enthalpy of F is less negative than that of Cl because of its small size as a result of which inter-electronic repulsions present in its 2p subshell are comparatively large.

17. **(b)** In case of nitrogen, d-orbitals are not available.
18. **(a)** We know that empirical formula of hypophosphorus acid is H_3PO_2. In this only one ionisable hydrogen atom is present i.e. it is monobasic. Therefore option (a) is correct structural formula of it.
19. **(c)** $2XeF_6 + SiO_2 \rightarrow SiF_4 + 2XeOF_4$
20. **(d)** The most abundant rare gas found in the atmosphere is argon and not helium.

Assertion/ Reason

1. **(c)** At higher temperatures, dinitrogen combines with metals to form ionic nitrides.
2. **(c)**
3. **(a)** Both assertion and reason are true and reason is the correct explanation of assertion.

$$\underset{\text{(metal)}}{M} + \underset{\text{(conc.)}}{HNO_3} \longrightarrow \underset{\text{(metal nitrate)}}{MNO_3} + \underset{\text{(nascent hydrogen)}}{H}$$

$$2HNO_3 + \underset{\text{(nascent hydrogen)}}{2H} \longrightarrow 2NO_2 + 2H_2O$$

4. **(b)** White phosphorus exists as P_4 tetrahedral molecule having P-P-P bond angle 60º. Hence the molecule is under strain and more reactive. On the other hand red phosphorus exists as P_4 tetrahedra which are joined together through covalent bonds giving polymeric structure.
5. **(c)** Bond angle of H_2S (92°) < H_2O (104°31). As the electronegativity of the central atom decreases, bond angle decreases. In the present case, S is less electronegative than oxygen. Thus bond pairs in H_2S are more away from the central atom than in H_2O and thus repulsive forces between bond pairs are smaller producing smaller bond angle.
6. **(a)** 7. **(a)**

Matching Based Questions

1. (b)	2. (a)	3. (a)	4. (c)
5. (a)	6. (b)	7. (b)	8. (b)
9. (b)	10. (a)	11. (c)	12. (a)

Critical Thinking Type Questions

1. **(b)** NO_2 and N_2O_4 has + 4 oxidation state for nitrogen.
2. **(c)** $3CuSO_4 + 2PH_3 \rightarrow Cu_3P_2 + 3H_2SO_4$
$3HgCl_2 + 2PH_3 \rightarrow Hg_3P_2 + 6HCl$
3. **(c)** From the given options we find option (a) is correct. The oxidising power of halogens follow the order $F_2 > Cl_2 > Br_2 > I_2$. Option (b) is incorrect because it in not the correct order of electron gain enthalpy of halogens.
The correct order is $Cl_2 > F_2 > Br_2 > I_2$. The low value of F_2 than Cl_2 is due to its small size. Option (c) is incorrect. The correct order of bond dissociation energies of halogens is $Cl_2 > Br_2 > F_2 > I_2$.
Option (d) is correct. It is the correct order of electronegativity values of halogens. Thus option (b) and (c) are incorrect.
4. **(a)** Metal halides with higher oxidation state are more covalent than the one in lower oxidation state.
5. **(d)** $\overset{+1}{NaClO} \longrightarrow \overset{+5}{NaClO_3} + 2\overset{-1}{NaCl}$
All statements are correct as evident from the reaction
6. **(d)** (i) The first ionization energy of xenon (1, 170 kJ mol^{-1}) is quite close to that of dioxygen (1,180 kJ mol^{-1}).
(ii) The molecular diameters of xenon and dioxygen are almost identical.
Based on the above similarities Barlett (who prepared $O_2^+[PtF_6]^-$ compound) suggested that since oxygen combines with PtF_6, so xenon should also form similar compound with PtF_6.

Chapter - 22 The d and f-Block Elements

Fill in the Blanks

1. **PbO_2** 2. **H_2S** 3. **2** 4. **Sc**
5. Gun metal is an alloy of Cu, Zn and Sn. It contains 88% Cu, 10% Sn and 2% Zn.
6. **CrO_4^{2-}** 7. **IO_3^-** 8. Pyrolusite (It is MnO_2)
9. **28** 10. **7**

True/ False

1. True	2. True	3. True	4. True
5. True	6. True	7. True	8. True
9. False	10. False	11. True	12. True

Conceptual MCQs

1. **(a)** According to VSEPR theory, a molecule with six bond pairs must be octahedral.
2. **(b)** Always transition metals combines with more than one carbonyl group.
3. **(b)** $2CuSO_4 + K_4[Fe(CN)_6] \longrightarrow \underset{\text{Chocolate ppt.}}{Cu_2[Fe(CN)_6]} + 2K_2SO_4$

4. **(c)** We know that regular decrease in the size of the atoms and ions is called lanthanide contraction. In vertical column of transition elements there is a very small change in size and some times size is found same from second member to third member.The similarity in size of the atoms of Zr and Hf is evident due to the object of lanthanide contraction. Therefore Zr and Hf both have same radius 160 pm.

5. **(d)** We know that chromium (III) salts dissolve in water to give violet solution. The violet colour is due to the hydrated chromium (III) in

$$[Cr(H_2O)_6]^{3+}.$$

6. **(b)** Manganese shows max. no. of oxidation states, +2, +3, + 4, + 5, + 6, + 7
Other metals shows the following oxidation states
Cr = + 2, +3, + 4, + 5, + 6 Fe = + 2, + 3
Ti = + 2, + 3, + 4

7. **(d)** Magnetic moment $\mu = \sqrt{n(n+2)}$ where n = number of unpaired electrons
$\sqrt{15} = \sqrt{n(n+2)}$ $\therefore$ n = 3

8. **(c)** In lanthanide series there is a regular decrease in the atomic as well as ionic radii of trivalent ions (M^{3+}) as the atomic number increases. Although the atomic radii do show some irregularities but ionic radii decreases from La(103 pm) to Lu (86pm).

9. **(a)** The basic character of the transition metal monoxide is TiO > VO > CrO > FeO because basic character of oxides decrease with increase in atomic number. Oxides of transitional metals in low oxidation state i.e., + 2 and + 3 are generally basic except Cr_2O_3.

10. **(b)** The cause of showing different oxidation is due to the fact that there is only a small difference between the energies of electron in the *ns* orbitals and *(n – 1)d* orbitals with the result both *ns* as well *(n – 1)d* electrons can be used for compound formation. Lesser energy difference between 5f and 6d orbitals than between 4f and 5d orbitals result in larger no. of oxidation state.

11. **(d)** The electronic configuration of different species given in the question are :

(a) $_{22}Ti^{3+} : 1s^2 2s^2 p^6 3s^2 p^6 d^1$

(b) $_{22}Ti^{+} : 1s^2 2s^2 p^6 3s^2 . p^6 d^2 4s^1$

(c) $_{22}Ti^{4+} : 1s^2 2s^2 p^6 3s^2 p^6$

(d) $_{22}Ti^{2+} : 1s^2 2s^2 p^6 3s^2 p^6 d^2$

Thus options (a) and (c) are discarded; now let us observe the second point of difference.

$_{23}V^{4+} : 1s^2 2s^2 p^6 3s^2 p^6 d^1$ Thus option (b) is discarded

$_{23}V^{3+} : 1s^2 2s^2 p^6 3s^2 p^6 d^2$

$_{24}Cr^{4+} : 1s^2 2s^2 p^6 3s^2 p^6 d^2$

$_{25}Mn^{5+} : 1s^2 2s^2 p^6 3s^2 p^6 d^2$

12. **(c)** For third ionization enthalpy last configuration of

		3d					4s
V	$-4s^0 3d^3$	1	1	1			
Cr	$-4s^0 3d^4$	1	1	1	1		
Mn	$-4s^0 3d^5$	1	1	1	1	1	
Fe	$-4s^0 3d^6$	1⇂	1	1	1	1	

For third Ionization enthalpy Mn has stable configuration due to half filled d-orbital.

13. **(c)** The transition metals and their compounds are used as catalysts. Because of the variable oxidation states, due to this, they easily absorb and re-emit wide range of energy to provide the necessary activation energy.

14. **(b)** There is a steady decrease in the radii as the atomic number of the lanthanide elements increases. For every additional proton added in nucleus the corresponding electron goes to 4*f* subshell.
The shape of f -orbitals is very much diffused and they have poor shielding effect. The effective nuclear charge increases which causes the contraction in the size of electron charge cloud. This contraction in size is quite regular and known as Lanthanoid contraction.
Since the change in the ionic radii in the lanthanide series is very small, thus their chemical properties are similar.

15. **(c)** Zinc blende mainly contains ZnS and not $ZnCl_2$.

16. **(b)** $Ag_2S + 4NaCN + 2O_2 \longrightarrow 2Na[Ag(CN)_2] + Na_2SO_4$

17. **(d)** Mohr's salt is $FeSO_4.(NH_4)_2SO_4.6H_2O$
The oxidation state of iron is +2 in it.

(a) $\underset{\text{Coloured}}{\overset{+7}{Mn}O_4^-} + 5Fe^{2+} + 8H^+ \longrightarrow \underset{\text{Colourless}}{Mn^{2+}} + 5Fe^{3+} + 4H_2O$

(b) It is a primary standard since it is available in pure state & can be stored without decomposition.

(c) It is a double salt since in solution it shows properties of Fe^{2+}, SO_4^{2-}, NH_4^+.

18. **(d)** $2HgCl_2 + SnCl_2 \longrightarrow \underset{\text{White ppt}}{HgCl_2} + SnCl_4$

$Hg_2Cl_2 + SnCl_2 \longrightarrow \underset{\text{grey}}{2Hg} + SnCl_4$

19. **(b)** The colour exhibited by transition metal ions is due to the presence of unpaired electrons in *d*-orbitals which permits the *d* - *d* excitation of electrons.

In TiF_6^{2-} – Ti is in + 4 O.S. ; $3d^0$ = colourless

In CoF_6^{3-} – Co is in + 3 O.S ; $3d^5$ = coloured

In Cu_2Cl_2 – Cu is in +1 O.S. ; $3d^{10}$ – colourless

In $NiCl_4^{2-}$ – Ni is in + 2 O.S ; $3d^8$ – coloured

20. **(c)** $E^0_{Cu^{+2}/Cu} = 0.34$ volt, other has – ve $E^0_{R.P.}$

$E^0_{Co^{++}/Co} = -0.28$ $E^0_{Ni^{++}/Ni} = -0.25$

$E^0_{Fe^{++}/Fe} = -0.44$

Assertion/ Reason

1. **(d)**
2. **(c)** The assertion is correct but the reason is false. Actually transition metal show variable valency due to very small difference between the ns^2 and $(n-1)d$ electrons.
3. **(b)** Due to larger surface area and variable valencies to form intermediate absorbed complex easily, transition metals are used as catalysts.
4. **(b)** The magnetic moments are lesser than the fact that 5*f* electrons of actinides are less effectively shielded which results in quenching of orbital contribution.
5. **(d)** Cu^+ (cuprous ion) does not have any unpaired electron while cupric (Cu^{2+}) ion has one unpaired electron in 3*d* shell.
   $Cu^+ = 3d^{10}\, 4s^0$
   $Cu^{2+} = 3d^9\, 4s^0$
   Cuprous ion is colourless because it does not have any unpaired electron but Cu^{2+} ion is blue in aqueous solution due to formation of complex with water molecules. So assertion is wrong but reason is true.
6. **(b)** The colour of CrO_4^{2-} is due to charge transfer spectra. There is no electron in the *d*-orbital of Cr (VI). So, no electronic excitation is possible with their *d*-orbital.

Matching Based Questions

1. **(b)** **2. (c)** **3. (a)** **4. (d)**

Critical Thinking Type Questions

1. **(d)**
2. **(d)** The ions with unpaired electrons are colourled and those with paired electrons are colourless.

$\underset{(\text{No. of } e^-\text{s} = 28)}{Zn^{2+}} = 1s^2, 2s^2p^6, 3s^2\, p^6\, d^{10}$

$\underset{(\text{No. of } e^-\text{s} = 21)}{Cr^{3+}} = 1s^2, 2s^2p^6, 3s^2\, p^6\, d^3$

$\underset{(\text{No. of } e^-\text{s} = 26)}{Ni^{2+}} = 1s^2, 2s^2p^6, 3s^2\, p^6\, d^8$

Thus Zn^{2+}, Cr^{3+} and Ni^{2+} have zero, 3 and 2 unpaired electrons respectively.

3. **(d)** V^{2+} – violet, V^{3+} – green V^{4+} – blue
   Fe^{2+} – green Fe^{3+} – yellow
4. **(b)** $Na_2Cr_2O_7$ is hygroscopic.
5. **(c)** $Mn_2O_7 \rightarrow$ acidic CrO $\rightarrow$ basic
   $V_2O_4 \rightarrow$ amphoteric $Cr_2O_3 \rightarrow$ amphoteric
6. **(b)** $KMnO_4$ reacts with H_2SO_4 to form Mn_2O_7 which is highly explosive substance.
   $2KMnO_4 + H_2SO_4 \longrightarrow K_2SO_4 + Mn_2O_7 + H_2O$
7. **(b)** $5Fe^{2+} + MnO_4^- + 8H^+ \longrightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$
   $5NO_2^- + 2MnO_4^- + 6H^+ \longrightarrow 2Mn^{2+} + 5NO_3^- + 3H_2O$
8. **(d)** If $KMnO_4$ was added slowly than option a was correct, but at a moment due to addition of large amount of $KMnO_4$, reduction of whole $KMnO_4$ added does not take place, it also react with Mn^{2+} which had formed in the solution to give MnO_2.
   $2MnO_4 + 3Mn^{2+} + 2H_2O \longrightarrow 5MnO_2 + 4H^+$
9. **(b)** Most of the Ln^{3+} compounds except La^{3+} and Lu^{3+} are coloured due to the presence of *f*-electrons.
10. **(a)**

Chapter - 23 Co-ordination Compounds

Fill in the Blanks

1. **Paramagnetism**
2. **Hexammine cobalt (III) chloride**
3. **5** **4.** **3** **5.** **6** **6.** **2**
7. **10, 1** **8.** **Both σ and π**

True/ False

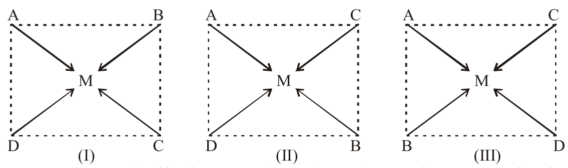
1. False	**2. True**	**3. True**	**4. True**
5. True	**6. True**	**7. False**	**8. False**
9. True	**10. True**	**11. True**	**12. True**

Conceptual MCQs

1. **(c)** In $(NH_4)_2\ (TiCl_6)$, Ti^{4+} ($3d^0\ 4s^0$) has no unpaired electrons.
In $K_2Cr_2O_7$, Cr^{6+} ($3p^6\ d^0$) has no unpaired electrons.
In $CoSO_4$, Co^{2+} (d^7) has three unpaired electrons in d-orbitals, so it is both paramagnetic and coloured.
In $K_3[Cu(CN)_4]$, Cu^+ ($3d^{10}$), no unpaired electron.

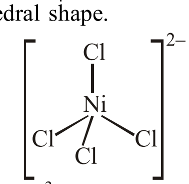
2. **(d)** Organometallic compounds are those compounds in which metal atom is directly bonded with C-atom. H_3C-Li.

3. **(a)** Complexes of the type M_{ABCD} may exist in three isomeric forms.



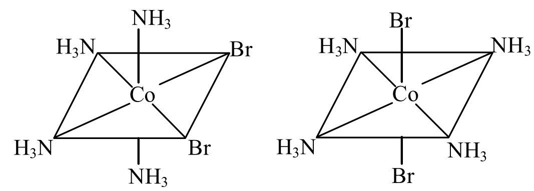
Similarly, $[Pt\ (Py)\ (NH_3)\ BrCl]$ may exist in three isomeric form in which
M = Pt A = Py, B = NH_3, C = Br, D = Cl.

4. **(b)** The configuration of Ni^{2+} is $3d^8$. For the elements of the first transition series, Cl^- behaves as a weak field/high spin ligand. Hence Ni in $[NiCl_4]^{2-}$ is sp^3 hybridised leading to tetrahedral shape.

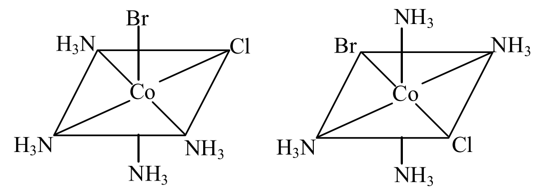


sp^3, Tetrahedral

5. **(a)** $Co(NH_3)_4Br_2Cl$ will show both geometrical and ionization isomerism.
$[Co(NH_3)_4Br_2]Cl$ and $[Co(NH_3)_4\ BrCl]Br$ are ionization isomers and geometrical isomers are



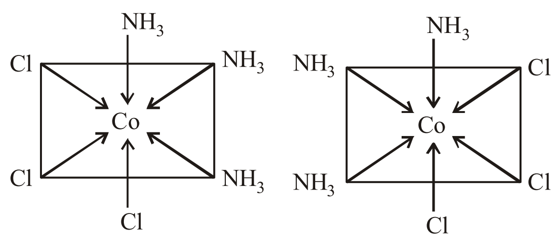
cis *trans*



cis *trans*

6. **(c)** The correct IUPAC name of the given compound is tetramminenickel (II) - tetrachloronickelate (II) thus (c) is the correct answer.

7. **(a)** The octahedral coordination compounds of the type MA_3B_3 exhibit fac-mer isomerism.

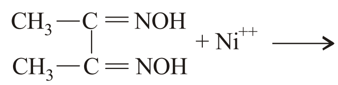


fac. mer.

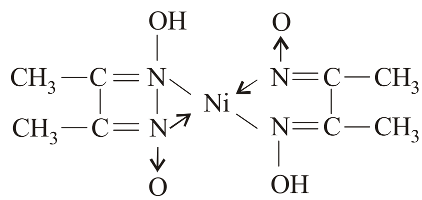
8. **(b)**

Atom/Ion Complex	Configuration	No. of unpaired electrons	Magnetic nature
Ni^{2+} (d^8)	3d: ↑↓ ↑↓ ↑↓ ↑ ↑; 4s: [ ]; 4p: [ ][ ][ ]	2	Paramagnetic
$[NiCl_4]^{2-}$	3d: ↑↓ ↑↓ ↑↓ ↑ ↑; 4s: :; 4p: : : : — sp^3	2	Paramagnetic
$[Ni(CN)_4]^{2-}$	3d: ↑↓ ↑↓ ↑↓ ↑↓ :; 4s: :; 4p: : : [ ] — Rearrangement, dsp^2	0	Diamagnetic
Ni (d^8s^2)	3d: ↑↓ ↑↓ ↑↓ ↑ ↑; 4s: ↑↓; 4p: [ ][ ][ ]	2	Paramagnetic
$[Ni(CO)_4]$	3d: ↑↓ ↑↓ ↑↓ ↑↓ ↑↓; 4s: :; 4p: : : : — Rearrangement, sp^3	0	Diamagnetic

9. **(c)** Nickel ions are frequently detected by the formation of red precipitate of the complex of nickel dimethylglyoxime, when heated with dimethylglyoxime.



Dimethylglyoxime



Nickel dimethylglyoxime

10. **(b)** $d^6 - t_{2g}^{\,2,2,2}\ e_g^{\,0,0}$ (in low spin)

$$\text{C.F.S.E} = -0.4 \times 6\Delta_0 + 3P = -\frac{12}{5}\Delta_0 + 3P$$

11. **(c)** We know that IUPAC name of $[Pt(NH_3)_3(Br)(NO_2)Cl]Cl$ istriamminebromochloronitroplatinum (IV) chloride.

12. **(d)** In $[Fe(CO)_5]$ Iron exist in zero oxidation state

13. **(b)** As in $[NiCl_4]^{-2}$ Chloride ion being a weak ligand is not able to paired the electron in d orbital.

14. **(a)** Since the precipitate of AgCl shows two ionisable chloride ion the complex must have the structure.

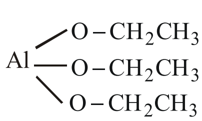
$$[Co(NH_3)_5Cl]Cl_2 + 2AgNO_3 \rightarrow [Co(NH_3)_5Cl](NO_3)_2 + 2AgCl$$

Hence two chlorine atoms satisfy the primary valency and one, secondary valency.

15. **(d)** $[Co(CO)_5NH_3]^{2+}$. In this complex. Co-atom attached with NH_3 through σ bonding with CO attached with dative π-bond.

16. **(a)** Chloro diaquatriammine cobalt (III) chloride is $[CoCl(NH_3)_3(H_2O)_2]Cl_2$

17. **(a)** Triethoxyaluminium has no Al – C linkage



18. **(c)** Square planar complex of the formula Mabcd gives three geometrical isomers.

19. **(c)** Diaminodichloroplatinum (II) commonly known as *cis* - platin is found to have anticancer property.

20. **(b)** Lesser is the number of unpaired electrons smaller will be the paramagnetic behaviour. As Cr^{++}, Mn^{++}, Fe^{++} & Ni^{++} contains.

Cr^{++} $(3d^4)$ = | 1 | 1 | 1 | 1 | |

= 4 unpaired e^-.

Mn^{++} $(3d^5)$ = | 1 | 1 | 1 | 1 | 1 |

= 5 unpaired e^-.

Fe^{++} $(3d^6)$ = | ⥮ | 1 | 1 | 1 | 1 |

= 4 unpaired e^-.

Ni^{++} $(3d^8)$ = | ⥮ | ⥮ | ⥮ | 1 | 1 |

= 2 unpaired e^-.

As Ni^{++} has minimum no. of unpaired e^- thus this is least paramagnetic.

Assertion/ Reason

1. **(c)** It is correct statement that NF_3 is a weaker ligand than $N(CH_3)_3$, the reason is that fluorine is highly electronegative therefore, it with draw electrons from nitrogen atom. Hence, the lone pair of nitrogen atom cannot be ligated. While $N(CH_3)_3$ is a strong ligand because CH_3 is electron releasing group.

2. **(b)** Both Assertion and Reason are true but Reason is not the correct explanation of statement-1. $[Fe(CN)_6]^{3-}$ is weakly paramagnetic as it has unpaired electrons while $[Fe(CN)_6]^{2-}$ has no unpaired electron.
$\therefore$ It is diamagnetic.

3. **(a)** Both Assertion and Reason are true and Reason is the correct explanation of statement-1. $[Sc(H_2O_6]^{3+}$ has no unpaired electron in its d subshell and thus d–d transition is not possible whereas $[Ti(H_2O)_6]^{3+}$ has one unpaired electron in its d subshell which gives rise to d–d transition to impart colour.

4. **(a)** In metal carbonyls a pair of π–bond arises from overlap of filled d-orbitals on the metal with a pair of π–antibonding orbitals projecting from the carbon of the CO.
The π–bonding has the effect of weakening the C–O bond as compared with free CO. Hence C–O bond in metal carbonyls is long.
Hence assertion and reason both are true and reason is a correct explanation of assertion.

5. **(a)** Optical isomerism is found in octahedral complexes with 1, 2 or 3 symmetrical bidentate ligands only. Since given compound is not having any bidentate ligand, it will not show optical isomerism.
It is because it has plane of symmetry, a plane which is perpendicular to equitorial plane. Thus both A and R are true and R is explantion of A.

6. **(c)** $[Ni(en)_3]Cl_2$ is more stable than $[Ni(NH_3)_6]Cl_2$ because ethylenediamine is a bidentate ligand, hence it forms chelating ring with Ni^{2+} ion.

Matching Based Questions

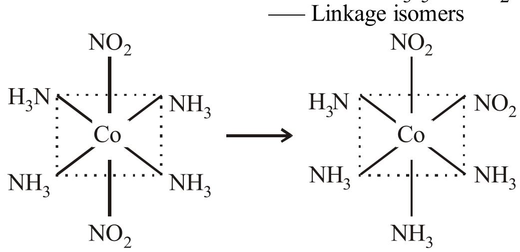
1. **(c)**
2 **(d)** A – (p), B – (r), C – (s), D – (q)
3. **(a)** $[NiCl_4]^{2-}$ is sp^3 hybridised and paramagnetic in nature $[Ni(CN)_4]^{2-}$ is square planar and diamagnetic. Chlorophyll contains Mg^{2+} Ziegler – Natta catalyst contains Ti^{4+} Deoxyhaemoglobin is nonplanar and oxyhaemoglobin planar.
4. **(d)** Crystal field splitting energy increases with increase in ligand field strength i.e., with increase in no. of 'en' groups and wavelength of absorbed light decrease with increase in ligand field strength $\therefore$ $[Ni(H_2O)_4(en)]^{2+}(aq)$ will absorb light of higher wavelength i.e., Red.
$[Ni(en)_3]^{2+}$ will absorb light of lower wavelength i.e., blue-green and $[Ni(H_2O)_4(en)_2]^{2+}$ will absorb yellow orange light.
5. **(a)** 6. **(a)**

Critical Thinking Type Questions

1. **(c)** As it forms two moles of silver chloride thus it has two moles of ionisable Cl.

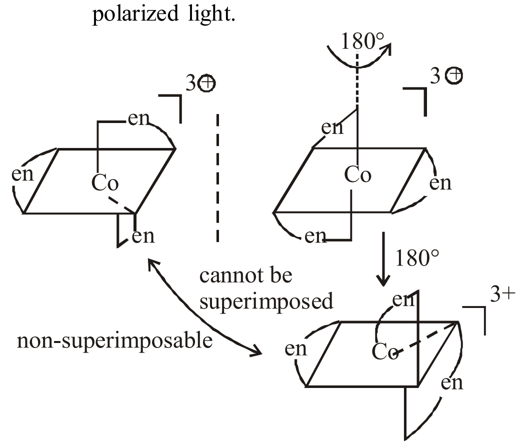
$$[Co(NH_3)_5NO_2]Cl_2 \rightarrow [Co(NH_3)_5NO_2]^{++} + 2Cl^-$$
$$2Cl^- + 2AgNO_3 \rightarrow 2AgCl + 2NO_3^-$$

2. **(b)** CN^- is coordinated to cobalt as the ligand and coordinated compounds have different properties than the individual species.
3. **(a)** The given compound may have linkage isomerism due to presence of NO_2 group which may be in the form $-NO_2$ or $-ONO$.
It may have ionisation isomerism due to presence of two ionisable group $-NO_2$ & $-Cl$. It may have geometrical isomerism in the form of *cis-trans* form as follows :
$[Co(NH_3)_4Cl(NO_2)]NO_2$ & $[Co(NH_3)(NO_2)_2]Cl$ —— Ionisation isomers.
$[Co(NH_3)_5(NO_2)_2]Cl$ & $[Co(NH_3)_5(ONO)_2]Cl$ —— Linkage isomers



Trans-form *Cis-form*
Geometrical isomers

4. **(a)**
5. **(c)** Complex is not superimposable on its mirror image hence optically active i.e., rotate plane polarized light.



6. **(b)** Lesser is the number of unpaired electrons smaller will be the paramagnetic behaviour. As Cr^{++}, Mn^{++}, Fe^{++} and Ni^{++} contains.

Cr^{++} $(3d^4)$ = $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{}$
= 4 unpaired e^-.

Mn^{++} $(3d^5)$ = $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$
= 5 unpaired e^-.

Fe^{++} $(3d^6)$ = $\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$
= 4 unpaired e^-.

Ni^{++} $(3d^8)$ = $\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}$
= 2 unpaired e^-.

As Ni^{++} has minimum no. of unpaired e^- thus this is least paramagnetic.

7. **(d)** Number of unpaired electrons in $[MnCl_6]^{3-}$ and $[Mn(CN)_6]^{3-}$ respectively are 4 and 2
$\therefore$ Magnetic moment will respectively be 4.8 and 2.8 $[MnCl_6]^{3-}$ is sp^3d^2 hybridised and $[Mn(CN)_6]^{3-}$ will be d^2sp^3 hybridised.
8. **(c)** In octahedral field the crystal field splitting of d- orbitals of a metal ion depends upon the field produced by the ligands. In general ligands can be arranged in a series in the order of increasing fields and splittings which they produce around a central metal ion. A portion of the series is given below.
cyanide > ethylene - diamine > ammonia > pyridine > thiocyanate > water > oxalate > hydroxide > fluoride > chloride > bromide > iodide.

Chapter - 24 Haloalkanes and Haloarenes

Fill in the Blanks

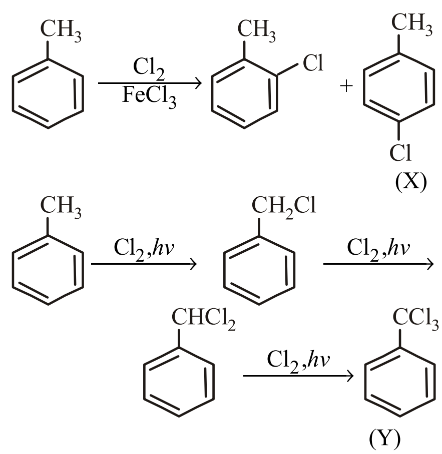
1. **Chlorine** 2. **Grignard (RMgX)**
3. **2** 4. $\underset{4}{CH_3}\underset{3}{CH_2}\underset{2}{\overset{\overset{\displaystyle Br}{|}}{C}}=CH-Cl$
   2-bromo-1-chloro but-1-ene
5. **transition state** 6. **CCl_2F_2**
7. **CCl_4** 8. **inductive effect**

True/ False

1.	False	2.	False	3.	True	4.	False
5.	True	6.	True	7.	True	8.	False
9.	False	10.	True	11.	True	12.	False

Conceptual MCQs

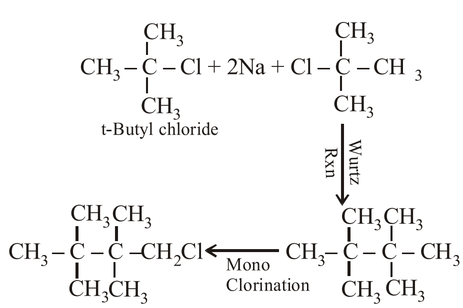
1. (c)



2. (b) At high temp. i.e., 400°C substitution occurs in preference to addition.

$$CH_3CH=CH_2 \xrightarrow[-HCl]{Cl_2,\,400°C} ClCH_2CH=CH_2$$

3. (a)



4. (b) The order of atomic size of halogens decrease in the order I > Br > Cl > F
   i.e on moving down a group atomic size increases. Further the bond length of C-X bond deccreases in the order
   C – I > C – Br > C – Cl > C – F
   and hence the bond dissociation energy decreases in the order
   R – F > R – Cl > R – Br > R – I
   hence R – I being a weakest bond break most easily.
   hence R – I is most reactive.

5. (a)

$$CH_3CH_2Cl \xrightarrow{NaCN} \underset{(X)}{CH_3CH_2CN} + NaCl$$

$$\xrightarrow{Ni/H_2} \underset{(Y)}{CH_3CH_2CH_2NH_2} \xrightarrow{(CH_3CO)_2O}$$

$$CH_3CH_2CH_2NHCOCH_3(Z) + CH_3COOH$$

6. (b) $CH_3 - CH_2 - CHCl_2 \xrightarrow[\Delta]{NaNH_2}$

$$CH_3 - CH = CHCl \xrightarrow[\Delta]{NaNH_2}$$

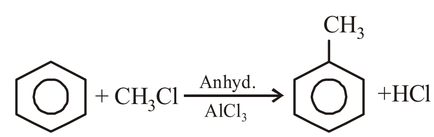
$$\underset{\text{Final Product}}{CH_3 - C \equiv CH}$$

7. (c) An ether solution of an alkyl halide (preferably bromide or iodide) gives an alkaline when heated with metallic sodium.

$$2RX + 2Na \xrightarrow{\text{Dry ether}} R - R + 2NaX;$$

$$2C_2H_5Br + 2Na \xrightarrow{\text{Dry ehter}} \underset{\text{Butane}}{C_2H_5 - C_2H_5} + 2NaBr$$

8. (d)



Toluene

Friedel Craft's reaction.

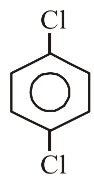
9. (b) $C_2H_5I \xrightarrow{alc.\,KOH} \underset{(X)}{CH_2 = CH_2} \xrightarrow{Br_2}$

$$\underset{(Y)}{\underset{Br\qquad Br}{CH_2 - CH_2}} \xrightarrow{KCN} \underset{(Z)}{\underset{Br}{CH_2} - CH_2CN}$$

10. (c) S_N1 reactions involve the formation of carbocations, hence higher the stability of carbocation, more will be reactivity of the parent alkyl halide. Thus tertiary carbocation formed from (c) is stabilized by two phenyl groups and one methyl group, hence most stable.

11. (d)

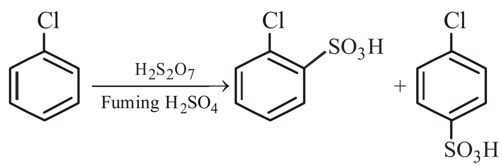
12. (d) Para-di-chlorobenzene has most symmetrical structure than others. It is found as crystalline lattice form, therefore, it has highest melting point (52°C) due to symmetrical structure.



Para Chlorobenzene

Option (d) is correct.

13. (d) On sulphonation of chlorobenzene, ortho and para chlorobenzene is formed because – Cl group is para and ortho directing.



14. (a,c) S_N2 mechanism is followed in the case of primary and secondary alkyl halides, but primary is more reactive than secondary i.e.

$$CH_3CH_2Cl > \begin{matrix} H_3C \\ H_3C \end{matrix} \!\!\!> CH-Cl$$

In comparision to p-halides reactivity of s-halides towards S_N2 reaction is negligible.

15. (a) Only 1° alkyl halides (i.e. CH_3Br) undergo S_N2 reaction.

16. (b) Dehydrobromination by strong base (alc. NaOH) followed by Markownikoff addition of HBr.

17. (b) The reaction proceeds via free radical mechanism.

As 2º free radical is more stable than 1º, so $CH_3CH_2CH(Br)CH_3$ would be formed.

18. (a) Chlorination beyond monochlorination during the preparation of alkyl halides in presence of UV light can be suppressed by taking alkane in excess.

Note : For isomeric alkanes the one having largest straight chain has highest b.p. because of large surface area.

19. (d) The given reaction is an example of electrophilic substitution. Further, CH_3 group in toluene is o, p-directing

20. (b) Addition of HBr of 2-pentyne gives two structural isomers (I) and (II)

$$CH_3-C\equiv C-CH_2CH_3 \xrightarrow{HBr}$$

$$\underset{(I)}{CH_3C(Br)=CHCH_2CH_3} + \underset{(II)}{CH_3CH=C(Br)CH_2CH_3}$$

Each one of these will exist as a pair of geometrical isomers. Thus, there are two structural and four configurational isomers.

Assertion/ Reason

1. **(d)** **Assertion** is false, because aryl halides do not undergo nucleophilic substitution under ordinary conditions. This is due to resonance, because of which the carbon–chlorine bond acquires partial double bond character, hence it becomes shorter and stronger and thus cannot be replaced by nucleophiles. However **Reason** is true.

2. **(c)** Alkyl halides give polyalkylation products.

3. **(b)** Carbon tetrachloride rises to atmosphere and deplete the ozone layer. This depletion of ozone layer increases exposure of UV rays to human being which lead to increase of skin cancer, eye diseases and disorder with discruption of the immune system.

4. **(c)** $CHCl_3$ is stored in dark bottles to prevent oxidation of $CHCl_3$ in presence of sunlight.

5. **(d)** CCl_4 is used as a fire extinguisher. The dense, non combustible vapours cover the burning substance and prevents the availability of oxygen around burning material.

Matching Based Questions

1. **(c)** In allylic halides hydrogen atom is bonded to sp^3 hybridized carbon atom. Whereas in vinylic halide, hydrogen atom is bonded to sp^2 hybridized carbon atom.

CH_3CHCl_2 Ethylidene chloride (gem-dihalide)

$$\begin{matrix} CH_2 & - & CH_2 \\ | & & | \\ Cl & & Cl \end{matrix}$$

Ethylene dichloride (vic-dihalide)

2. **(a)** Alkyl iodides are often prepared by the reaction of alkyl chlorides/bromides with NaI in dry acetone. This reaction is known as Finkelstein reaction.

$$R-X + NaI \longrightarrow R-I + NaX$$

X = Cl, Br

NaCl or NaBr thus formed is precipitated in dry acetone.

It facilitates the forword reaction according to le chatelier's principle. The synthesis of alkyl fluorides is best accomplished by heating an alkyl chloride/bromide in the presence of a metallic fluoride such as AgF, Hg_2F_2, CoF_2 or SbF_3. The reaction is termed as Swarts reaction.

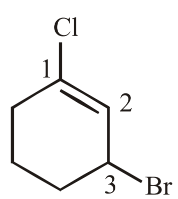
$$H_3C-Br + AgF \longrightarrow H_3C-F + AgBr$$

3. **(b)** **4.** **(b)**

5. **(b)** Chloramphenicol, produced by soil microorganism is very effective for the treatment of typhoid fever. Our body produces iodine containing hormone thyroxine, the deficiency of which causes a disease called goiter. Synthetic halogen compounds, viz chloroquine is used for the treatment of malaria; halothane is used as an anaesthetic during surgery. Certain fully fluorinated compounds are being considered as potential blood substitutes in surgery.

Critical Thinking Type Questions

1. **(c)**



2. **(b)** Addition of HBr of 2-pentyne gives two structural isomers (I) and (II)

$$CH_3-C\equiv C-CH_2CH_3 \xrightarrow{HBr}$$

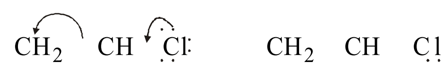
$$\underset{\text{(I)}}{CH_3C(Br)=CHCH_2CH_3} + \underset{\text{(II)}}{CH_3CH=C(Br)CH_2CH_3}$$

Each one of these will exist as a pair of geometrical isomers. Thus, there are two structural and four configurational isomers.

3. **(b)** Chlorine atom is highly reactive so it will react with all type of hydrogen available while the Br atom is highly selective so it will react with that hydrogen which give the highly stabilize tertiary alkyl radical so only one product is formed.

4. **(d)** CH_2 CH Cl
(Vinyl Chloride)

The halogen atom in vinyl chloride is not reactive as in other alkyl halides. The non-reactivity of chlorine atom is due to resonance stabilisation. The $\ell.p.$ on Cl-atom can participate in delocalisation (Resonance) to give two canonical structure.



5. **(d)** The rate of S_N2 substitution reaction is maximum in case of CH_3CH_2Br because S_N2 mechanism is followed in case of primary and secondary halides i.e., S_N2 reaction is favoured by small groups on the carbon atom attached to halogens so

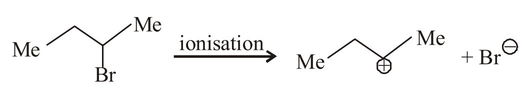
$$CH_3\,CH_2\,Br > CH_3\,CH_2\,CH_2\,Br >$$

$$CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-Br > CH_3-\underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{C}}}}-Br$$

6. **(a)**

(A)

(B)



(C)

Since S_N1 reactions involve the formation of carbocation as intermediate in the rate determining step, more is the stability of carbocation higher will be the reactivity of alkyl halides towards S_N1 route. Now we know that stability of carbocations follows the order : 3° > 2° > 1°, so S_N1 reactivity should also follow the same order.

3° > 2° > 1° > Methyl **(S_N1 reactivity)**

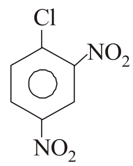
7. **(a)** A strong nucleophile favours the S_N2 reaction and a weak nucleophile favours the S_N1 reaction.

First reaction is S_N1 reaction because C_2H_5OH is used as solvent which is a weak nucleophile.

Second reaction is S_N2 reaction because $C_2H_5O^-$ is strong nucleophile.

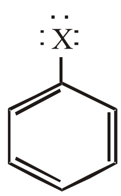
8. **(a)** Primary halide < Secondary halide < Tertiary halide.

9. **(d)** —NO_2 group is electron attractive group, so it is able to deactivate the benzene ring.



hence withdrawl of electrons from ortho and para position cause easy removal of –Cl atom due to development of +ve charge on o- and p positions.

10. **(c)** The carbon-halogen bonds of aryl halides are both shorter and stronger (due to possibility of resonance) than the carbon-halogen bonds of R–X and in this respect as well as in their chemical behaviour, they resemble vinyl halides (CH_2=CHX) more than alkyl halides.

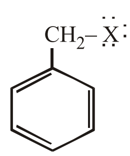


$CH_2 = CH–\ddot{X}:$

Aryl halides Vinyl halides

Halogen attached to C is sp^2 hybridised C, C–X bond is shorter and stronger because of partial double bond character due to delocalisation of electrons on halogens

$R–CH_2–\ddot{X}:$ $CH_2 = CH–CH_2–\ddot{X}:$



Alkyl halides Allyl halides Benzyl halides

Halogen attached to sp^3 hybridised C. Delocalisation of electrons on halogen is not possible, hence C–X bond does not acquire double bond character, hence it is weaker and reactive.

Chapter - 25 Alcohols, Phenols and Ethers

Fill in the Blanks

1. **aldol (β-hydroxybutanal);**
2. **resonance stabilization**
3. **nucleophilic**
4. **phenoxide ion**
5. **peroxides**
6. **Secondary.**
7. **4**
8. **2-methylphenol**
9. **esters**
10. **Phenol**

True/ False

1. **False** 2&3. **False** 4. **True**
5. **True** 6. **True** 7. **False** 8. **True**
9. **True** 10. **False**

Conceptual MCQs

1. **(d)** The order of reactivity of alcohol with Lucas reagent is *tert.* > *sec.* > *pri.*
Lucas test is based on the difference in the three types of alcohols (having 6 or less carbon) towads Lucas reagent (a mixture of conc. hydrochloric acid and anhydrous zinc chloride) at room temperature.

$$ROH + HCl \xrightarrow{ZnCl_2} RCl + H_2O$$

The tertiary alcohols produce turbidity immediately, the secondary alcohols give turbidity within 5 – 10 minutes, and the primary alcohols do not give turbidity at all, at room temperature.
Hence 2-methylpropan-2-ol (a 3° alcohol) reacts fastest.

2. **(b)** Compounds having $-\underset{\underset{O}{\|}}{C}-CH_3$ groups show positive iodoform test.
Hence, $CH_3-CH_2-CH_2-\underset{\underset{O}{\|}}{C}-CH_3$
(pentanone-2) gives this test.

3. (c) 1, 2 – Diols, when treated with an aqueous solution of periodic acid give aldehyde or ketones

$$\begin{array}{l} CH_2OH \\ | \\ CH_2OH \end{array} \xrightarrow{HIO_4} CH_2O + CH_2O$$

Note that a 1° alcohol gives CH_2O. Since in glycol both the OH groups, are primary hence give 2 molecules of CH_2O as by product.

4. (c) Secondary alcohols oxidise to produce kenone.

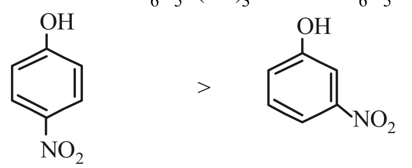
$$\underset{\text{2-Butanol}}{CH_3CHOHCH_2CH_3} \xrightarrow{(O)} \underset{\text{Ethyl methyl ketone}}{CH_3COCH_2CH_3}$$

5. (a) $$\underbrace{CO + H_2}_{\text{water gas}} + H_2 \xrightarrow[300^\circ C]{Cr_2O_3 - ZnO} \underset{\text{Methanol}}{CH_3OH}$$

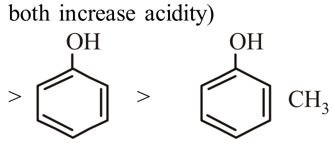
6. (c) $C_2H_5OC_2H_5 + 2\ HI \xrightarrow{\Delta} 2\ C_2H_5I + H_2O$

7. **(d)** $C_6H_5CH_3 + Cl_2(\text{exc.}) \xrightarrow{\text{light, heat}} C_6H_5CCl_3$
$\xrightarrow{\text{aq. NaOH}} C_6H_5C(OH)_3 \xrightarrow{-H_2O} C_6H_5COOH$

8. **(b)**



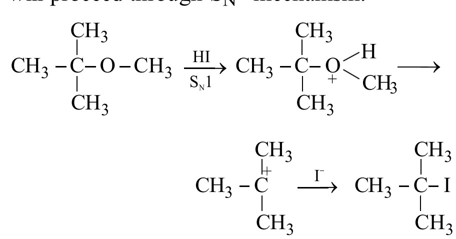
(iv) (iii)
(– I and – M effects, both increase acidity) (only – I effect)



(i) (ii)
(+ I effect of CH_3 group decreases acidity)

9. **(b)** Note : This reaction is an example of Williamson's synthesis.
$C_2H_5O^-$ will abstract proton from phenol converting the latter into phenoxide ion. This would then make nucleophilic attack on the methylene carbon of alkyl iodide forming $C_6H_5OC_2H_5$. But if $C_2H_5O^-$ is in excess, $C_2H_5OC_2H_5$ will be formed. $C_2H_5O^-$ is a better nucleophile than $C_6H_5O^-$ (phenoxide) ion because in the former the negative charge is localised over oxygen, while in the latter it is delocalised over the whole molecular framework. So, it is $C_2H_5O^-$ ion that would make nucleophilic attack at ethyl iodide to give diethyl ether (Williamson's synthesis).

10. (b) The reaction will proceed via S_N1 or S_N2 based on nature of alkyl group. If alkyl group attached is 3°. The reaction will proceed through the S_N1 mechanism and if alkyl group is primary reaction will proceed through S_N2 mechanism.



(Highly stable)

11. (b) By heating benzaldehyde with conc. NaOH or KOH (Cannizzaro reaction).

$$\underset{\text{Benzaldehyde}}{C_6H_5CHO} + NaOH \longrightarrow \underset{\text{Benzyl alcohol}}{C_6H_5CH_2OH} + \underset{\text{Sod. benzoate}}{C_6H_5COONa}$$

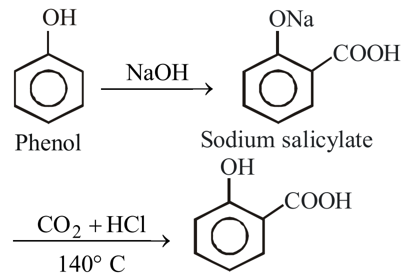
12. (c) Formation of diethylether from ethanol is based on dehydration.

$$C_2H_5\boxed{OH \quad + \quad H}-O-C_2H_5 \xrightarrow[-H_2O]{X,\,\Delta} C_2H_5-O-C_2H_5$$

X could be conc. H_2SO_4 at 413 K or Al_2O_3 at 523 K.

13. (d)

14. (d)



Phenol Sodium salicylate Salicylic acid

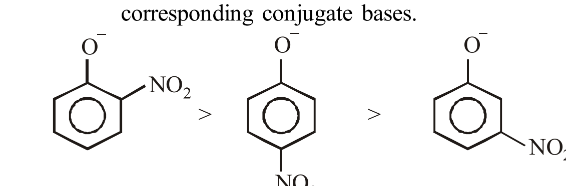
Hence, option (d) is correct.

15. (c)

$$CH_3CH_2OH \xrightarrow{PBr_3} CH_3CH_2Br \xrightarrow{\text{alc.KOH}} CH_2 = CH_2 \xrightarrow{H_2SO_4} CH_3-CH_2-HSO_4 \xrightarrow[\text{heat}]{H_2O} CH_3CH_2OH$$

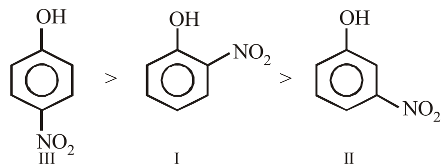
16. (b) The solubility of alcohols depend on number of C-atoms of alcohols. The solubility of alcohols in water is decreased by increasing number of C-atoms of alcohol. As resulting molecular weight increases, the polar nature of O – H bond decreases and hence strength of hydrogen bond decreases.
Option (b) is correct.

17. (c) Observe the relative stability of their corresponding conjugate bases.

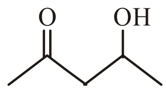


I: Stabilised by both –I and – R effects of the $–NO_2$ group
III: Stabilised by both –I and – R effects, but – I is less than in I
II: Stabilised only by –I effect

However, the acidity of the corresponding phenols will be different because of H–bonding in the ortho isomer.



III > I > II

18. (c) Dehydration of  give more stable conjugated alkene.

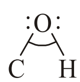
19. (d) The rates of reaction with lucas reagent follows the order.
3° alcohol > 2° alcohol > 1° alcohol
since carbocations are formed as intermediate, more stable the carbocation, higher will be the reactivity of the parent compound (alcohol). 2-Methylpropan-2-ol generates a 3° carbocation, so it will react fastest; other three generates either 1° or 2° carbocations.

$$CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-OH \xrightarrow{H^+} CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}^{\oplus} \xrightarrow{Br^-} CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-Br$$

2-Methyl-2-propanol

20. (a) Due to H-bonding, the boiling point of ethanol is much higher than that of the isomeric diethyl ether.

Assertion/ Reason

1. **(a)** The bond angle  in alcohols is slightly less than the tetrahedral angle (109°-28′). It is due to the repulsion between the unshared electron pairs of oxygen.

2. **(b)** The correct explanation is : In Lucas test, tertiary alcohols react immediately because of the formation of the more stable tertiary carbocations.

3. **(c)** The correct reason is : Nucleophilic attack of phenolate ion through the *ortho*-carbon atom occurs on CCl_4 (a neutral electrophile) to form an intermediate which on hydrolysis gives salicylic acid (ArSE reaction).

4. **(a)** **R** is the correct explanation of **A**. Due to +M effect of $-\ddot{\underset{\cdot\cdot}{O}}H$, its intermediate carbocation is more stable than the one in benzene.

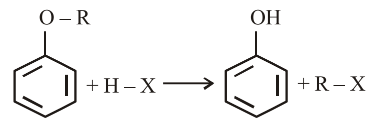
5. **(c)** The usual halogenation of benzene takes place in the presence of a Lewis acid, such as $FeBr_3$, which polarises the halogen molecule. In case of phenol, the polarisation of bromine molecule takes place even in the absence of Lewis acid.
It is due to the highly activating effect of –OH group attached to the benzene ring.

6. **(b)**

7. **(a)** **R** is the correct explanation of **A**.

8. **(d)** **9.** **(c)**

10. **(c)** Alkyl aryl ethers are cleaved at the alkyl-oxygen bond due to the more stable aryl-oxygen bond. The reaction yields phenol and alkyl halide



Ethers with two different alkyl groups are also cleaved in the same manner.

$$R-O-R'+HX \to R-X+R'-OH$$

Matching Based Questions

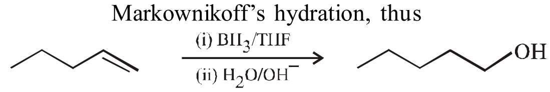
1. **(d)** **2.** **(c)** **3.** **(b)**

Critical Thinking Type Questions

1. **(c)** $KMnO_4$ (alkaline) and OsO_4 / CH_2Cl_2 are used for hydroxylation of double bond while O_3 /Zn is used for ozonolysis. Therefore, the right option is (c), i.e.,

$$3CH_3CH=CH_2 \xrightarrow{BH_3 \text{ in THF}} (CH_3CH_2CH_2)_3B$$
$$\xrightarrow[NaOH]{3H_2O_2} \underset{\text{1-propanol}}{3CH_3CH_2CH_2OH} + H_3BO_3$$

2. **(a)** Hydroboration-oxidation leads to *anti*-Markownikoff's hydration, thus



1-Pentanol

3. **(a)**

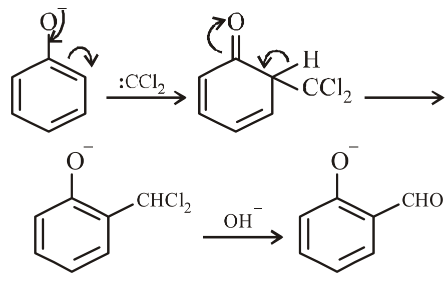
4. **(b)** Reaction of 1–chloropropane leads to the formation of the primary carbocation which rearranges to more stable secondary carbocation, hence (ii) and (iii) give similar products.

5. **(a)** $CH_2=CH-OH$ represents vinylic alcohol. In vinylic alcohols –OH group is attached to sp^2 hybridized carbon whereas in allylic alcohols – OH group is attached to sp^3 hybridized carbon.

6. **(d)** Riemer-Tiemann reaction involves electrophilic substitution on the highly reactive phenoxide ring.

$$HCCl_3 + OH^- \longrightarrow H_2O + {}^-:CCl_3$$
$$\longrightarrow Cl^- + :CCl_2$$

Note the C has only a sextet of electrons



A benzal chloride

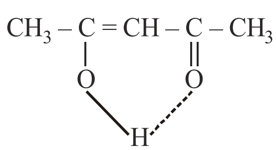
7. **(d)** $CH_3CH_2OH \xrightarrow{P+I_2} \underset{A}{CH_3CH_2I} \xrightarrow[\text{Ether}]{Mg}$

$$\underset{(B)}{CH_3CH_2MgI} \xrightarrow{HCHO} \underset{(C)}{H-\overset{\overset{\large CH_2CH_3}{|}}{\underset{\underset{\large H}{|}}{C}}-OMgI}$$

$$\xrightarrow{H_2O} \underset{\substack{(D)\\ \text{n-propyl alcohol}}}{H-\overset{\overset{\large CH_2CH_3}{|}}{\underset{\underset{\large H}{|}}{C}}-OH}$$

Chapter - 26 Aldehydes, Ketones and Carboxylic Acids

Fill in the Blanks

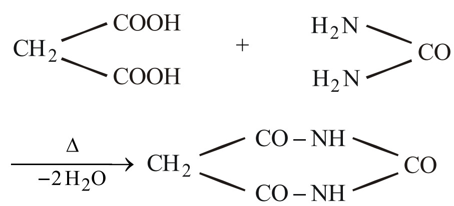
1. **CO**
2. **$C_6H_5CH(OCOCH_3)_2$ benzylidene acetate**
3. 
4. **3, 3, 3-trichloropropanal**
5. **p-p overlapping**
6. Secondary alcohols on oxidation give ketones.
7. **CrO_2Cl_2** 8. **HCHO**
9. **R_2Cd** 10. **Iodoform reaction**

True/ False

1.	False	2.	False	3.	True	4.	False
5.	False	6.	True	7.	True	8.	True
9.	False	10.	True	11.	True	12.	False

Conceptual MCQs

1. **(c)**



Barbituric acid

Malonic ester

2. **(d)** Acetone forms mesitylene (1,3,5-trimethyl benzene) on distillation with conc. H_2SO_4.
3. **(d)** I_2 and Na_2CO_3 react with acetophenone ($C_6H_5COCH_3$) to give yellow ppt. of CHI_3 but benzophenone ($C_6H_5COC_6H_5$) does not and hence can be used to distinguish between them.
4. **(d)** The intermediate is carbocation which is destabilised by C = O group (present on α-carbon to the –OH group) in the first three cases. In (d), α–hydrogen is more acidic which can be removed as water. Moreover, the positive charge on the intermediate carbocation is relatively away from the C = O group.
5. **(a)** among acetic acid, phenol and n-hexanol only CH_3COOH reacts with $NaHCO_3$ to evolve CO_2 gas.

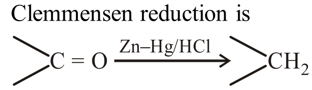
$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + CO_2 + H_2O$$

6. **(d)** Aldehydes which contain a α-hydrogen on a saturated carbon, i.e., CH_3CH_2CHO undergo aldol condensation.

$$\underset{\text{propanol}}{CH_3CH_2-\overset{\overset{\large H}{|}}{C}=O} + H-H\overset{\overset{\large CH_3}{|}}{\underset{\alpha}{C}}-CHO$$

$$\xrightarrow{OH^-} \underset{\text{3.hydroxy,2 methyl pentanal}}{CH_3CH_2-\overset{\overset{\large CH_3}{\beta|}}{\underset{\underset{\large OH}{|}}{C}}-\overset{\overset{\large CH_3}{\alpha|}}{C}HCHO}$$

7. **(d)** Methyl acetate and ethyl acetate on hydrolysis give CH_3COOH which is a liquid. Similarly ethyl formate on hydrolysis will give formic acid which is also a liquid. Only ethyl benzoate on hydrolysis will give benzoic acid which is a solid.
8. **(b)** Clemmensen reduction is



9. **(c)** $CH_3COOH + CaCO_3 \rightarrow (CH_3COO)_2Ca \xrightarrow{\text{Heat}} \begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!>CO \xrightarrow{I_2+NaOH}$

$CHI_3 + NaI + CH_3COONa + 3H_2O$

10. **(a)** $C_6H_5COOC_2H_5 \xrightarrow{CH_3MgBr} C_6H_5-\underset{CH_3}{\overset{OMgBr}{\overset{|}{\underset{|}{C}}}}-OC_2H_5 \xrightarrow{-Mg(OC_2H_5)Br} C_6H_5-\overset{O}{\overset{||}{C}}-CH_3 \xrightarrow[CH_3MgBr]{\text{Excess}}$

$C_6H_5-\overset{O}{\overset{||}{C}}-CH_3 \xrightarrow[CH_3MgBr]{\text{Excess}} \underset{\text{'B'}}{C_6H_5-\underset{CH_3}{\overset{OMgBr}{\overset{|}{\underset{|}{C}}}}-CH_3} \xrightarrow{H_2O} C_6H_5-\underset{OH}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}}-CH_3 \xrightarrow[\Delta]{\text{Con. } H_2SO_4}$

$C_6H_5-\overset{CH_3}{\overset{|}{C}}=CH_2 \xrightarrow{\text{Ozonolysis}} \overset{\text{'B'}}{C_6H_5COCH_3} + HCHO \quad C_6H_5COCH_3 \xrightarrow{3I_2+4\,NaOH} CHI_3$

11. **(c)** By oxidation of tertiary alcohol with stronger oxidising agents ketones may be formed along with carboxylic acid.

$(CH_3)_3COH \xrightarrow{4[O]} CH_3COCH_3+CO_2+2H_2O$

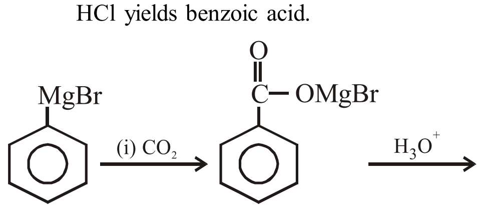
$(CH_3)_3COH \xrightarrow{8[O]} CH_3COOH+2CO_2+3H_2O$

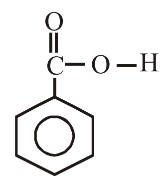
12. **(c)** $CH_3-\overset{O}{\overset{||}{C}}-H + HCN \longrightarrow CH_3-\underset{CN}{\overset{OH}{\overset{|}{\underset{|}{C}}}}-H \xrightarrow{\text{Hydrolysis}} CH_3-\underset{OH}{\underset{|}{CH}}-COOH$

2-Hydroxypropanol

(As it has a chiral C-atom thus it is optically active)

13. **(b)** Grignard reagent forms addition product with bubbled carbondioxide which on hydrolysis with HCl yields benzoic acid.





+ Mg(OH)Br

'P'

Benzoic acid

14. **(a)** Enolic form predominates in compounds containing two carbonyl groups separated by a $-CH_2$ group. This is due to following two factors.

(i) Presence of conjugation which increases stability.

(ii) Formation of intramolecular hydrogen bond between enolic hydroxyl group and second carbonyl group which leads to stablisation of the molecule. Hence the correct answer is III > II > I.

15. **(a)** $R-\overset{O}{\overset{||}{C}}-R' \xrightarrow[KCN]{HCN} R-\underset{R'(A)}{\overset{OH}{\overset{|}{\underset{|}{C}}}}-CN$

$\xrightarrow[LiAlH_4(B)]{\text{Reduction by}} R-\underset{R'}{\overset{OH}{\overset{|}{\underset{|}{C}}}}-CH_2NH_2$

16. **(c)** Zn/Hg and HCl reduce carboxyl group to methylene group (Clemmensen reduction).

17. **(b)** Recall that presence of electron-withdrawing group increases, while presence of electron-releasing group decreases the acidity of carboxylic acids.

$$\underset{\text{(electron-withdrawing gp.)}}{ClCH_2COOH} >$$

$$H-\overset{\overset{O}{||}}{C}-OH > CH_3-\overset{\overset{O}{||}}{C}-OH > C_2H_5-\overset{\overset{O}{||}}{C}-OH$$

(Electron-releasing character increasing from Left to Right)

18. **(a)** Aldehydes containing no α-hydrogen atom on warming with 50% NaOH or KOH undergo disproportionation i.e. self oxidation - reduction known as cannizzaro's reaction.

$$2C_6H_5CHO + NaOH \xrightarrow{50\%\ NaOH} C_6H_5COONa + C_6H_5CH_2OH$$

19. **(a)** Aldehydes and ketones having at least one α-hydrogen atom in presence of dilute alkali give β-hydroxy aldehyde or β-hydroxy ketone

$$\underset{\text{Acetaldehyde}}{CH_3-\overset{\overset{O}{||}}{\underset{\underset{H}{|}}{C}}} + HCH_2CHO \xrightarrow{\text{dil.NaOH}}$$

$$\underset{\text{Aldol}}{CH_3-\overset{\overset{OH}{|}}{\underset{\underset{H}{|}}{C}}-CH_2-CHO} \xrightarrow[-H_2O]{\Delta} \underset{\text{Crotonaldehyde}}{CH_3-CH=CH.CHO}$$

20. **(a)** Carbonyl compounds (aldehydes and ketones) are obtained by the oxidation of 1° and 2° alcohols respectively. Among the given options, only (a) is 2° alcohol hence it can be oxidized to ketone.

$$\underset{2-\text{hydroxypropane}}{H_3C\ \overset{\overset{OH}{|}}{CH}\ CH_3} \xrightarrow{\text{oxidation}} \underset{\text{Acetone}}{H_3C\ \overset{\overset{O}{||}}{C}\ CH_3}$$

Assertion/ Reason

1. **(a)** **2.** **(a)** **3.** **(b)**

4. **(a)** The molecular mass of acetic acid in benzene is 120 instead of 60 because the carboxylic acids exists as cyclic dimers in which two molecules of the acid are held together by two strong hydrogen bond.

Matching Based Questions

1. (a)	**2.** (c)	**3.** (b)	**4.** (d)
5. (b)	**6.** (c)	**7.** (c)	

Critical Thinking Type Questions

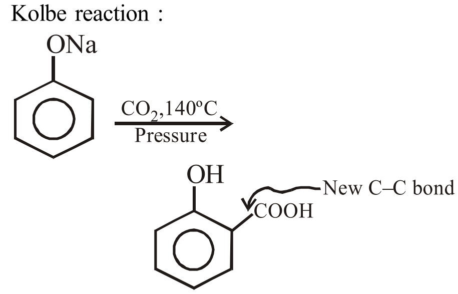
1. **(d)**

2. **(d)** Aldol condensation :

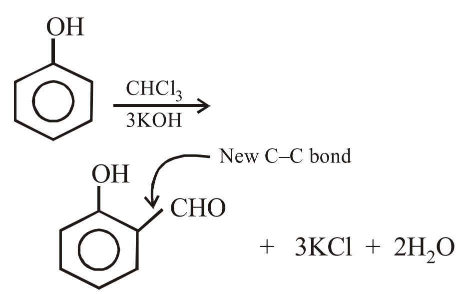
$$2CH_3CHO \xrightarrow{\overset{-}{OH}} H_3C-\overset{\overset{OH}{|}}{\underset{\underset{H}{|}}{C}}-CH_2CHO$$

New C–C bond

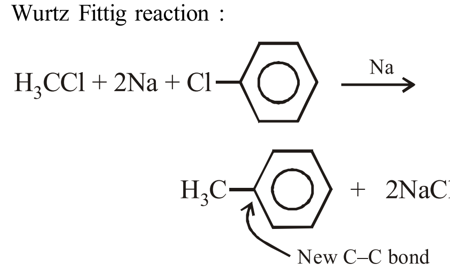
Kolbe reaction :



Reimer-Tiemann reaction :



Wurtz Fittig reaction :



3. **(d)** Being reversible reaction, the backward reaction i.e. acetal -hemiacetal step can be restricted by minimizing water content, i.e. by using dry HCl.

The step hemiacetal - aldehyde can be restricted by using excess of alcohol.

4. **(c)** OH^- and $^-CH_2CHO$ act as nucleophile in the first two steps.

$$CH_3CHO \xrightarrow{OH^-} \overset{-}{C}H_2CHO \xrightarrow{CH_3CHO} CH_3\underset{\underset{CH_2CHO}{|}}{\overset{\overset{O^-}{|}}{C}}H$$

$$\xrightarrow[\text{(as an acid)}]{H_2O} CH_3\underset{\underset{CH_2CHO}{|}}{\overset{\overset{OH}{|}}{C}}H$$

5. **(d)** If we observe the haloform reaction carefully, we see that $-COCH_3$ group is first halogenated to the trihalo $-COCX_3$ through monohalogeno and dihalogeno compound. It is the $-COCX_3$ part which then undergoes nucleophilic addition. The product easily loses $-CX_3$ since it is a very good leaving group.

$$\underset{\text{I}}{CH_3-\overset{\overset{O}{||}}{C}-CH_3} \xrightarrow{X_2,\ O\overset{-}{H}} \underset{\text{II}}{CH_3-\overset{\overset{O}{||}}{C}-CH_2Cl}$$

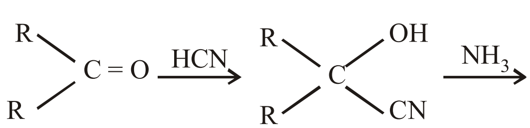
$$\longrightarrow \underset{\text{III}}{CH_3-\overset{\overset{O}{||}}{C}-CHCl_2} \longrightarrow \underset{\text{IV}}{CH_3-\overset{\overset{O}{||}}{C}-CCl_3}$$

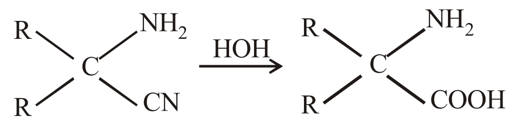
$$CH_3-\overset{\overset{O}{||}}{C}-CCl_3 \xrightarrow{O\overset{-}{H}} CH_3-\underset{\underset{OH}{|}}{\overset{\overset{O^-}{|}}{C}}-CCl_3$$

$$\longrightarrow CH_3-\underset{\underset{OH}{|}}{\overset{\overset{O}{||}}{C}} + \overset{-}{C}Cl_3$$

Thus all compounds (I to IV) are ultimately converted to $CHCl_3$ (chloroform).

6. **(b)**





7. **(a)**

8. **(b)** The carbon atom of the carbonyl group of benzaldehyde is less electrophilic than carbon atom of the carbonyl group present in propanal. The polarity of the carbonyl group is reduced in benzaldehyde due to resonance as shown below and hence it is less reactive than propanal.

9. **(b)** Dry hydrogen chloride protonates the oxygen of the carbonyl compounds and therefore, increases the electrophilicity of the carbonyl carbon facilitating the nucleophilic attack by the alcohol molecule. Dry HCl gas also absorbs the water produced in these reactions thereby shifting the equilibrium in the forward direction.

10. **(d)**

11. **(b)**

12. **(a)** The correct order of increasing acid strength

$CF_3COOH > MeOCH_2COOH > CH_3COOH > (Me)_2CH.COOH$

Electron withdrawing groups increase the acid strength and electron donating groups decrease the acid strength.

Chapter - 27 Amines

Fill in the Blanks

1.	2°	2.	$LiAlH_4$ in ether
3.	more, less	4.	$(CH_3)NH$
5.	atmospheric oxidation		
6.	Gatterman reaction		
7.	H_3PO_2	8.	C_2H_5OH
9.	Dyeing	10.	bromobenzene

True/ False

1.	True	2.	False	3.	False	4.	True
5&6.	True	7.	False	8.	True	9.	True
10.	False						

Conceptual MCQs

1. **(a)** When nitro compound is reduced with a neutral reducing agent (Zn dust + NH_4Cl) the corresponding hydroxyl amine is formed

$$C_6H_5NO_2 + 4[H] \xrightarrow{\text{Zn dust}+NH_4Cl} \underset{\text{Phenyl hydroxyl amine}}{C_6H_5NHOH}$$

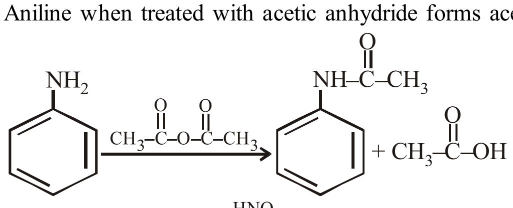
(Hoffman's bromamide reaction)

2. **(b)** Acetamide and ethylamine can be distinguished by heating with NaOH solution.Acetamide evolves NH_3 but ethylamine does not.

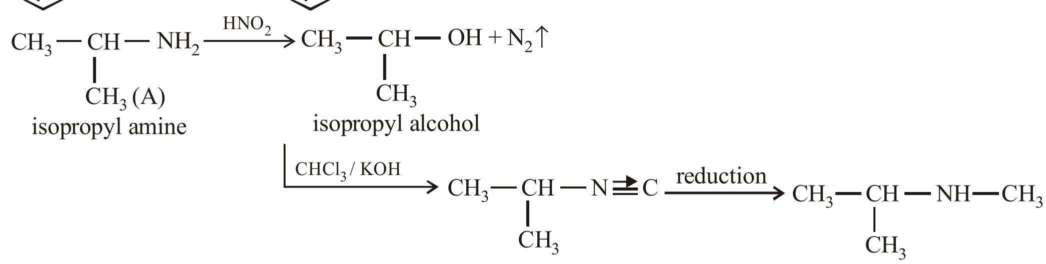
$$CH_3CONH_2 + NaOH \xrightarrow{\Delta} CH_3COONa + NH_3$$

$$CH_3CH_2NH_2 + NaOH \longrightarrow \text{No reaction.}$$

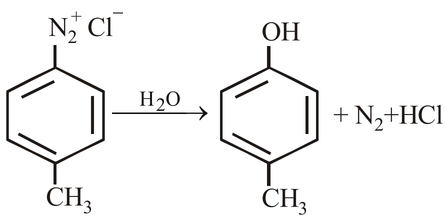
3. **(d)** Aniline when treated with acetic anhydride forms acetanilide (nucleophilic substitution)



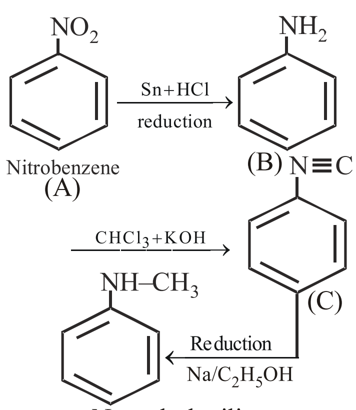
4. **(a)**



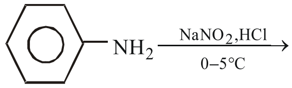
5. **(b)**

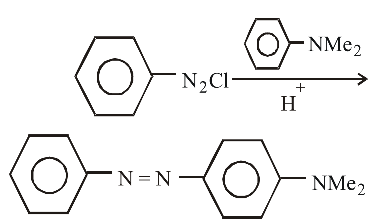

p- cresol

6. **(c)**

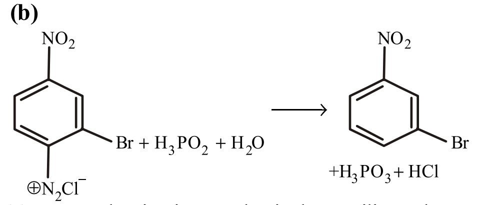


7. **(c)**



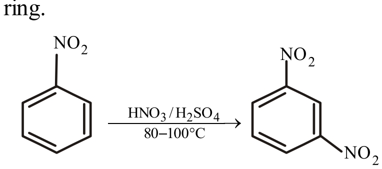


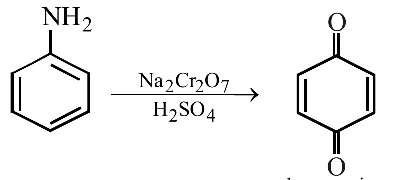
8. **(b)**



9. **(c)** Benzylamine is more basic than aniline. The reason is that in aniline, the lone pair of nitrogen is conjugated with benzene ring so it is not available readily for others. On the other hand in Benzylamine, nitrogen is not directly attached with ring so lone pairs are not conjugated with ring.

10. **(a)**



11. **(c)** 

p-benzoquinone

12. **(d)** (i) $RCONH_2 + Br_2 + KOH \longrightarrow RCONHBr + KBr + H_2O$

(ii) $RCONHBr + KOH \longrightarrow RNCO + KBr + H_2O$

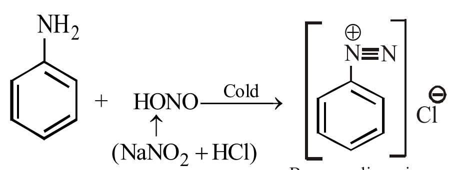
(iii) $RNCO + 2KOH \longrightarrow RNH_2 + K_2CO_3$

$RCONH_2 + Br_2 + 4KOH \longrightarrow RNH_2 + 2KBr + K_2CO_3 + 2H_2O$

13. **(a)** 1° amines (aliphatic and aromatic) react with $CHCl_3$/KOH to yield isocyanide (foul smelling) This is known as carbylamine test which is not given by 2° & 3° amines.

14. **(d)** Nitrous acid reacts differently with aliphatic and aromatic amines in cold.

$$\underset{1^\circ\text{ Amine}}{C_2H_5NH_2} + HONO \longrightarrow \underset{\text{Alcohol}}{C_2H_5OH} + N_2$$



Benzene diazonium chloride

However, at higher temperature nitrous acid reacts with aniline to form phenol.

15. **(b)** $CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-\overset{\overset{\displaystyle H}{|}}{N}-H \xrightarrow[-H_2O]{P_2O_5\Delta} CH_3C\equiv N$

$\xrightarrow[-NH_4Cl]{2H_2O\ +\ HCl} CH_3COOH$ (Acetic acid)

$\xrightarrow[-2H_2O\ +Na_2CO_3]{2NaOH\,(CaO)} CH_4$ (Methane)

16. **(c)** When ethyl amine reacts with chloroform in the presence of alcoholic potash, then ethylisocynide is formed. This reaction is known as carbyl amine reaction.

$C_2H_5-NH_2 + CHCl_3 + 3KOH \longrightarrow C_2H_5-NC + 3KCl + 3H_2O$

Ethyl amine Chloroform Ethyl isocyanide (bad smelling compound)

Option (c) is correct.

17. **(b)** Wurtz reaction is for the preparation of hydrocarbons from alkyl halide

$$RX + 2Na + XR \longrightarrow R-R + 2NaX$$

18. **(d)** Ethyl isocyanide on hydrolysis form primary amines.

$$CH_3CH_2N \equiv C + H_2O \xrightarrow{H^+} CH_3CH_2NH_2 + HCOOH$$

Therefore it gives only one mono chloroalkane.

19. **(b)** The alkyl groups are electron releasing group (+I), thus increases the electron density around the nitrogen thereby increasing the availability of the lone pair of electrons to proton or lewis acid and making the amine more basic. Hence more the no. of alkyl group more basic is the amine. Therefore the correct order is $NH_3 < CH_3NH_2 < (CH_3)_2N$

20. **(d)** **Note :** Aromatic amines are less basic than aliphatic amines. Among aliphatic amines the order of basicity is 2° > 1° > 3°. The electron density is decreased in 3° amine due to crowding of alkyl group over N atom which makes the approach and bonding by a proton relatively difficult. Therefore the basicity decreases. Further Phenyl group show – I effect, thus decreases the electron density on nitrogen atom and hence the basicity.
$\therefore$ dimethylamine (2° aliphatic amine) is strongest base among given choices.
$\therefore$ The correct order of basic strength is Dimethylamine > Methyl amine > Trimethyl amine > Aniline.

Assertion/ Reason

1. **(a)** **2.** **(d)**

3. **(a)** Amines are basic due to the presence of a lone pair of electrons on nitrogen atom. The lone pair can be easily donated.

4. **(d)**

5. **(c)** Acetylation decreases the electron-density in the benzene ring thereby preventing oxidation.

6. **(a)** **7.** **(c)**

8. **(a)** $HNO_3 + 2H_2SO_4 \rightleftharpoons 2HSO_4^- + NO_2^+ + H_3O^+$

Matching Based Questions

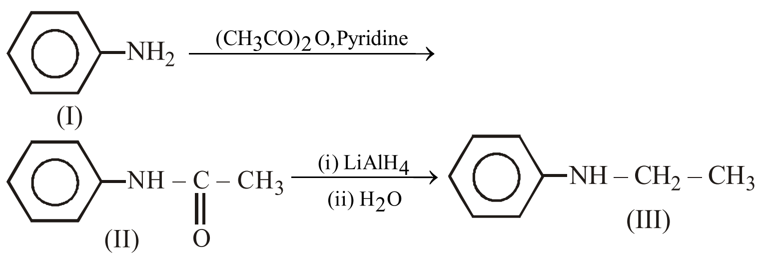
1. (a) 2. (a) 3. (b) 4. (c)

Critical Thinking Type Questions

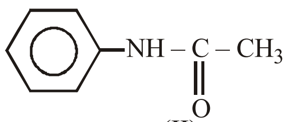
1. **(c)** The compound is derivative of aniline. The positions of groups are shown by numbering the nuclear C-atoms.

2. **(d)** All aliphatic amines are stronger bases than NH_3 and among different ethylamines order of basictity is 2° > 1° > 3°. Thus, the correct order is (d) i.e., $(C_2H_5)_2NH > C_2H_5NH_2 > (C_2H_5)_3N > NH_3$
This anomolous behaviour of tertiary ethyl amine is due to steric factors i.e., crowding of alkyl groups cover nitrogen atom from all sides and thus makes the approach and bonding by a lewis acid relatively difficult which results the maximum steric strain in tertiary amines. The electrons are there but the path is blocked resulting the reduction in its basicity.

3. **(a)**

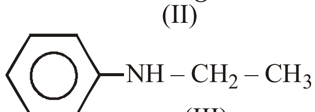


Product (II) is



and (III) is

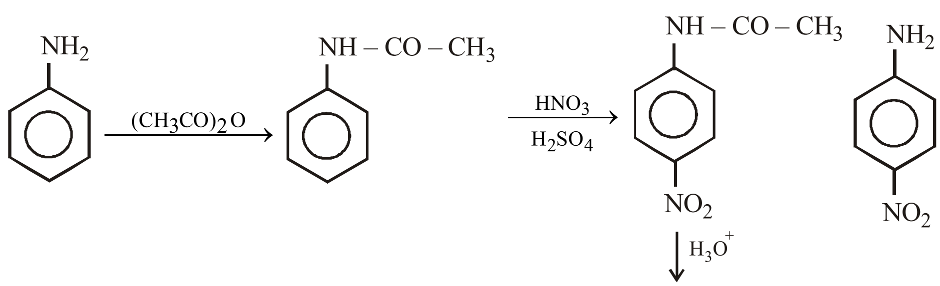
(II)



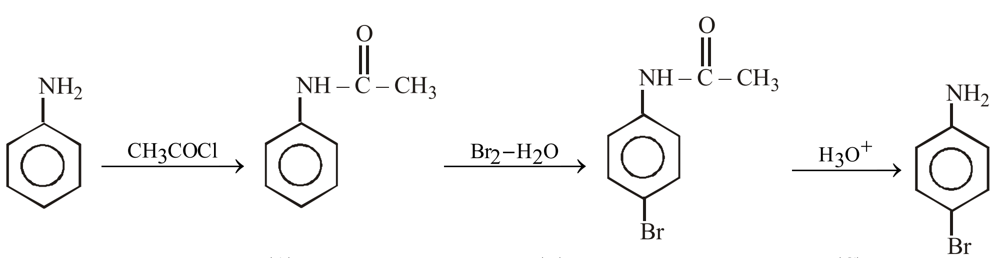
(III)

∴ III > I > II, As + I effect increases the basic strength and – R, – I effect shown by – $COCH_3$ reduces the basic strength.

4. **(b)**

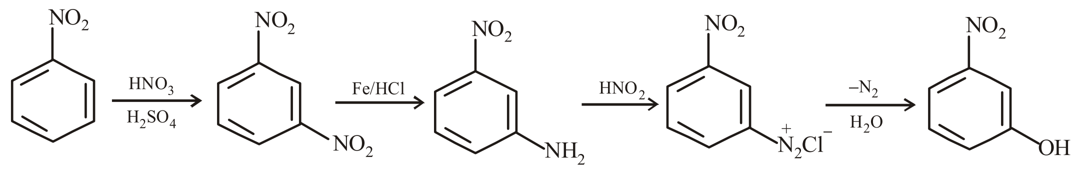


5. **(c)**



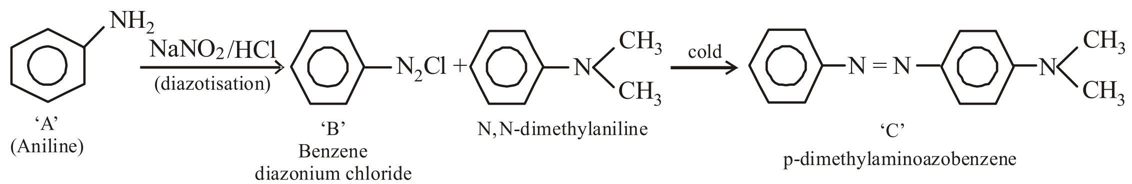
(A) (B) (C)

6. (b)



7. (a) It is a tertiary amine hence shows above observations.

8. (d) The reaction can be completed as follows:



Chapter - 28 Biomolecules

Fill in the Blanks

1. **Monosaccharides** 2. **Aldehyde group**
3. **Six**
4. Open chain structure is unstable and converted to cyclic.
5. **5** 6. **amylopectin**
7. **long unbranched chain**
8. **branched chain, C1-C4, C1-C6**
9. **protein** 10. **protein, 51**

True/ False

1. True	2. False	3. False	4. True
5. True	6. True	7. True	8. False
9. True	10. True	11. True	12. True
13. True	14. False	15. False	

Conceptual MCQs

1. (d) Glucose being an aldose responds to Tollen's test while fructose, although a ketose, undergoes rearrangement in presence of basic medium (provided by Tollen's reagent) to form glucose, which then responds to Tollen's test.

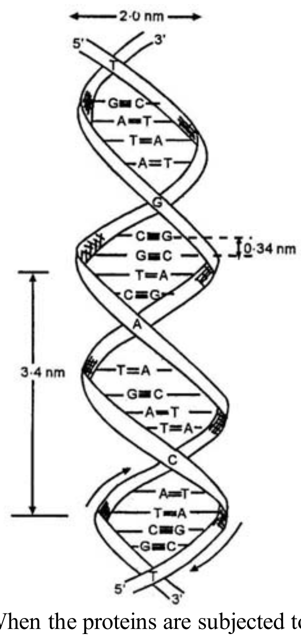
2. (b) The two isomeric forms (α – and β –) of D-glucopyronose differ in configuration only at C–1; hence these are called anomers.

3. (a) Sucrose does not have free — CHO or CO group, hence it does not undergo mutarotation.

4. (b) Cellulose is a linear polymer of β–D– glucose in which C_1 of one glucose unit is connected to C_4 of the other through β–D glucosidic linkage. It does not undergo hydrolysis easily. However on heating with dilute H_2SO_4 under pressure. It does undergo hydrolysis to give only D–glucose.

$$(C_6H_{10}O_5)n + nH_2O \xrightarrow{H+} \underset{D-Glucose}{nC_6H_{12}O_6}$$

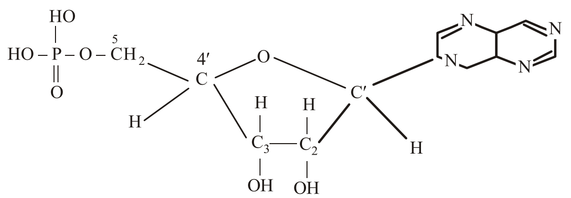
5. (b) DNA consists of two polynucleotide chains, each chain forms a right handed spiral with ten bases in one turn of the spiral. The two chains coil to double helix and run in opposite direction held together by hydrogen bonding.



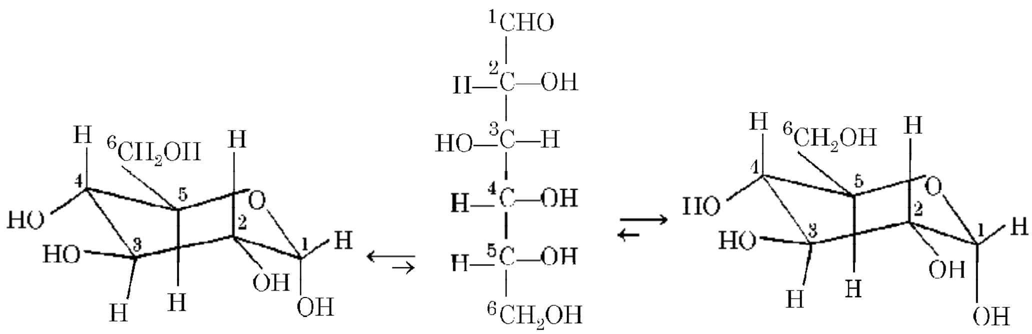
6. (c) When the proteins are subjected to the action of heat, mineral acids or alkali, the water soluble form of globular protein changes to water insoluble fibrous protein. This is called denaturation of proteins. During denaturation secondary and tertiary structures of protein destroyed but primary structures remains intact.

7. **(b)** Insulin is a biochemically active peptide harmone secreted by pancreas.

8. **(b)** In DNA and RNA heterocyclic base and phosphate ester are at C_1' and C_5' respectively of the sugar molecule.



9. **(b)** Cyclization of the open chain structure of D-(+)-glucose has created a new stereocenter at C_1 which explains the existence of two cyclic forms of D-(+)-glucose, namely α– and β–. These two cyclic forms are *diasteromers, such diastereomers which differ only in the configuration of chiral carbon developed on hemiacetal formation* (it is C_1 in glucose and C_2 in fructose) *are called* anomers and the hemiacetal carbon (C_1 or C_2) is called the anomeric carbon.



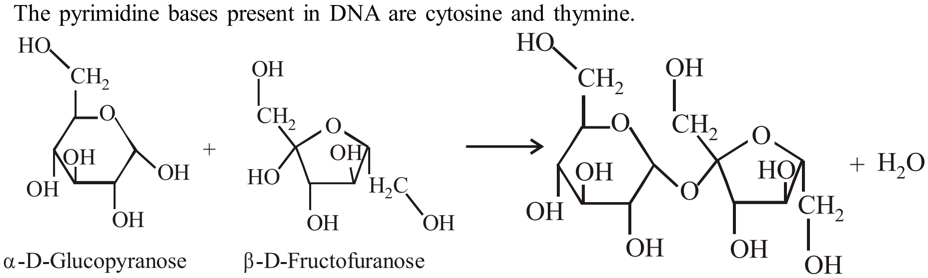
α–D-(+)-Glucopyranose m.p. 146°C : $[\alpha]_D = +112.2°$ (36% at equilibrium)

Open chain form of D-(+)-glucose (negligible % at equbilibrium)

β–D-(+)-Glucopyranose m.p. 150°C : $[\alpha]_D = +18.7°$ (64% at equilibrium)

10. **(a)** The pyrimidine bases present in DNA are cytosine and thymine.

11. **(b)**



α-D-Glucopyranose β-D-Fructofuranose

Sucrose is a disaccharide of α–D-Glucopyranose and β–D-Fructofuranose.

12. (c) Since $\alpha-D-(+)-\text{glucose}$ and $\beta-D-(+)$ glucose differ in configuration at C – 1 atom so they are anomers.
NOTE : Anomers are those diastereomers that differ in configuration at C – 1 atom.
i.e., (c) in the correct answer.

13. (a)

$$\begin{array}{l} CHO \\ | \\ CHOH \\ | \\ (CHOH)_3 \\ | \\ CH_2OH \end{array} \xrightarrow{3PhNHNH_2} \begin{array}{l} CH{=}N.NHPh \\ | \\ CH{=}N.NHPh \\ | \\ (CHOH)_3 \\ | \\ CH_2OH \end{array} + PhNH_2 + NH_3$$

14. (b) Xanthoproteic reaction: On treatment with concentrated nitric acid, certain proteins give yellow colour. This yellow colour is the same that is formed on the skin when the latter comes in contact with the concentrated nitric acid.

15. (d) Tollen's reagent is reduced by glucose due to aldehydic group and gives grey colour as silver metal.
Option (d) is correct.

16. (b) Glucose and fructose both are reduced by Fehling's solution, Tollen's reagent and Bendict's solution. Therefore, these three reagents can not be used to distinguish between glucose and fructose.

17. (a) Proteins and peptides are linked by peptide linkages $(-\overset{\overset{\large O}{\|}}{C}-NH)$.

18. (c) Cellulose is a polymer of carbohydrate which is essential constituent of plant cell.

19. (b) $\propto$ - Amino acid is the building block unit of protein which is formed by polymerisation of amino acid through peptide linkage.

$$\left[\begin{array}{c} -NH-\underset{\underset{\large O}{\|}}{C}- \end{array}\right]$$

Option (b) is correct.

20. (a) Isoelectric point (pH)

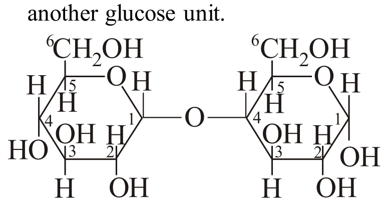
$$= \frac{pK_{a_1}+pK_{a_2}}{2} = \frac{2.34+9.60}{2} = 5.97$$

Assertion/ Reason

1. **(c)**

2. **(a)** The hydrolysis of sucrose brings about a change in the sign of rotation from dextro (+) to laevo (–) and the product is named as invert sugar.

3. **(d)** Maltose is compound of two α-D - glucose units in which C1 of one glucose is linked to C4 of another glucose unit.



I α-D-glucose   II α-D-glucose

4. **(a)** **R** is the correct explanation of **A**.

5. **(d)** Vitamin D is a fat soluble vitamin and can be stored in the body since it is not excreted out of the body.

Matching Based Questions

1. **(c)** **2. (a)** **3. (b)**

4. **(c)**

Vitamin A	-	Xerophthalmia
Vitamin B_{12}	-	Pernicious anaemia
Vitamin C	-	Scurvy
Vitamin E	-	Sterility
Vitamin K	-	Haemorrhage

Critical Thinking Type Questions

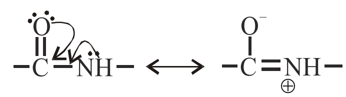
1. **(c)** Melting point of α-glucose→ 419 K and β-glucose is 323 K.

2. **(b)** The two monosoccharides are held together by a glycosidic linkage between C1 of α-glucose and C2 of β-fructose. Since the reducing groups and glucose and fructose are involved in glycosidic bond formed. Sucrose is non-reducing sugar.

3. **(c)**

4. **(c)** Most of the carbohydrates have a general formula, $C_x(H_2O)_y$, and were considered as hydrates of carbon. All the compounds which fit into this formula may not be classified as carbohydrates. Acetic acid (CH_3COOH) fits into this general formula, $C_2(H_2O)_2$ but is not a carbohydrate. Similarly, rhamnose, $C_6H_{12}O_5$ is a carbohydrate but does not fit in this definition. A large number of their reactions have shown that they contain specific functional groups. Chemically, the carbohydrates may be defined as optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis.

5. **(a)** Due to resonance C — N bond in protein acquires double bond character and is smaller than usual C — N bond.



6. **(a)** Vitamin C is water soluble. Therefore, it is readily excreted in urine and cannot be stored in our body and is supplied regularly in diet.

Chapter - 29 Polymers

Fill in the Blanks

1. **Cellulose acetate, Cellulose nitrate**

2. **Condensation** **3.** **Low**

4. **Acrylonitrile** **5.** **Nylon-6**

6. **Melamine** **7.** Nylon 6

8. **Nylon-6**

True/ False

1.	**True**	**2.**	**False**	**3.**	**False**	**4.**	**False**
5.	**False**	**6.**	**True**	**7.**	**False**	**8.**	**True**
9.	**False**	**10.**	**True**	**11.**	**True**	**12.**	**True**

Conceptual MCQs

1. (a) Neoprene is a polymer of chloroprene (2 – chloro – 1, 3 – butadiene).

2. (c) Aldo-(keto) pentoses having 5 carbon
Aldo-(keto) hexoses having 6 carbon
is an example of Pentose Sugar, arabinose (aldopentose) glucose, galactose and fructose are important examples of hexose sugar.

3. (c) Nylon-66 is prepared by the reaction between adipic acid and hexamethylene diamine.

4. (b) PVC is a polymer of $CH_2 = CH.Cl$

$$n\,CH_2 = CHCl \longrightarrow \left[-CH_2 - \underset{\underset{Cl}{|}}{CH} - \right]_n$$

Hence, option (b) is correct.

5. (d) DNA is a biopolymer.

6. (c) We know that polytetrafluoroethylene or teflon is a tough material, resistance to heat and bad conductor of electricity. Therefore it is used for coating the cookware to make them non-sticky.

7. (b) Nylon-66 is an example of first synthetic fibres produced from the simple molecules. It is prepared by condensation polymerisation of adipic acid and hexamethylene diamine.

8. (b) Acrilan is a polyacrylonitrile (PAN).

9. (b) Biodegradable polymer is Nylon-2-Nylon-6 which is copolymer of glycine ($H_2N - CH_2 - COOH$) and amino caproic acid ($H_2N-(CH_2)_5 - COOH$).

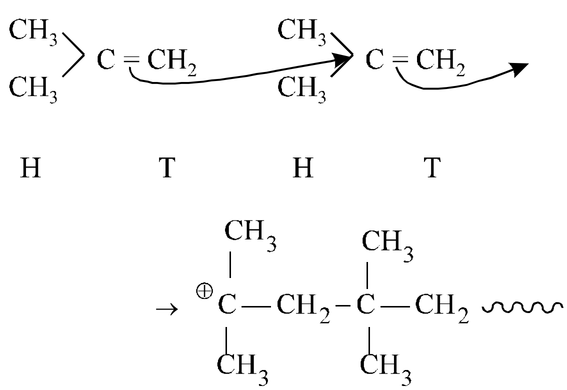
$$\underset{\text{glycine}}{nH_2N - CH_2 - COOH} + \underset{\text{amino caproic acid}}{nH_2N - (CH_2)_5 - COOH}$$

$$\downarrow$$

$$\underset{\text{nylon} - 2 - \text{nylon} - 6}{\left(HN - CH_2 - \overset{\overset{O}{\|}}{C} - HN - (CH_2)_5 - \overset{\overset{O}{\|}}{C} \right)_n}$$

10. (c) Polystyrene is made up by polymerization of $C_6H_5 - CH = CH_2$, in which $C_6H_5 - \underset{|}{C}H = CH_2^-$ is the repeating unit.

11. (a) Addition of monomers follows isoprene rule



12. (d) The given compound is a copolymer of hexamethyline diamine and adipic acid. It is actually Nylon-66.

13. (d) Copolymer of adipic acid (6C) and hexamethylene diamine (6C).

$$n\ \underset{\text{Adipic acid}}{HOOC(CH_2)_4COOH} + \underset{\text{Hexamethylene diamine}}{nH_2N(CH_2)_6NH_2}$$

$$\rightarrow \underset{\text{Nylon 66}}{\left(\overset{\overset{O}{\|}}{C} - (CH_2)_4 - \overset{\overset{O}{\|}}{C} - NH - (CH_2)_6 - NH \right)_n}$$

It has high tenacity and elasticity. It is resistant to abrasion and not affected by sea water. It is used for reinforcement of rubber tyres, manufacture of parachute, safety belts, carpets and fabrics.

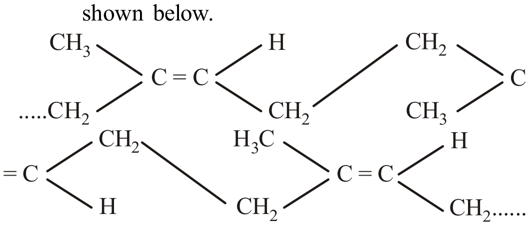
14. (a) Polymerisation starts either by condensation or addition reactions between monomers. Condensation polymers are formed by the combination of monomers with the elimination of simple molecules.Where as the addition polymers are formed by the addition together of the molecules of the monomer or monomers to form a large molecule without elimination of any thing.

15. (b) Nylon is a polyamide polmer.

16. (c) Nylon is a general name for all synthetic fibres forming polyamides.

17. (b) Buna – N is a copolymer of butadiene ($CH_2 = CH - CH = CH_2$) and acrylonitrile ($CH_2 = CHCN$).

18. (c) Natural rubber is *cis*-1, 4 poly isoprene and has only *cis* configuration about the double bond as shown below.



19. (b) Liquid hydrogen and liquid oxygen are used as excellent fuel for rockets. $H_2(\ell)$ has low mass and high enthalpy of combustion whereas oxygen is a strong supporter of combustion.

20. (b) Monomer of teflon is Tetrafluoro ethylene C_2F_4.

Assertion/ Reason

1. **(a)**

2. **(b)** Due to the presence of strong C–F bonds, teflon has high thermal stability and chemical inertness.

3. **(c)** Bakelite can be heated only once.

4. **(b)** Vulcanisation is a process of treating natural rubber with sulphur or some compounds of sulphur under heat so as to modify its properties. This cross-linking give mechanical strength to the rubber.

5. **(d)** The time of vulcanisation is reduced by adding accelerators and activators.

6. **(d)**

Matching Based Questions

1. **(b)** 2. **(c)** 3. **(b)** 4. **(b)** 5. **(a)** 6. **(c)**
7. **(a)**
(A) Polystyrene is used as insulator.
(B) Glyptal a polymer of ethylene glycol and phthali acid is used in manufacture of paints and lacquers.
(C) Bakelite, a polymer of phenol & formal dehyde is used for making electrical switches, handles of utensils and computer disc's.
(D) PVC, a polymer of vinyl chloride is used in manufacture of raincoat and flooring.

Critical Thinking Type Questions

1. **(d)** Nylon and cellulose, both have intermolecular hydrogen bonding, polyvinyl chloride has dipole-dipole interactions, while natural rubber has van der Waal forces which are weakest.

2. **(b)** The condensation polymerisation of hexamethylene diamine and adipic acid is done in solution form by interface technique. In this liquid nylon polymer is obtained.

$$n.H_2N-(CH_2)_6-NH_2 + nHOOC-(CH_2)_4-COOH \xrightarrow[-nH_2O]{\text{Polymerisation}}$$

$$\underset{\text{Nylon}}{[-HN-(CH_2)_6-NHCO-(CH_2)_4-CO-]_n}$$

3. **(a)** $$\dot{C}_6H_5-\overset{O}{\overset{\|}{C}}-O-O-\overset{O}{\overset{\|}{C}}-C_6H_5 \longrightarrow 2C_6H_5-\overset{O}{\overset{\|}{C}}-\dot{O}$$

$$\longrightarrow \underset{\substack{(A)\\ \text{Phenyl radical}}}{2\dot{C}_6H_5}$$

$$\underset{(A)}{\dot{C}_6H_5} + CH_2=CH_2 \longrightarrow \underset{(B)}{C_6H_5-CH_2-CH_2-CH_2-\dot{C}H_2}$$

$$\underset{(B)}{C_6H_5-CH_2-CH_2-CH_2-\dot{C}H_2} + nCH_2=CH_2 \longrightarrow \underset{(C)}{C_6H_5-(CH_2-CH_2)_nCH_2-\dot{C}H_2}.$$

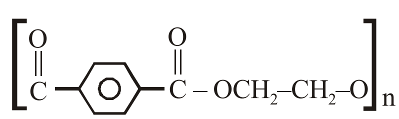
$$C_6H_5-(CH_2-CH_2)_n-CH_2-\dot{C}H_2 + C_6H_5-(CH_2-CH_2)_n-CH_2\dot{C}H_2$$

$$\longrightarrow C_6H_5-(CH_2-CH_2)_n-CH_2-CH_2-CH_2-(CH_2-CH_2)_n-C_6H_5$$

4. **(d)** $$n\underset{\text{Chloroprene}}{CH_2=CH-\overset{Cl}{\overset{|}{C}}=CH_2} \xrightarrow{O_2 \text{ or peroxides}} \underset{\text{Neoprene}}{(-CH_2-CH=\overset{Cl}{\overset{|}{C}}-CH_2-)_n}$$

5. **(a)** Terylene is prepared by condensing terephthalic acid and ethylene glycol

Terephthalic acid Ethylene glycol



Terylene

6. (a)
7. (d) As the amide density along the chain increases the melting point increases.

Chapter - 30 Chemistry in Everyday Life

Fill in the Blanks

1. **Catalyse** 2. **Tofranil**
3. **Barbituric acid derivatives**
4. **Tuberculosis** 5. **Antiseptic**
6. **Chloroxylenol and terpeneol**
7. **Chloramphenicol** 8. **Glycerol**

True/ False

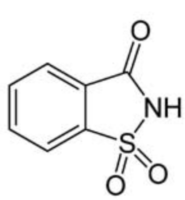
1.	True	2.	True	3.	True	4.	True
5.	False	6.	False	7.	False	8.	True
9.	True	10.	True	11.	True	12.	False
13.	False						

Conceptual MCQs

1. (d) The mixture of chloroxylenol and terepeneol are dettol which is used as antiseptic.
2. (c) We know that N-acetyl-para-aminophenol (or paracetamol) is an antipyretic which can also be used as an analgesic to relieve pains.
3. (a) Antipyretics are those compounds which reduce the body temperature in fever. Examples are aspirin (acetyl salicylic acid), paracetamol, phenacetin, novalgin and analgin.
4. (c) Any oils which are good for eating or cooking, can be used in making soap. One of the best is said to be Coconut oil. Groundnut, Shea butter, Cocoa butter, Sun flower and many other vegetable oils are also used.
5. (a) Vitamin B complex is water soluble vitamin whereas vitamin A, D, E and K are fat soluble vitamin.
6. (d) Cobalt (60) isotope is used in the treatment of cancer.
7. (b) Alkaline hydrolysis of esters is known as saponification.

$$R-COOR' + NaOH \longrightarrow R'OH + RCOONa$$

8. (c)



Saccharine

9. (d) Chloroamphenicol is a broad spectrum antibiotic.
10. (b) Enzymes can increase the rate of a reaction upto 10 million times. Even very small amount can accelerate a reaction.
11. (b) Dilute solutions of boric acid and hydrogen peroxide are weak antiseptics.
12. (c) 13. (d)
14. (c) Linear alkylbenzenesulphonates (LAB) carrying phenyl chains at secondary positions are biodegradable
15. (d) 16. (c)
17. (b) Cetyltrimethyl ammonium bromide which is a germicide, is a popular cationic detergent.
18. (c) 19. (c) 20. (c)

Assertion/Reason

1. (d) The drugs which act on the central nervous system and help in reducing anxiety are called tranquilizers.
2. (a) Tranquilizers are chemicals which are used to cure mental diseases.
3. (a) Broad spectrum antibiotics are those medicines which are effective against several different types of harmful micro organisms.
4. (b) Antiseptics are those chemical which kill or prevent the growth of micro organism. Antiseptics do not harm the living tissues and can be applied on cuts and wounds. They help to reduce odour resulting from the bacterial decomposition in the mouth and on the body.
5. (a) A small quantity of sedative produces a feeling of relaxation, calmness and drowsiness.
6. (d) 7. (b)

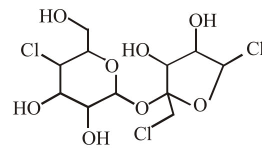
Matching Based Questions

1. (c) 2. (a) 3. (a) 4. (c) 5. (b)

Critical Thinking Type Questions

1. (c)
2. (d) Bacteriostatic drugs inhibit the growth of organism while bactericidal drugs kill the microorganisms.
3. (d) Drugs that mimic the natural messenger by switching on the receptor are called agonists. While drugs that binds to the receptor site and inhibit its natural function are called antagonists.

4. **(b)**
5. **(b)** Chloramphenicol is bacteriostatic antibiotic while ofloxacin is bactericidal type antibiotic.
6. **(c)** Narrow spectrum antibiotics are effective against Gram–positive or Gram-negative bacteria. Limited spectrum antibiotics are effective against a single organism or disease.
7. **(c)**



Sucrolose

8. **(b)** Aspartame cannot be used in baked food as it is unstable at cooking temperature thus its use is limited to cold foods and soft drinks.

1 The Living World

Fill in the Blanks :

1. In Bracketed key _______ pair/s of contrasting characters are used.
2. Indented key is also known as _______ .
3. In place of phylum, _______ is used, in plants.
4. The taxon _______ is used in Trinomial and not binomial, system of classification.
5. The world famous botanical garden is at _______ .
6. The _______ is the taxon between family and class.
7. The international code of zoological nomenclature was published in two languages, i.e. _______ .
8. The term 'taxon' for animals was given by _______ .
9. Two animals which are the members of the same order must also be the members of the same _______.
10. The common characteristics between tomato and potato will be maximum at the level of their_______.
11. In printed scientific names, only the ______ is capitalized.
12. Each category of taxonomic hierarchy refers to as a unit of ______.

True/ False :

1. Growth cannot be taken as a defining property of living organism.
2. Lower the taxon, more are the characteristics that the members within the taxon share.
3. Genus comprises a group of related species.
4. Reproduction is the production of progeny possessing features dissimilar to their parents.
5. All living organisms have ability to respond the environment stimuli which could be physical, chemical or biological.
6. Classification is the providing of standardize names to the organisms such that a particular organism known by the same all over the world.
7. Genus comprises a group of related species which has more characters in common in comparison to species of other genera.
8. In animals growth is seen up to a certain age.

Conceptual MCQs :

1. Basic unit or smallest taxon of taxonomy/ classification is
   (a) species (b) kingdom
   (c) family (d) variety
2. Which of the following is a correct name –
   (a) *Solenum tuberosum*
   (b) *Solenum Tuberosum*
   (c) *Solenum tuberosum Linn.*
   (d) all the above
3. Most of the botanical names are drawn from the following language –
   (a) german (b) greek
   (c) latin (d) spanish
4. Which of the following is a species ?
   (a) *Tamarindus*
   (b) *Indicus*
   (c) *Indica*
   (d) *Tamarindus indicus*
5. The term taxon refers to –
   (a) name of a species
   (b) name of genus
   (c) name of family
   (d) a taxonomic group of any rank

6. Plant nomenclature means
(a) To give names to plants without any rules
(b) Nomenclature of plants under the international rules
(c) Nomenclature of plants in local language
(d) Nomenclature of plants in english language

7. Scientific name of Mango plant is *Mangifera indica* (Linn) Santapau. In the above name Santapau refers to –
(a) variety of Mango
(b) a taxonomist who proposed the present nomenclature in honour of Linnaeus
(c) a scientist who for the first time described mango plant
(d) a scientist who changed the name proposed by Linnaeus and proposed present name

8. Practical significants of taxonomy is –
(a) classification
(b) to understand diversity
(c) to understand of evolution
(d) identification of organisms

9. Which one of the following is considered important in the development of seed habit?
(a) Heterospory
(b) Haplontic life cycle
(c) Free -living gametophyte
(d) Dependent sporophyte

10. Which one of the following aspects is an exclusive characteristic of living things ?
(a) Isolated metabolic reactions occur in vitro
(b) Increase in mass from inside only
(c) Perception of events happening in the environment and their memory
(d) Increase in mass by accumulation of material both on surface as well as internally.

11. Which one of the following organisms is scientifically correctly named, correctly printed according to the International Rules of Nomenclature and correctly described?
(a) Musca domestica - The common house lizard, a reptile.
(b) Plasmodium falciparum – A protozoan pathogen causing the most serious type of malaria.
(c) Felis tigris - The Indian tiger, well protected in Gir forests.
(d) E.coli - Full name Entamoeba coli, a commonly occurring bacterium in human intestine.

12. Which one of the following is not a correct statement ?
(a) Botanical gardens have collection of living plants for reference.
(b) A museum has collection of photographs of plants and animals
(c) Key is taxonomic aid for identification of specimens.
(d) Herbarium houses dried, pressed and preserved plant specimens.

13. A group of interconnected genera is called
(a) family (b) order
(c) phylum (d) class

14. The first organisms to appear on earth were
(a) photoautotrophs
(b) chemoautotrophs
(c) chemoheterotrophs
(d) coacervates

15. *Systema Naturae* was written by
(a) Linnaeus (b) Aristotle
(c) Hippocrates (d) Darwin

16. The binomial of sunn hemp is
(a) *Crotolaria juncea*
(b) *Erythrina indica*
(c) *Glycine max*
(d) *Arachis hypogea*
(e) *Dalbergia sissoo*

17. Which one of the following series includes the orders ranales, parietales and malvales?
(a) Bicarpellatae (b) Thalamiflorae
(c) Calyciflorea (d) Disciflorae

18. Which of the following statements regarding universal rules of nomenclature is wrong?
(a) The first word in a biological name represents the genus.
(b) The first word denoting the genus starts with a capital letter.
(c) Both the words in a biological name, when handwritten, are separately underlined.
(d) Biological names are generally in Greek and written in italics.
(e) The second component in a biological name denotes the specific epithet.

19. Select the incorrect statements.
(A) Lower the taxon, more are the characteristics that the members within the taxon share.

(B) Order is the assemblage of genera which exhibit a few similar characters.
(C) Cat and dog are included in the same family Felidae.
(D) Binomial nomenclature was introduced by Carolus Linnaeus.
(a) B & C (b) B, C & D
(c) A & D (d) C & D

20. Which one of the following is a taxonomical aid for identification of plants and animals based on similarities and dissimilarities?
(a) Flora (b) Keys
(c) Monographs (d) Catalogues

Assertion/ Reason :

DIRECTIONS (Qs. 1-12): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion**: Botany deals with the study of plants and zoology deals with the study of animals.
Reason: Biology is the study of living beings.

2. **Assertion**: Study of internal structure is called anatomy.
Reason: It is useful for phylogentic study.

3. **Assertion**: The science of classifiying organisms is called taxonomy.
Reason: Systematics and taxonomy have same meaning.

4. **Assertion**: Formation of new species is called speciation.
Reason: The deme has a common gene pool.

5. **Assertion**: Phylogeny is the developmental history of a species.
Reason: Species is the basic unit of taxonomy.

6. **Assertion**: Whittaker's classification for algae is not acceptable.
Reason: Whittaker grouped algae in different kingdoms.

7. **Assertion**: Chemotaxonomy is classifying organisms at molecular level.
Reason: Cytotaxonomy is classifying organisms at cellular level.

8. **Assertion**: Systematics is the branch of biology that deals with classification of living organisms.
Reason: The aim of classification is to group the organisms.

9. **Assertion**: To give scientific name to plant, there is ICBN.
Reason: It uses articles, photographs and recommendations to name a plant.

10. **Assertion**: Taxon and category are different things.
Reason: Category shows hierarchical classification.

11. **Assertion**: The hierarchy includes seven obligate categories.
Reason: Intermediate categories are used to make taxonomic positions more informative.

12. **Assertion**: The species is reproductively isolated natural population.
Reason: Prokaryotes cannot be kept under different species on the basis of reproductive isolation.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column-I (Common name)		Column-II (Taxonomic category–Order)	
(A)	Wheat	I.	Primata
(B)	Mango	II.	Diptera
(C)	Housefly	III.	Sapindales
(D)	Man	IV.	Poales

(a) A – I; B – II; C – IV; D – III
(b) A – IV; B – III; C – II; D – I
(c) A – II; B – IV; C – I; D – III
(d) A – III; B – IV; C – II; D – I

2.

Column-I (Common Name)	**Column-II (Taxonomic category–Family)**
(A) Man	I. Poaceae
(B) Datura	II. Anacardiaceae
(C) Mango	III. Solanaceae
(D) Wheat	IV. Hominidae

(a) A – IV; B – III; C – II; D – I
(b) A – IV; B – III; C – I; D – II
(c) A – I; B – II; C – III; D – IV
(d) A – I; B – III; C – II; D – IV

3.

Column-I (Class)	**Column-II (Biological name)**
(A) Homo sapiens	I. Dicotyledonae
(B) Musca domestica	II. Mammalia
(C) Mangifera indica	III. Monocotyledonae
(D) Triticum aestivum	IV. Insects

(a) A – IV; B – II; C – I; D – III
(b) A – II; B – IV; C – III; D – I
(c) A – II; B – IV; C – I; D – III
(d) A – II; B – I; C – IV; D – III

4.

Column-I	**Column-II**
(A) National Botanical Research Institute	I. Carolus Linneaus
(B) Indian Botanical Garden	II. Taxon
(C) Binomial Nomenclature	III. Howrah (India)
(D) A unit of classification	IV. Lucknow

(a) A – III; B – IV; C – I; D – II
(b) A – IV; B – III; C – I; D – II
(c) A – IV; B – III; C – II; D – I
(d) A – IV; B – I; C – III; D – II

5.

Column-I	**Column-II**
(A) Family	I. *tuberosum*
(B) Kingdom	II. Polymoniales
(C) Order	III. *Solanum*
(D) Species	IV. Plantae
(E) Genus	V. Solanaceae

(a) A – IV; B – III; C – V; D – II; E – I
(b) A – V; B – IV; C – II; D – I; E – III
(c) A – IV; B – V; C – II; D – I; E – III
(d) A – V; B – III; C – II; D – I; E – IV

6.

Column I	**Column II**
(A) Growth	I. Production of offspring.
(B) Reproduction	II. Composed of one or more cells.
(C) Metabolism	III. Increase in mass and increase in number of individuals.
(D) Cellular organization	IV. Sum total of all chemical reactions occurring in body.

	A	B	C	D
(a)	I	II	III	IV
(b)	III	I	II	IV
(c)	III	I	IV	II
(d)	II	IV	III	I

7.

Column I	**Column II**
(A) Taxon	I. Basic unit of classification
(B) Species	II. A taxonomic group of any rank
(C) Phylum	III. Division is the same category in case of
(D) Genus	IV. Identified based on a number of similar characters
(E) Order	V. Group of related species having more character in common with others

	A	B	C	D	E
(a)	V	II	IV	III	I
(b)	III	I	IV	II	V
(c)	II	I	III	V	IV
(d)	III	II	IV	I	V

8.

Column I	Column II
(A) Herbarium	I. Includes those specimens which can be easily classified on their observable characters.
(B) Botanical garden	II. Preserved specimens on sheets become a store house for future use.
(C) Museum	III. Generally set up in educational institutes.
(D) Zoological Park	IV. Includes those animals which are identified based on their aggregates of characters.
(E) Key	V. All animals provided similar conditions to their natural habitat.
	VI. Includes animals of related orders.
	VII. Includes collection of living plants for reference.
	VIII. It identifies animals and plants on the basis of their similarities and dissimilarities.

	A	B	C	D	E
(a)	I	II	VIII	V	III
(b)	III	I	IV	II	V
(c)	II	VII	III	V	VIII
(d)	II	III	VII	I	IV

Critical Thinking Type Questions :

1. Identify the correct sequence of taxonomic categories.
(a) Species $\rightarrow$ Genus $\rightarrow$ Order $\rightarrow$ Class $\rightarrow$ Family $\rightarrow$ Phylum/Division $\rightarrow$ Kingdom
(b) Species $\rightarrow$ Genus $\rightarrow$ Family $\rightarrow$ Class $\rightarrow$ Phylum/Division $\rightarrow$ Order $\rightarrow$ Kingdom
(c) Species $\rightarrow$ Genus $\rightarrow$ Family $\rightarrow$ Order $\rightarrow$ Class $\rightarrow$ Phylum/Division $\rightarrow$ Kingdom
(d) Species $\rightarrow$ Genus $\rightarrow$ Family $\rightarrow$ Order $\rightarrow$ Class $\rightarrow$ Phylum/Division $\rightarrow$ Kingdom

2. Two plants can be conclusively said to belong to the same species if they
(a) have same number of chromosomes.
(b) can reproduce freely with each other and form seeds.
(c) have more than 90 per cent similar genes.
(d) look similar and possess identical secondary metabolites.

3. 'Taxa' differs from 'taxon' due to being
(a) a higher taxonomic category than taxon.
(b) lower taxonomic category than taxon.
(c) the plural of taxon.
(d) the singular of taxon.

4. Taxonomic hierarchy refers to
(a) step-wise arrangement of all categories for classification of plants and animals.
(b) a group of senior taxonomists who decide the nomenclature of plants and animals.
(c) a list of botanists or zoologists who have worked on taxonomy of a species or group.
(d) classification of a species based on fossil record.

5. One of the **most** important functions of botanical gardens is that
(a) they provide a beautiful area for recreation.
(b) one can observe tropical plants there.
(c) they allow *ex-situ* conservation of germ plasm.
(d) they provide the natural habitat for wildlife.

6. The disadvantage of using common names for species is that
(a) the names may change.
(b) one name does not apply universally.
(c) one species may have several common names and one common name may be applied to two species.
(d) all of the above

7. The most important feature of all living systems is to
(a) utilize oxygen to generate energy.
(b) replicate the genetic information.
(c) produce gametes.
(d) utilize solar energy for metabolic activities.

8. Refer the botanical name of wheat "*Triticum aestivum*" and identify the statement which correctly describes it.
(a) The second word belongs to genus and starts with a small letter.

(b) Both the words "*Triticum aestivum*" denote the specific epithet.

(c) The first word *Triticum* denotes the genus which starts with a capital letter.

(d) The first word *Triticum* denotes the specific epithet while the second word denotes the genus.

9. Which of the following shows the correct example of taxonomic category - Genus?

(a) Potato, tomato and brinjal belong to Solanum.

(b) Monkey, gorilla and gibbon placed in Mammalia.

(c) Solanum, Petunia, and Datura placed in Solanacea.

(d) Mangifera indica, Solanum tuberosum, and Panthera leo.

10. "X" being a higher category is the assemblage of families which exhibit a few "Y" characters. The "Z" characters are less in a number as compared to different genera included in a family. Identify "X", "Y", and "Z".

(a) X - Order; Y - Similar; Z - Similar

(b) X - Genus; Y - Similar; Z - Different

(c) X - Species; Y - Different; Z - Similar

(d) X - Class; Y - Different; Z - Different

2 Biological Classification

Fill in the Blanks :

1. ______ is an example of amoeboid protozoans ?
2. ________ is used extensively in biochemical and genetic work.
3. The subunit of capsid is called ________
4. The genetic material of virus includes ________
5. Clamp connection is found in ________
6. The bacteria which oxidize various inorganic substances and use the released energy for their ATP production are called _______________.
7. Virus which attack bacteria are called as _______.
8. ________ is the protein covering of TMV.
9. AIDS virus contains ________.
10. The integrated viral genome is called ________.

True / False :

1. *Neurospora,* which is used in biochemical and genetic work is a member of this class.
2. Reproduction in fungi can take place by vegetative means – fragmentation, fission and budding.
3. Mycoplasma is the smallest living organism.
4. *Alternaria*, *Colletotrichum* and *Trichoderma* are examples of deuteromycetes.
5. Cyanobacteria are chemosynthetic autotrophs.
6. Archaea have some novel features that are absent in other prokaryotes and eukaryotes.
7. Asexual reproduction takes place by zoospores (motile) or by aplanospores (non-motile) in Ascomycetes.

Conceptual MCQs :

1. Kingdom monera comprises the –
   (a) plants of economic importance
   (b) all the plants studied in botany
   (c) prokaryotic organisms
   (d) plants of thallophyta group
2. Whittaker is famous for –
   (a) two kingdom classification
   (b) four kingdom classification
   (c) five kingdom classification
   (d) distinguishing in bacteria and blue green algae
3. In Whittaker's five kingdom classification, eukaryotes were assigned to –
   (a) all the five kingdom
   (b) only four of the five kingdoms
   (c) only three kingdom
   (d) only one kingdom
4. Which group of plant have embryo but not vascular tissue –
   (a) cyanophyta (b) tracheophyta
   (c) bryophyta (d) chlorophyta
5. Kingdom of unicellular eukaryotes –
   (a) monera (b) protista
   (c) fungi (d) plantae
6. A true species consists of a population –
   (a) sharing the same niche
   (b) interbreeding
   (c) feeding over the same food
   (d) reproductivity isolated
7. Which one belongs to monera?
   (a) *Amoeba* (b) *Escherichia*
   (c) *Gelidium* (d) *Spirogyra*
8. Protista includes
   (a) heterotrophs
   (b) chemoheterotrophs
   (c) chemoautotrophs
   (d) all the above

9. Protistan genome has
(a) membrane bound nucleoproteins embedded in cytoplasm
(b) free nucleic acid aggregates
(c) gene containing nucleoproteins condensed together in loose mass
(d) nucleoprotein in direct contact with cell substance

10. The main difference in Gram (+)ve and Gram (–)ve bacteria resides in their
(a) cell wall (b) cell membrane
(c) cytoplasm (d) flagella

11. Organisms which are indicator of SO_2 pollution of air
(a) Mosses (b) Lichens
(c) Mushrooms (d) Puffballs

12. Decomposers are organisms that
(a) illaborate chemical substances, causing death of tissues
(b) operate in living body and simplifying organic substances of cells step by step
(c) attack and kill plants as well as animals
(d) operate in relay terms, simplifying step by step the organic constituents of dead body

13. The chemical compounds produced by the host plants to protect themselves against fungal infection is
(a) phytotoxin (b) pathogen
(c) phytoalexins (d) hormone

14. Mycorrhiza is
(a) a symbiotic association of plant roots and certain fungi
(b) an association of algae with fungi
(c) a fungus parasitising root system of higher plants
(d) an association of *Rhizobium* with the roots of lenguminous plants

15. Phylogenetic system of classification is based on:
(a) morphological features
(b) chemical constituents
(c) floral characters
(d) evolutionary relationships

16. Mannitol is the stored food in:
(a) *Porphyra* (b) *Fucus*
(c) *Gracillaria* (d) *Chara*

17. Compared with the gametophytes of the bryophytes the gametophytes of vascular plant are
(a) smaller but have larger sex organs
(b) larger but have smaller sex organs
(c) larger and have larger sex organs
(d) smaller and have smaller sex organs

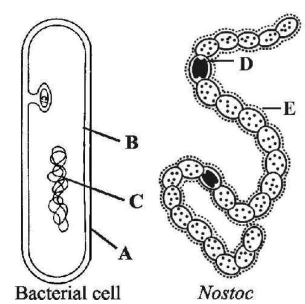
18. *Selaginella* and *Salvinia* are considered to represent a significant step toward evolution of seed habit because:
(a) female gametophyte is free and gets dispersed like seeds
(b) female gametophyte lacks archaegonia
(c) megaspores possess endosperm and embryo surrounded by seed coat
(d) embryo develops in female gametophyte which is retained on parent sporophyte.

19. Powdery mildew of wheat is caused by a species of
(a) *Puccinia* (b) *Erysiphe*
(c) *Ustilago* (d) *Albugo*

20. Movements by pseudopodia of *Amoeba* are due to change in
(a) pressure (b) atmosphere
(c) temperature (d) viscosity

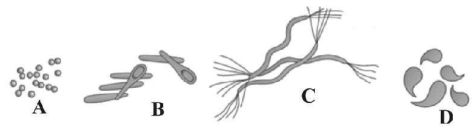
Diagram Based Questions :

1. Refer the given figure of bacteria cell and *Nostoc* and choose the option which shows correct label for the structure marked as A, B, C, D and E ?



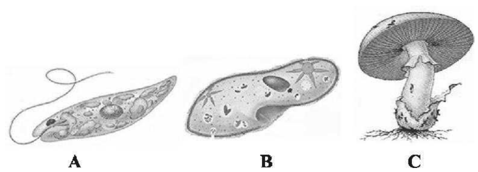
(a) A – Cell wall; B – Cell membrane; C – Heterocyst; D – DNA; E – Mucilagenous sheath
(b) A – Cell wall; B – Cell membrane; C – DNA; D – Heterocyst; E – Mucilagenous sheath
(c) A – Mucilagenous sheath; B – Cell membrane; C – DNA; D – Heterocyst; E – Cell wall
(d) A – Cell membrane; B – Cell wall; C – DNA; D – Heterocyst; E – Mucilagenous sheath

2. Choose the correct names of the different bacteria given below according to their shapes.



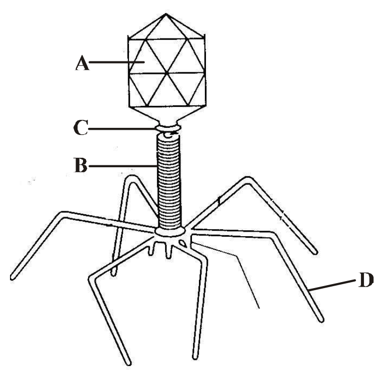
(a) A – Cocci; B – Bacilli; C – Spirilla; D – Vibrio
(b) A – Bacilli; B – Cocci; C – Spirilla; D – Vibrio
(c) A – Spirilla; B – Bacilli; C – Cocci; D – Vibrio
(d) A – Spirilla; B – Vibrio; C – Cocci; D – Bacilli

3. Identify the following figures A, B and C.



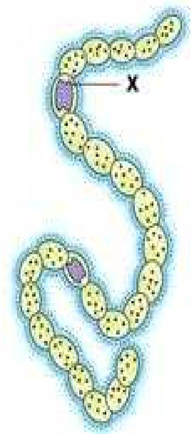
(a) A – *Euglena*, B – *Paramecium*, C –*Agaricus*
(b) A – *Euglena*, B – *Planaria*, C – *Agaricus*
(c) A – *Planaria*, B – *Paramecium*, C – *Agaricus*
(d) A – *Euglena*, B – *Paramecium*, C – *Aspergillus*

4. The figure given below shows the structure of a bacteriophage. Identify its parts labelled as A, B, C and D.



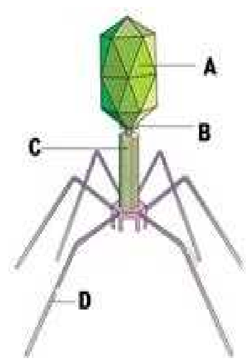
	A	B	C	D
(a)	Tail fibres	Head	Sheath	Collar
(b)	Sheath	Collar	Head	Tail fibres
(c)	Head	Sheath	Collar	Tail fibres
(d)	Collar	Tail fibres	Head	Sheath

5. The given figure shows the structure of filamentous blue green algae, Nostoc with a structure marked as "X". Select the option which shows the correct identification of the "X" with its feature.



(a) Spores - Reproduction
(b) Heterocysts - Nitrogen fixation
(c) Pellicle - Recycling of nutrition
(d) Mucilaginous sheath - Photosynthesis

6. The given figure shows some labelled structure as A, B, C and D. In which structure the protein coat that encloses the nucleic acid is present?



(a) A
(b) B
(c) C sheath
(d) D tail fibres

Assertion/ Reason :

DIRECTIONS (Qs. 1-12): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion:** Viruses are not considered organism.
Reason: Viruses are nucleoproteins and lack cell organelle, *etc*.

2. **Assertion :** Bacteria have three basic shapes, *i.e.*, round , rod, spiral.
Reason : *Cocci and Bacilli* may form clusters or chain of a definite length.

3. **Assertion :** Aflatoxins are produced by *Aspergillus flavus*.
Reason : These toxins are useful to mankind.

4. **Assertion :** TMV is a virus which causes mosaic disease.
Reason : TMV has RNA as genetic material.

5. **Assertion :** Plasmids are extrachromosomal DNA.
Reason : Plasmids are found in bacteria and are useful in genetic engineering.

6. **Assertion:** Plasmids are single-stranded extra chromosomal DNA.
Reason: Plasmids are usually present in eukaryotic cells.

7. **Assertion :** Yeasts such as *Saccharomyces cerevisiae* are used in baking industry.
Reason : Carbon dioxide produced during fermentation causes bread dough to rise by thermal expansion.

8. **Assertion :** *Escherichia coli*, *Shigella* sp. and *Salmonella* sp. are all responsible for diarrhoeal diseases.
Reason : Dehydration is common to all types of diarrhoeal diseases and adequate supply of fluids and electrolytes should be ensured.

9. **Assertion :** Gram-negative bacteria do not retain the stain when washed with alcohol.
Reason : The outer face of the outer membrane of gram-negative bacteria contains lipopolysaccharides, a part of which is integrated into the membrane lipids.

10. **Assertion :** *Neurospora* is commonly called water mould.
Reason : It belongs to basidomycetes fungi.

11. **Assertion :** Lichen is important for chemical industries.
Reason : Litmus and Orcein are formed from lichens.

12. **Assertion :** Yeasts such as *Saccharomyces cerevisiae* are used in baking industry.
Reason : Carbon dioxide produced during fermentation causes bread dough to rise by thermal expansion.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I		Column-II
(A)	*Escherichia coli*	I.	Nif gene
(B)	*Rhizobium melilotae*	II.	Digestive hydrocarbon of crude oil
(C)	*Bacillus thuringiensis*	III.	Production of human insulin
(D)	*Pseudomonas putida*	IV.	Biological control of fungal disease
		V.	Bio-decomposed insectiside

(1) A - III; B - I; C - V; D - IV
(2) A - I; B - II; C - III; D - IV
(3) A - II; B - I; C - III; D - IV
(4) A - III; B - I; C - V; D - II

2.

	Column-I (Group)		Column-II (Example)
(A)	Bacillariophyceae	I.	*Paramecium*
(B)	Dinoflagellates	II.	*Euglena*
(C)	Euglenoids	III.	Gonyaulax
(D)	Protozoans	IV.	Diatoms

	A	B	C	D
(1)	I	III	II	IV
(2)	I	IV	III	II
(3)	IV	II	III	I
(4)	IV	III	II	I

3. **Column-I (Spores)** — **Column-II (Organisms)**

(A) Ascospores — I. Diatoms
(B) Endospores — II. Agaricus
(C) Auxospores — III. Bacteria
(D) Basidiospores — IV. Yeast
V. Nephrolepis

(1) A - IV; B - III; C - I; D - II
(2) A - IV; B - I; C - III; D - II
(3) A - IV; B - I; C - V; D - II
(4) A - IV; B - V; C - I; D - II

4.

Column-I	Column-II
A. M13 bacteriophage	I. dsRNA
B. Rice dwarf virus	II. ssRNA
C. Cauliflower mosaic virus	III. ssDNA
D. Polio virus	IV. dsDNA

	A	B	C	D
(1)	III	I	IV	II
(2)	II	I	III	IV
(3)	III	IV	II	I
(4)	IV	III	I	II

5. **Column-I (Class of fungi)** — **Column-II (Common name)**

(A) Phycomycetes — I. Sac fungi
(B) Ascomycetes — II. Algal fungi
(C) Basidiomycetes — III. Fungi imperfecti
(D) Deuteromycetes — IV. Club fungi

(a) A – II; B – I; C – IV; D – III
(b) A – II; B – IV; C – I; D – III
(c) A – IV; B – I; C – II; D – III
(d) A – IV; B – III; C – II; D – I

6. **Column-I (Terms)** — **Column-II (Examples)**

(A) Ascus — I. *Spirulina*
(B) Basidium — II. *Penicillium*
(C) Protista — III. *Agaricus*
(D) Cyanobacteria — IV. *Euglena*
(E) Animalia — V. Sponges

(a) A – II; B – III; C – IV; D – V; E – I
(b) A – I; B – II; C – III; D – V; E – IV
(c) A – II; B – V; C – III; D – I; E – IV
(d) A – II, B – III, C – IV, D – I, E – V

7. **Column-I (Kingdom)** — **Column-II (Class)**

(A) Plantae — I. Archaebacteria
(B) Fungi — II. Euglenoids
(C) Protista — III. Phycomycetes
(D) Monera — IV. Algae

(a) A – IV; B – III; C – II; D – I
(b) A – I; B – II; C – III; D – IV
(c) A – III; B – IV; C – II; D – I
(d) A – IV; B – II; C – III; D – I

8. **Column-I (Fungus name)** — **Column-II (Commonly called)**

(A) *Puccinia* — I. Yeast
(B) *Ustilago* — II. Mushroom
(C) *Agaricus* — III. Smut fungus
(D) *Saccharomyces* — IV. Rust fungus

(a) A – I; B – II; C – III; D – IV
(b) A – II; B – III; C – IV; D – I
(c) A – III; B – IV; C – I; D – II
(d) A – IV; B – III; C – II; D – I

9. **Column-I (Type of Protozoans)** — **Column-II (Examples)**

(A) Amoeboid protozoans — I. *Paramecium*
(B) Ciliated protozoans — II. *Plasmodium*
(C) Flagellated protozoans — III. *Amoeba*
(D) Sporozoans — IV. *Trypanosoma*

(a) A – I; B – III; C – IV; D – II
(b) A – III; B – I; C – II; D – IV
(c) A – III; B – I; C – IV; D – II
(d) A – III; B – IV; C – I; D – II

10. **Column-I (Characters/features)** — **Column-II (Examples)**

(A) Red dinoflagellates — I. *Rhizopus*
(B) Unicellular fungi used to make bread and beer — II. *Gonyaulax*
(C) Source of antibiotics — III. Yeast
(D) Bread mould — IV. *Penicillium*

(a) A – III; B – II; C – I; D – IV
(b) A – II; B – III; C – I; D – IV
(c) A – II; B – III; C – IV; D – I
(d) A – II; B – IV; C – III; D – I

Critical Thinking Type Questions

1. Bacteria lack alternation of generation because there is
   (a) neither syngamy nor reduction division.
   (b) no distinct chromosomes.
   (c) no conjugation.
   (d) no exchange of genetic material.
2. Yeast is not included in protozoans but in fungi because
   (a) it has no chlorophyll.
   (b) some fungal hyphae grow in such a way that they give the appearance of pseudomycelium.
   (c) it has eukaryotic organization.
   (d) cell wall is made up of cellulose and reserve food material is starch.
3. A virus can be considered a living organism because it
   (a) responds to touch stimulus
   (b) respires
   (c) reproduces (inside the host)
   (d) can cause disease
4. Lichens indicate SO_2 pollution because they
   (a) show association between algae and fungi.
   (b) grow faster than others.
   (c) are sensitive to SO_2.
   (d) flourish in SO_2 rich environment.
5. When a moist bread is kept exposed in air, it becomes mouldy and black because
   (a) spores are present in the water.
   (b) spores are present in the bread.
   (c) spores are present in the air.
   (d) the bread decomposes.
6. In some viruses, RNA is present instead of DNA indicating that
   (a) their nucleic acid must combine with host DNA before replication.
   (b) they cannot replicate.
   (c) there is no hereditary information.
   (d) RNA can transfer heredity material.
7. *Ustilago* causes plant diseases (called smuts) because
   (a) they parasitize on cereals.
   (b) they lack mycelium.
   (c) they develop sooty masses of spores.
   (d) their affected parts becomes completely black.
8. Bacteria were regarded to be plants because
   (a) some of them are green in colour.
   (b) they are present every where.
   (c) some of them cannot move.
   (d) they have a rigid cell wall.
9. A fungus contains cells with two nuclei from different genomes. The nuclei do not fuse but divide independently and simultaneously as new cells are formed. This fungus belongs to
   (a) phycomycetes (b) zygomycetes
   (c) deuteromycetes (d) basidiomycetes
10. Which one single organism or the pair of organisms is correctly assigned to its taxonomic group?
    (a) *Paramecium* and *Plasmodium* belong to the same kingdom as that of *Penicillium.*
    (b) Lichen is a composite organism formed from the symbiotic association of an alga and a protozoan.
    (c) Yeast used in making bread and beer is a fungus.
    (d) *Nostoc* and *Anabaena* are examples of protista.

3 PLANT KINGDOM

Fill in the Blanks :

1. The Natural system of classification for flowering plants was given by __________ and __________
2. Cytological information like chromosome number, structure, behaviour are related with __________ .
3. Fusion of two gametes which are dissimilar in size is termed as _______.
4. _______ represent the reproductive organs amongst gymnosperms.
5. In bryophytes, male and female sex organs are called ______ and ______ respectively.
6. The heterosporous pteridophyte belonging to the class lycopsida is __________ .
7. Protonema and leafy stage are the predominant stage of the life cycle of __________ .

True/ False :

1. Pteridophyte gametophyte has a protonemal and leafy stage.
2. Antheridiophores and archegoniophores are present in pteridophytes.
3. Most rhodophyta grow at great depths, the chlorophyll can only absorb light in the red area of the spectrum. So, rhophyta exhibits red in colour.
4. Double fertilization is unique to gymnosperms and monocotyledons.
5. Phaeophyceae members possess chlorophyll *a*, *c*, carotenoids and xanthophylls.
6. Leafy stage are attached to the soil through unicellular and branched rhizoids in moss.
7. All seed – bearing plants *i.e.,* gymnosperms and angiosperms follow dipontic life patterns of plants.
8. In *Ginkgo,* male gametophyte is not independent.

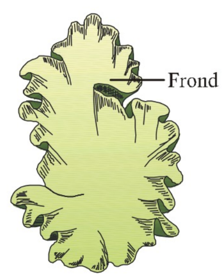
Conceptual MCQs :

1. Bryophytes are amphibians because
   (a) they require a layer of water for carrying out sexual reproduction
   (b) they occur in damp places
   (c) they are mostly aquatic
   (d) all the above
2. Pteridophytes differ from mosses/bryophytes in possessing
   (a) independent gametophyte
   (b) well developed vascular system
   (c) archegonia
   (d) flagellate spermatozoids
3. In Chlorophyceae, sexual reproduction occurs by
   (a) isogamy and anisogamy
   (b) isogamy, anisogamy and oogamy
   (c) oogamy only
   (d) anisogamy and oogamy
4. *Cycas* have two cotyledons but not included in angiosperms because of
   (a) naked ovules
   (b) seems like monocot
   (c) circinate ptyxis
   (d) compound leaves
5. In angiosperms, functional megaspore develops into
   (a) embryo sac (b) ovule
   (c) endosperm (d) pollen sac
6. Which one of the following is a living fossil?
   (a) *Pinus* (b) *Opuntia*
   (c) *Ginkgo* (d) *Thuja*

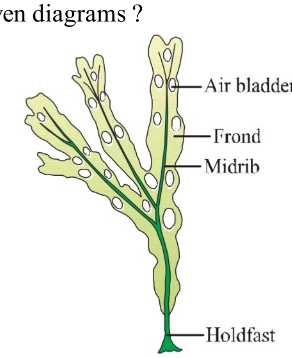
7. Blue-green algae belong to
   (a) eukaryotes (b) prokaryotes
   (c) rhodophyceae (d) chlorophyceae
8. Bioindicators are –
   (a) lichens tracing the presence of pollution
   (b) fossil lichens
   (c) special type of litmus paper
   (d) none above
9. The endosperm of Gymnosperm is-
   (a) haploid (b) diploid
   (c) triploid (d) tetraploid
10. When pollen of a flower is transferred to the stigma of another flower of the same plant, this pollination is referred to as –
   (a) xenogamy (b) geitonogamy
   (c) autogamy (d) allogamy
11. When pollen tube enters through funiculus or integument, it is called –
   (a) porogamy (b) chalazogamy
   (c) cesogamy (d) isogamy
12. Reinder moss is the common name of –
   (a) *Usnea comosa*
   (b) *Cladonia rangiferina*
   (c) *Funaria hygrometrica*
   (d) *Sphagnum aceutifolium*
13. Male and female gametophytes are independent and free -living in:
   (a) *Mustard* (b) Castor
   (c) *Pinus* (d) *Sphagnum*
14. Cycas and *Adiantum* resemble each other in having:
   (a) Seeds
   (b) Motile Sperms
   (c) Cambium
   (d) Vessels
15. Sporocarp is a reproductive structure of
   (a) Some algae
   (b) Some aquatic ferns having sori
   (c) Angiosperms having spores
   (d) Bryophytes
16. Coralloid roots of *Cycas* is distinguished from angiosperm roots by
   (a) absence of pith
   (b) having xylem tissue
   (c) absence of algal zone
   (d) presence of algal zone
17. Heterocysts are present in
   (a) *Riccia* (b) *Ulothrix*
   (c) *Albugo* (d) *Nostoc*
18. In gymnosperms, the pollen chamber represents
   (a) a cell in the pollen grain in which the sperms are formed
   (b) a cavity in the ovule in which pollen grains are stored after pollination
   (c) an opening in the mega gametophyte through which the pollen tube approaches the egg
   (d) the microsporangium in which pollen grains develop
19. Which one of the following is a saprophytic bryophyte?
   (a) *Riccia fluitans*
   (b) *Buxbaumia aphylla*
   (c) *Funaria hygrometrica*
   (d) *Sphagnum*
20. Iodine is obtained from
   (a) *Laminaria* (b) *Chlorella*
   (c) *Polysiphonia* (d) *Porphyra*

Diagram Based Questions :

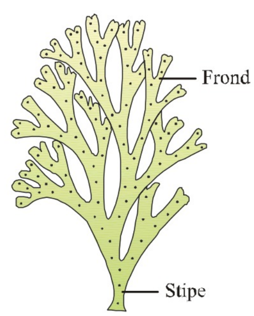
1. The given figures (A, B, C, D) represents the exampels of types of algae. Identify the correct option for the given diagrams ?



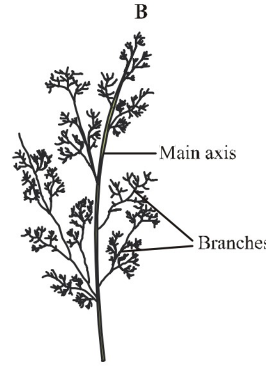
A



B



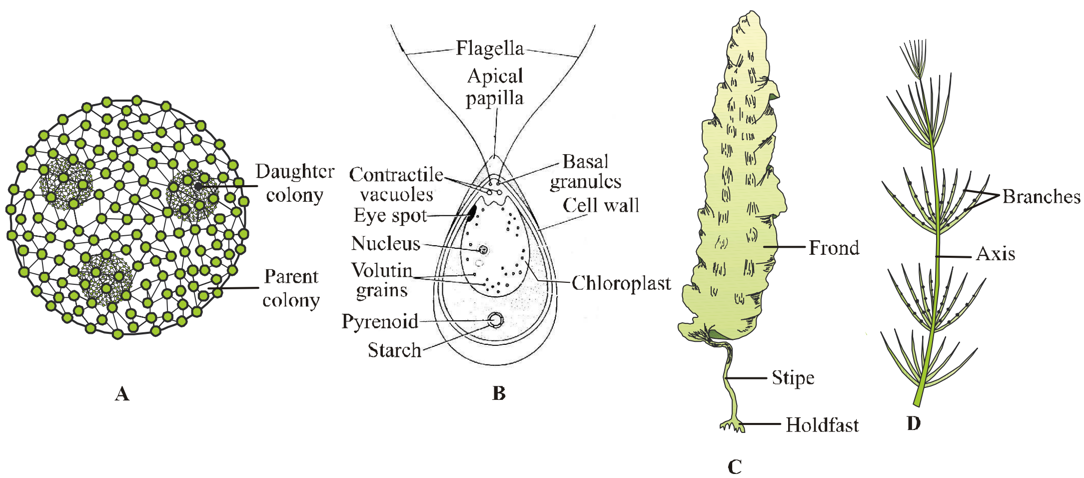
C



D

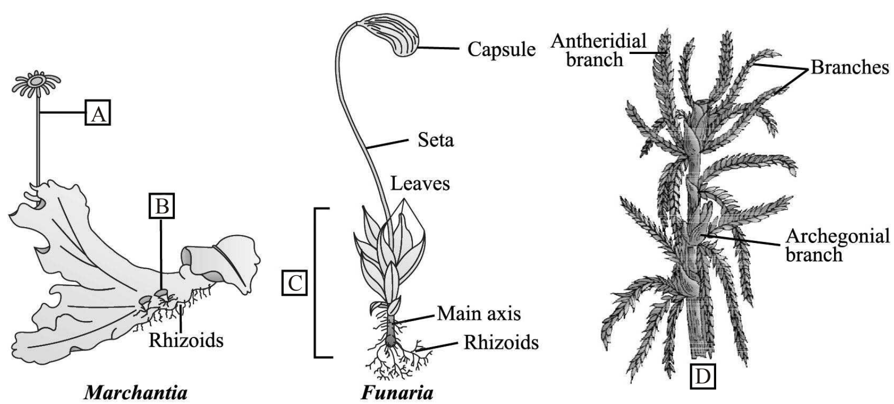
S. No.	A	B	C	D
(a)	*Porphyra*	*Fucus*	*Dictyota*	*Polysiphonia*
(b)	*Polysiphonia*	*Porphyra*	*Dictyota*	*Fucus*
(c)	*Fucus*	*Dictyota*	*Porphyra*	*Polysiphonia*
(d)	*Porphyra*	*Polysiphonia*	*Fucus*	*Dictyota*

2. Refer the given figure (A, B, C and D) and answer the question. Which of the following figures are the members of green algae?



(a) A, B and D (b) A, B and C (c) B, C and D (d) C, D and A

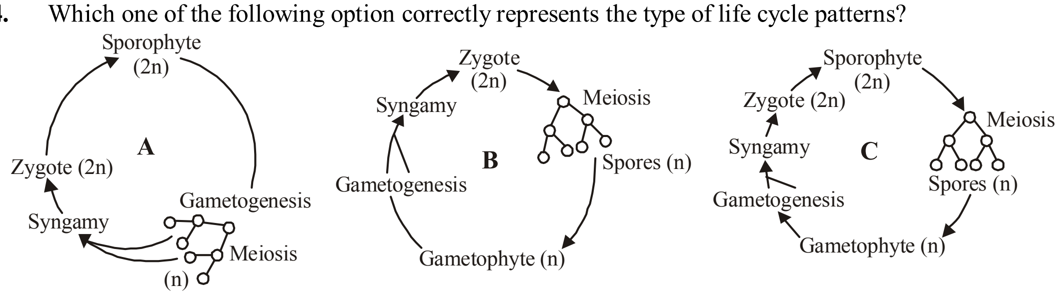
3. The given figure represents the examples of bryophytes. In them few structure/part are marked as A, B, C and D.



Identify the option which shows the correct labeling of A, B, C and D.

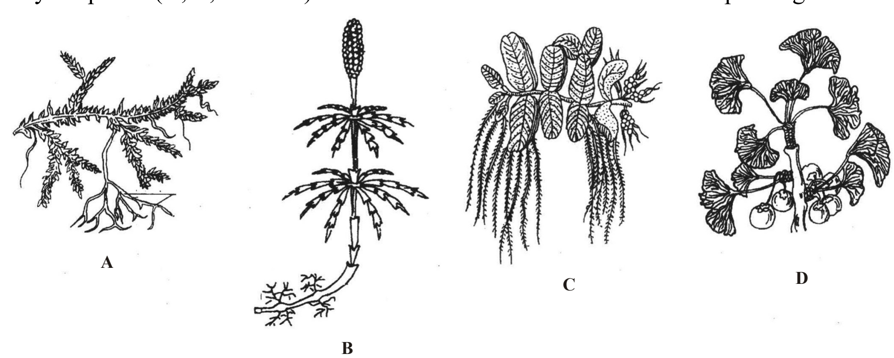
S. No.	A	B	C	D
(a)	Gemma cup	Archegoniophore	Sporophyte	*Sphagnum*
(b)	Archegoniophore	Gemma cup	Gametophyte	*Sphagnum*
(c)	Archegonia	Antheridia	Gemma cup	*Sphagnum*
(d)	Antheridia	Archegonia	Gemma cup	*Sphagnum*

4. Which one of the following option correctly represents the type of life cycle patterns?



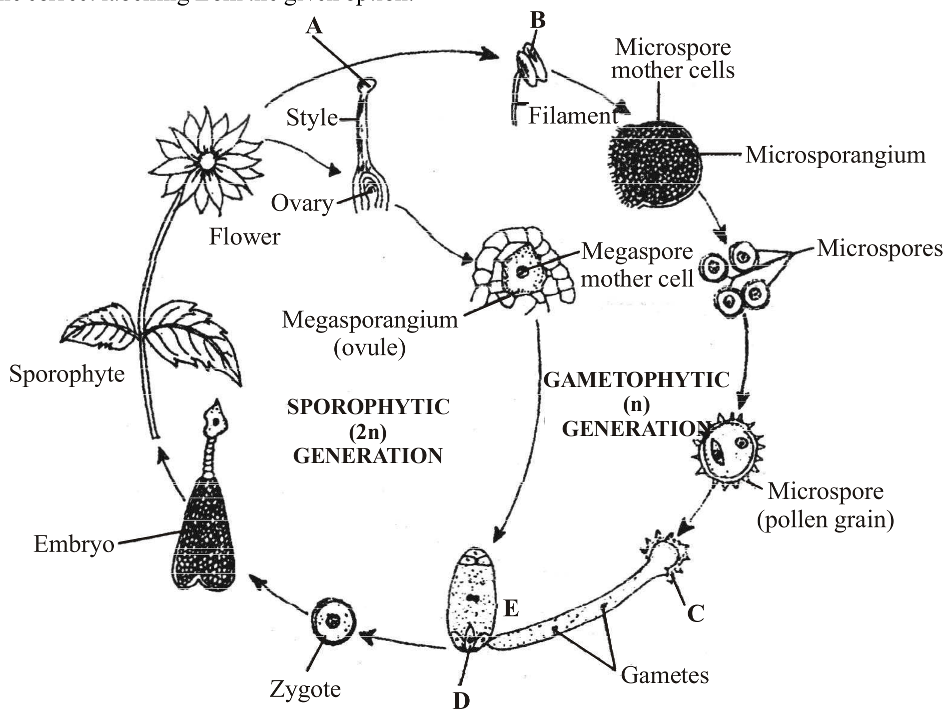
(a) A - Diplontic; B - Haplodiplontic; C - Haplontic
(b) A - Haplodiplontic; B - Haplontic; C - Diplontic
(c) A - Haplontic; B - Diplontic; C - Haplodiplontic
(d) A- Diplontic; B - Haplontic; C - Haplodiplontic

5. Identify the plants (A, B, C and D) and choose their correct name from the options given below.



S. No.	A	B	C	D
(a)	*Equisetum*	*Ginkgo*	*Selaginella*	*Lycopodium*
(b)	*Selaginella*	*Equisetum*	*Salvinia*	*Ginkgo*
(c)	*Funaria*	*Adiantum*	*Salvinia*	*Riccia*
(d)	*Chara*	*Marchantia*	*Fucus*	*Pinus*

6. The given figure shows the life cycle of an angiosperm. Few plants are marked as A, B, C, D and E. Identify the correct labelling from the given option.



(a) A–Stigma; B–Anther; C–Male gametophyte; D–Egg; E–Female gametophyte
(b) A–Stigma; B–Anther; C–Female gametophyte; D–Egg; E–Male gametophyte
(c) A–Stigma; B–Anther; C–Male gametophyte; D–Fertilized egg; E–Female gametophyte
(d) A–Stigma; B–Anther; C–Embryo sac; D–Egg; E–Female gametophyte

Assertion/ Reason :

Directions for (Qs. 1-9) : *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false.
(e) If the assertion is false but the reason is true.

1. **Assertion :** In hemianatropous ovule, the funicle lies parallel to body of ovule.
Reason : Here, body of ovule has rotated by 90°.

2. **Assertion :** Mosses are evolved from algae.
Reason : Protonema of mosses is similar to some green algae.

3. **Assertion :** Red algae contributes in producing coral reefs.
Reason : Some red algae secrete and deposit calcium carbonate over their walls.

4. **Assertion :** Coconut tree is distributed in coastal areas over a large part of the world.
Reason : Coconut fruit can float and get dispersed over thousands of kilometers before losing viability.

5. **Assertion :** The fungi are widespread in distribution and they even live on or inside other plants and animals.

Reason : Fungi are able to grow anywhere on land, water or on other organisms because they have a variety of pigments, including chlorophyll, carotenoids, fucoxanthin and phycoerythrin.

6. **Assertion :** Algae and fungi are classified as thallophytes.
Reason : They both are autotrophs.

7. **Assertion :** Conifer trees produce a large quantity of wind borne pollen grains.
Reason : The pollen grains have wings.

8. **Assertion :** Red algae contributes in producing coral reefs.
Reason : Some red algae secrete and deposit calcium carbonate over their walls.

9. **Assertion:** The peristome is a fringe of teeth-like projections found at the mouth of the capsule.
Reason: It may be of two types nematodontous and orthodontus.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I (Group of Plant Kindgdom)		Column-II (Examples)
(A)	Algae	I.	*Solanum tuberosum*
(B)	Fungi	II.	*Equisetum*
(C)	Angiosperm	III.	*Cycas*
(D)	Pteridophyte	IV.	*Chlamydomonas*
(E)	Gymnosperm	V.	*Rhizopus*

(a) A – V; B – IV; C – I; D – II; E – III
(b) A – IV; B – V; C – I; D – II; E – III
(c) A – IV; B – I; C – V; D – II; E – III
(d) A – IV; B – I; C – V; D – III; E – II

2.

	Column -I (Classes of pteridophytes)		Column-II (Examples)
(A)	Psilopsida	I.	*Selaginella*
(B)	Lycopsida	II.	*Psilotum*
(C)	Sphenopsida	III.	*Dryopteris*
(D)	Pteropsida	IV.	*Equisetum*

(a) A – II; B – I; C – IV; D – III
(b) A – I; B – II; C – IV; D – III
(c) A – II; B – I; C – III; D – IV
(d) A – II; B – IV; C – I; D – III

3.

	Column-I		Column-II
(A)	Agar	I.	Single cell protein, used as food supplements by space travellers
(B)	Algin	II.	Red algae
(C)	Carrageen	III.	Brown algae
(D)	*Chlorella and Spirullina*	IV.	*Gelidium*, *Gracilaria*

(a) A – I; B – II; C – III; D – IV
(b) A – IV; B – III; C – II; D – I
(c) A – II; B – I; C – III; D – IV
(d) A – III; B – II; C – I; D – IV

4.

	Column-I		Column-II
(A)	Phaeophyceae	I.	*Have an elaborate mechanism of spore dispersal*
(B)	Rhodophyceae	II.	*first terrestrial plant with vascular tissue-phloem and xylem*
(C)	Mosses	III.	*Asexual reproduction by biflagellate zoosposes*
(D)	Pteridophytes	IV.	*Polysiphonia*, *Porphyra*, *Gracilaria*

(a) A – III; B – IV; C – I; D – II
(b) A – IV; B – III; C – I; D – II
(c) A – IV; B – III; C – II; D – I
(d) A – IV; B – I; C – III; D – II

5.

	Column-I (Pattern of life cycle in plant)		Column-II (Examples)
(A)	Haplontic life cycle	I.	Bryophytes, Pteridophytes, *Ectocarpus*, *Polysiphonia*, Kelps

(B)	Diplontic life cycle	II.	Seed bearing plants (Gymnosperm and Angiosperm), *Fucus*
(C)	Haplo-diplontic life cycle	III.	Many algae (*Volvox*, *Spirogyra)* and some species of *Chlamydomonas*

(a) A – III; B – II; C – I
(b) A – I; B – II; C – III
(c) A – II; B – I; C – III
(d) A – III; B – I; C – II

6.

	Column-I (System of classification)		**Column-II (Characteristics)**
(A)	Artificial system of classification	I.	Based on few morphological characters
(B)	Natural system of classification	II.	Based on evolutionary relationships between the various organisms
(C)	Phylogenetic system of classification	III.	Based on natural affinities among the organisms and consider external as well as internal features.

(a) A – II; B – I; C – III
(b) A – I; B – III; C – II
(c) A – III; B – II; C – I
(d) A – I; B – II; C – III

7.

	Column-I		**Column-II**
(A)	Smallest flowing plant	I.	*Eucalyptus*
(B)	Male sex organ in flowering plant	II.	*Wolffia*
(C)	Female sex organ in flowering plant	III.	Stamen
(D)	Tallest tree	IV.	Pistil

(a) A – I; B – II; C – III; D – IV
(b) A – IV; B – III; C – II; D – I
(c) A – II; B – III; C – IV; D – I
(d) A – II; B – IV; C – III; D – I

8.

	Column-I		**Column-II**
(A)	Amphibian of the plant kingdom	I.	*Sphagnum*
(B)	Specialized structures in liverworts for asexual reproduction	II.	Angiosperms
(C)	Monocotyledons and dicotyledons	III.	Bryophytes
(D)	A plant which has capacity to holding water	IV.	Gemmae

(a) A – III; B – IV; C – I; D – II
(b) A – III; B – IV; C – II; D – I
(c) A – IV; B – III; C – II; D – I
(d) A – III; B – II; C – IV; D – I

9.

	Column-I (features)		**Column-II (term)**
(A)	Presence of tap roots and coralloid roots	I.	Bryophyte
(B)	The synergids and antipodal cells degenerates after fertilization	II.	Pteridophytes
(C)	The food is stored as floridean starch which is very similar to amylopectin and glycogen in structure	III.	Red algae
(D)	Presence of sporophyte which is not free living but attached to the photosynthetic gametophytes and derives nourishment from it	(IV)	Angiosperms
(E)	Members of this group are used for medicinal purposes, as soil binders and frequently grown as ornamentals	(V)	Gymnosperms

	A	B	C	D	E
(a)	I	II	III	IV	V
(b)	III	V	II	IV	I
(c)	III	I	V	II	IV
(d)	V	IV	III	I	II

Critical Thinking Type Questions :

1. Which of the following, examples belongs to the same class of algae?
   (a) *Chara*, *Fucus*, *Polysiphonia*
   (b) *Volvox*, *Spirogyra*, *Chlamydomonas*
   (c) *Porphyra*, *Ectocarpus*, *Ulothrix*
   (d) *Sargassum*, *Laminaria*, *Gracilaria*
2. A bryophyte differs from pteridophytes in having
   (a) archegonia.
   (b) lack of vascular tissue.
   (c) swimming antherozoids.
   (d) independent gametophytes.
3. Fern plant is a
   (a) haploid gametophyte
   (b) diploid gametophyte
   (c) diploid sporophyte
   (d) haploid sporophyte
4. The unique feature of bryophytes compared to other plant groups is that
   (a) they produce spores.
   (b) they lack vascular tissues.
   (c) they lack roots.
   (d) their sporophyte is attached to the gametophyte.
5. If there are 4 cells in anther, what will be the number of pollen grains?
   (a) 8 (b) 4
   (c) 16 (d) 12
6. Bryophytes are different from fungi in having
   (a) land habit.
   (b) sterile jacket layers.
   (c) multiflagellate gametes.
   (d) gametophytic plant body.
7. Moss peat is used as a packing material for sending flowers and live plants to distant places because
   (a) it reduces transpiration.
   (b) it serves as a disinfectant.
   (c) it is easily available.
   (d) it is hygroscopic.
8. If the cells of root in wheat plant have 42 chromosomes, then the no. of chromosome in the cell of pollen grain is
   (a) 14 (b) 21
   (c) 28 (d) 42
9. A research student collected certain alga and found that its cells contained both chlorophyll *a* and chlorophyll *d* as well as phycoerythrin on the basis of his observation the students conclude that the alga belongs to
   (a) rhodophyceae
   (b) bacillariophyceae
   (c) chlorophyceae
   (d) phaeophyceae
10. Fruits are not formed in gymnosperms because of
    (a) absence of pollination.
    (b) absence of seed.
    (c) absence of fertilization.
    (d) absence of ovary.
11. What is common in all the three, *Funaria, Dryopteris* and *Ginkgo*?
    (a) Independent sporophyte
    (b) Presence of archegonia
    (c) Well developed vascular tissues
    (d) Independent gametophyte
12. In angiosperms, a mature male gametophyte is derived from a pollen mother cell by
    (a) three mitotic divisions.
    (b) one meiotic and two mitotic divisions.
    (c) two meiotic divisions.
    (d) a single meiotic division.
13. If you are asked to classify the various algae into distinct groups then which of the following characters you should choose for the classification ?
    (a) Nature of habitat
    (b) Structural organization of thallus
    (c) Chemical composition of the cell wall
    (d) Types of pigments present in the cell.

4

Animal Kingdom

Fill in the Blanks :

1. When any plane passing through the central axis of the body divides the organism into two identical halves, the organism is called _______.
2. Animals like annelids, arthropods, etc. where the body can be divided into identical left and right halves in only one plane, exhibit_____symmetry.
3. In ctenophora, the body bears _______ external rows of ciliated comb plates, which help in locomotion.
4. Aquatic annelids (like *Nereis*) possess lateral appendages called _______________, which help in swimming.
5. A file like rasping organ for feeding, called radula, present in the phylum __________.
6. In phylum echinodermata, the adult echinoderms are _______, _______ but larvae are _______ _______ .
7. In amphibians, heart is ________ chambered.
8. __________ is responsible for maintaining the current of water in sponge.

True / False :

1. Parapodia are lateral appendages in arthropods used for swimming.
2. Radula in molluscs are structures involved in excretion.
3. Circulatory system in arthropods is of closed type.
4. The pelvic fins of female sharks bear claspers.
5. In *Obelia*, polyps produce medusae sexually and medusae form the polyps asexually.
6. Flame cells in platyhelminthes help in osmoregulation and excretion.
7. In non-chordates, central nervous system is ventral, solid and double.
8. Nematocysts are characteristic feature of the phylum cnidaria.
9. Millipedes have two pairs of appendages in each segment of the body.

Conceptual MCQs :

1. A chordate character is
   (a) gills
   (b) spiracles
   (c) post anal tail
   (d) chitinous exoskeleton
2. Malpighian tubules are
   (a) excretory organs of insects
   (b) excretory organs of annelids
   (c) respiratory organs of insects
   (d) respiratory organs of annelids
3. Male and female cockroaches can be distinguished externally through
   (a) anal styles in male
   (b) anal cerci in female
   (c) anal style and antennae in females
   (d) both b and c
4. Venom of cobra attacks
   (a) digestive system
   (b) respiratory system
   (c) nervous system
   (d) circulatory system
5. What is common in Whale, Bat and Rat ?
   (a) Absence of neck
   (b) Muscular diaphragm between thorax and abdomen
   (c) Extra-abdominal testes to avoid high temperature of body
   (d) Presence of external ears

6. All vertebrates possess
(a) renal portal system
(b) dorsal hollow central nervous system
(c) four chambered ventral heart
(d) pharyngeal gill slits

7. What is true about all sponges without exception
(a) They are all marine
(b) They have flagellated collar cells
(c) They have a mixed skeleton consisting of spicules and spongin fibres
(d) They reproduce only asexually by budding

8. Which of the following characteristic is shared by all arthropods ?
(a) Complete metamorphosis
(b) Wings
(c) Jointed appendages
(d) Asexual reproduction

9. Octopus has 8 arms and it belongs to the class :
(a) cephalopoda (b) rhizopoda
(c) gastropoda (d) pelecypoda

10. Which of the following is closest relative of man ?
(a) Chimpanzee (b) Gorilla
(c) Orangutan (d) Gibbon

11. Presence of gills in the tadpole of frog indicates that –
(a) fishes evolved from frog like ancestors
(b) frogs will have gills in future
(c) frogs evolved from gilled ancestors
(d) fishes were amphibious in the past

12. Pupa of Mosquito is called –
(a) bolus (b) tumbler
(c) maggot (d) wriggler

13. Which one of the following kinds of animals are triploblastic?
(a) Flat worms (b) Sponges
(c) Ctenophores (d) Corals

14. What will you look for to identify the sex of the following?
(a) Female *Ascaris*- Sharply curved posterior end
(b) Male frog- A copulatory pad on the first digit of the hind limb
(c) Female cockroach-Anal cerci
(d) Male shark-Claspers borne on pelvic fins

15. Which one of the following statements is totally wrong about the occurrence of notochord, while the other three are correct?
(a) It is present only in larval tail in Ascidians
(b) It is replaced by a vertebral column in adult frog
(c) It is absent throughout life in humans from the very beginning
(d) It is present throughout life in *Amphioxus*

16. Which one of the following pairs of animals are similar to each other pertaining to the feature stated against them?
(a) *Pteropus* and *Ornithorhyncus* - Viviparity
(b) *Garden lizard* and Crocodile - Three chambered heart
(c) *Ascaris* and *Ancylostoma* - Metameric segmentation
(d) Sea horse and Flying fish - Cold blooded (poikilothermal)

17. Which of the following are correctly matched with respect to their taxonomic classification?
(a) Centipede, millipede, spider, scorpion-Insecta
(b) House fly, butterfly, tse tse fly, silverfish-Insecta
(c) Spiny anteater, sea urchin, sea cucumber-Echinodermata
(d) Flying fish, cuttlefish, silverfish-Pisces

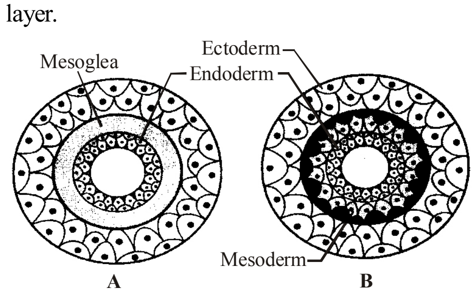
18. "Portuguese man of war" is
(a) Soldier of world war I
(b) Portuguese soldier
(c) A sponge
(d) A polymorphic, colonial, coelenterata

19. Which are exclusively viviparous ?
(a) Bony fishes
(b) Cartilagenous fishes
(c) Sharks
(d) Whales

20. Aristotle's lantern is a characteristic of the following class of Echinodermata
(a) Echinoidea (b) Ophiuroidea
(c) Holothuroidea (d) Asteroidea

Diagram Based Questions :

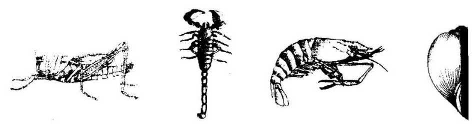
1. The given figures (A & B) shows the germinal layer.



The animals having structures shown in the figures are respectively called

(a) diploblastic, triploblastic
(b) triploblastic, diploblastic
(c) diploblastic, diploblastic
(d) triploblastic, triploblastic

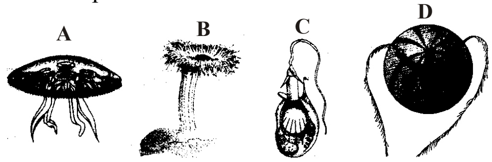
2. Refer the figures A, B, C and D given below. Which of the following options shows the correct name of the animals shown by the figures A, B, C and D ?



A B C D

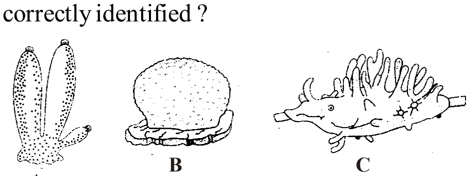
(a) A – Locust, B – Scorpion, C – Prawn, D – *Pila*
(b) A – Locust, B – Prawn, C – Scorpion, D – *Pila*
(c) A – Locust, B – Scorpion, C – Prawn, D – Snail
(d) A – Butterfly, B – Scorpion, C – Prawn, D – *Pila*

3. Refer the given figures A, B, C and D and identify the option which shows their correct name.



	A	B	C	D
(a)	*Pleurobrachia*	*Cnidoblast*	*Aurelia*	*Adamsia*
(b)	*Aurelia*	*Adamsia*	*Cnidoblast*	*Pleurobrachia*
(c)	*Cnidoblast*	*Pleurobrachia*	*Adamsia*	*Aurelia*
(d)	*Adamsia*	*Aurelia*	*Pleurobrachia*	*Cnidoblast*

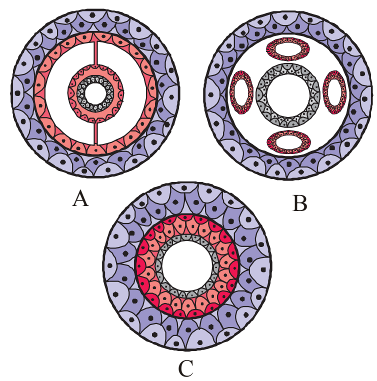
4. Examine the figures A, B and C. In which one of the four options all the items A, B and C are correctly identified ?



A B C

	A	B	C
(a)	*Sycon*	*Euspongia*	*Spongilla*
(b)	*Euspongia*	*Spongilla*	*Sycon*
(c)	*Spongilla*	*Sycon*	*Euspongia*
(d)	*Euspongia*	*Sycon*	*Spongilla*

5. Identify the figures and select the correct option.



(a) A - Pseudocoelomate; B - Coelomate; C-Acoelomate.
(b) A - Coelomate; B - Pseudocoelomate; C- Acoelomate
(c) A - Coelomate; B- Acoelomate; C - Pseudocoelomate
(d) A - Coelomate; B- Acoelomate; C-Eucoelomate

6. Identify the figure with its correct name and phylum.

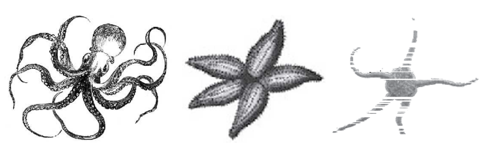
(a) *Sycon* - Porifera
(b) *Aurelia* - Coelenterata
(c) *Pleurobrachia* - Ctenophora
(d) Tapeworm - Platyhelminthes

7. Identify the figures A, B and C and choose the correct option.

A B C

(a) A - Male *Ascaris*; B - *Hirudinaria* (leech); C- *Nereis*
(b) A - Female *Ascaris*; B - *Nereis*; C-*Hirudinaria* (leech)
(c) A - Female *Ascaris;* B- *Hirudinaria* (leech); C - *Nereis*
(d) A - Male *Ascaris*; B - *Nereis*; C- *Hirudinaria* (leech)

8. Identify the animals shown in the given figures A, B and C from options given below.



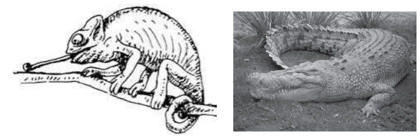
A B C

(a) A - Octopus; B -*Asterias*, C- *Ophiura*
(b) A - *Asterias*; B - *Ophiura*, C- Octopus
(c) A - *Echinus*; B - Octopus C - *Ophiura*
(d) A - *Ophiura*; B - *Echinus*, C- Octopus

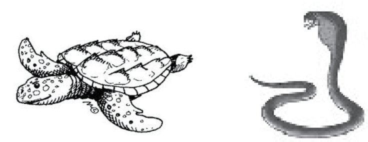
9. Identify the figure with its correct name and phylum.

(a) *Cucumaria* – Echinodermata
(b) *Ascidia* – Urochordata
(c) *Balanoglossus* – Hemichordata
(d) *Hirudinaria* – Annelida

10. The given figures A, B, C and D are the examples of first true land vertebrates. They are dominant in mesozoic era and belong to phylum 'X'. Identify 'X' and the animals which have four chambered heart.



A B



C D

(a) X – Reptile; B (b) X – Reptile; A
(c) X – Amphibia, C (d) X – Pisces; D

Assertion/ Reason :

DIRECTIONS (Qs. 1-10): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Acraniata is a group of organisms which do not have distinct cranium.
Reason : It includes small marine forms without head.

2. **Assertion:** Sponges belong to Porifera.
Reason: Sponges have canal system.

3. **Assertion :** Birds have one ovary.
Reason : This reduces the body weight for flight.

4. **Assertion :** *Plasmodium vivax* is responsible for malaria.

Reason : Malaria is caused by polluted water.

5. **Assertion:** Lateral line system is found in fishes and aquatic larval amphibians.
Reason: Lateral line system has receptor of sensory cells derived from ectoderm.

6. **Assertion :** Bats and whales are classified as mammals.
Reason : Bats and whales have four-chambered heart.

7. **Assertion :** Holoblastic cleavage with almost equal sized blastomeres is a characteristic of placental animals.
Reason : Eggs of most mammals, including humans, are of centrolecithal type.

8. **Assertion :** All birds, except the ones like koel (cuckoo) build nests for retiring and taking rest during night time (day time for nocturnal).
Reason : Koel lays its eggs in the nests of tailor bird.

9. **Assertion :** Tapeworm, roundworm and pinworm are endoparasites of human intestine.
Reason : Improperly cooked food is the source of intestinal infections.

10. **Assertion :** The honey bee queen copulates only ones in her life time.
Reason : The honey bee queen can lay fertilized as well as unfertilized eggs.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column -I (Types of animals)		Column -II (Examples)
(A)	Limbless reptiles	I.	Elephant
(B)	Jawless vertebrates	II.	Lamprey
(C)	Flightless bird	III.	*Ichthyophis*
(D)	Largest terrestrial animal	IV.	Ostrich
E.	Limbless amphibia	V.	Cobra

(a) A – II; B – V; C – IV; D – I; E – III
(b) A – V; B – II; C – IV; D – I; E – III
(c) A – V; B – II; C – I; D – IV; E – III
(d) A – V; B – IV; C – II; D – I; E – III

2.

	Column- I (Organism)		Column -II (Excretory structures)
(A)	Cockroach	I.	Nephridia
(B)	Cat fish	II.	Malpighian tubules
(C)	Earthworm	III.	Kidneys
(D)	*Balanoglossus*	IV.	Flame cells
(E)	Flatworm	V.	Proboscis gland

(a) A – I; B – III; C – II; D – IV; E – V
(b) A – III; B – I; C – II; D – V; E – IV
(c) A – II; B – I; C – III; D – V; E – IV
(d) A – II; B – III; C – I; D – V; E – IV

3.

	Column-I (Characteristic feature/term)		Column-II (Phylum)
(A)	Choanocytes	I.	Platyhelminthes
(B)	Cnidoblasts	II.	Ctenophora
(C)	Flame cells	III.	Porifera
(D)	Nephridia	IV.	Coelenterata
E.	Comb plates	V.	Annelida

(a) A – II; B – I; C – IV; D – V; E – III
(b) A – II; B – IV; C – I; D – V; E – III
(c) A – V; B – I; C – III; D – II; E – IV
(d) A – III; B – IV; C – I; D – V; E – II

4.

	Column -I		Column- II
(A)	*Physalia*	I.	Sea anemone
(B)	*Meandrina*	II.	Brain coral
(C)	*Gorgonia*	III.	Sea fan
(D)	*Adamsia*	IV.	Portuguese man-of-war

(a) A – III; B – II; C – I; D – IV
(b) A – IV; B – III; C – II; D – I
(c) A – IV; B – II; C – III; D – I
(d) A – II; B – III; C – I; D – IV

5.

	Column -I (Organisms)		Column -II (Comman name)
(A)	*Pennatula*	I.	Sea-lily
(B)	*Antedon*	II.	Sea- pen
(C)	*Echinus*	III.	Sea-urchin
(D)	*Cucumaria*	IV.	Sea - cucumber

(a) A – II; C – III; D – I; E – IV
(b) A – II; C – IV; D – I; E – III
(c) A – II; C – I; D – III; E – IV
(d) A – II; C – I; D – III; E – IV

6.

Column -I (Phylum)	Column- II (Examples)
(A) Echinodermata	I. *Ascidia*, *Doliolum*
(B) Hemichordata	II. *Asterias*, *Ophiura*
(C) Urochordata	III. *Branchiostoma*
(D) Cephalochordata	IV. *Balanoglossus, Saccoglossus*

(a) A – IV; B – II; C – I; D – III
(b) A – II; B – IV; C – I; D – III
(c) A – II; B – IV; C – III; D – I
(d) A – II; B – I; C – IV; D – III

7.

Column -I (Phylum)	Column- II (Special features present)
(A) Porifera	I. Mammary glands
(B) Mollusca	II. Cloaca
(C) Ctenophora	III. Choanocytes
(D) Amphibia	IV. Radula
E. Mammalia	V. Comb plates

(a) A – III; B – IV; C – V; D – II; E – I
(b) A – IV; B – III; C – V; D – II; E – I
(c) A – III; B – IV; C – II; D – V; E – I
(d) A – III; B – V; C – IV; D – II; E – I

Critical Thinking Type Questions :

1. Which of the following group of animals belongs to the same phylum?
(a) Earthworm, pinworm, tapeworm
(b) Prawn, scorpion, *Locusta*
(c) Sponge, *Sea anemone*, starfish
(d) Malarial parasite, *Amoeba*, mosquito

2. Which of the following traits is not shared by both *sea anemones* and jellyfish ?
(a) A medusa as the dominant stage in the life cycle.
(b) Possession of a gastro vascular cavity.
(c) Sexual reproduction.
(d) Nematocysts present on the tentacles.

3. The combination of a true coelom and repeating body segmentation allows the annelids (unlike the anatomically "simpler" worms) to do which of the following?
(a) Attain complex body shapes and thus locomote more precisely.
(b) Move through loose marine sediments.
(c) Be hermaphroditic.
(d) Inject paralytic poisons into their prey.

4. The transition from aquatic to terrestrial lifestyles required many adaptations in the vertebrate lineage. Which of the following is not one of those adaptations ?
(a) Switch from gill respiration to air-breathing lungs.
(b) Improvements in water resistance of skin.
(c) Alteration in mode of locomotion.
(d) Development of feathers for insulation.

5. Which of the following sets of animals give birth to young ones?
(a) *Platypus*, Penguin, Bat, Hippopotamus.
(b) Shrew, Bat, Cat, Kiwi.
(c) Kangaroo, Hedgehog, Dolphin, *Loris*.
(d) Lion, Bat, Whale, Ostrich.

6. Which one of the following features is common in silverfish, scorpion, dragonfly and prawn?
(a) Three pairs of legs and segmented body.
(b) Chitinous cuticle and two pairs of antennae.
(c) Jointed appendages and chitinous exoskeleton.
(d) Cephalothorax and tracheae.

7. Which of the following is a correct match of a phylum with their three examples?
(a) Platyhelminthes–*Planaria, Schistosoma, Enterobius*
(b) Mollusca – *Loligo, Sepia,* Octopus
(c) Porifera – *Spongilla, Euplectella,* Pennatula
(d) Cnidaria – *Bonellia, Physalia, Aurelia*

8. Hemichordates have now been placed with the non-chordates, close to echinoderms, because true
(a) notochord is absent.
(b) pharyngeal gill-slits are lacking.
(c) dorsal nerve cord is absent.
(d) heart is lacking.

5 Morphology of Flowering Plants

Fill in the Blanks :

1. Stilt roots occur in __________ .
2. The region of the stem where leaves are born are called ___________ while ___________ are the portions between two ___________.
3. A branch in which each node bearing a rossette of leaves and a tuft of roots is found in aquatic plants like _________ and _________.
4. Leaves of dicotyledonous plants possess _______ venation, while _________ venation is the characteristic of most monocotyledons.
5. The main purpose of phyllotaxy for the leaves is to provide sufficient_______.
6. The flower is the reproductive unit in the ______ meant for _________ reproduction.
7. When a flower has both androecium and gynoecium, it is known as__________.
8. A scar on the seed coat through which the developing seeds attached to the fruit is called as ________.
9. Pollen grains are produced within _________of stamen.

True / False :

1. Bulb of *Allium cepa* is a modified stem.
2. Each stamen which represents the male reproductive organ consists of a stalk or a filament and an anther.
3. An actinomorphic flower can be dissected into two equal halves from any plane.
4. Calyx is the outermost whorl of the flower and are called sepals.
5. The arrangement of veins and the veinlets in the lamina of leaf is called venation.
6. Pulvinus leaf-base is present in some leguminous plants.
7. In *Alstonia,* the petioles expand, become green and synthesize food.
8. Pneumatophores are seen in *Rhizophora.*
9. Maize and sugarcane have prop roots.

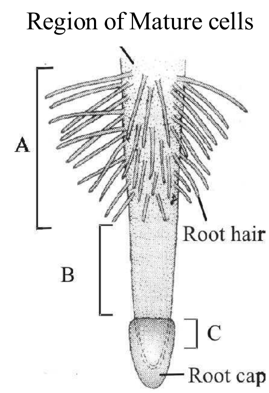
Conceptual MCQs :

1. Most plants are green in colour because
   (a) the atmosphere filters out all the colours of the visible light spectrum except green
   (b) green light is the most effective wavelength region of the visible spectrum in sunlight for photosynthesis
   (c) chlorophyll is least effective in absorbing green light
   (d) green light allows maximum photosynthesis
2. In a cereal grain the single cotyledon of embryo is represented by
   (a) scutellum (b) prophyll
   (c) coleoptile (d) coleorhiza
3. Function of stem is –
   (a) bear leaves and branches
   (b) conduction of water & minerals
   (c) conduction and storage of food
   (d) all
4. Main function of leaf is –
   (a) manufacture of food
   (b) exchange of gases
   (c) both 1 and 2
   (d) none of the above
5. Arrangement of leaves on a stem branch is –
   (a) venation (b) vernation
   (c) inflorescence (d) phyllotaxy
6. A modification of leaf is –
   (a) phyllode (b) phylloclade
   (c) cladode (d) corm

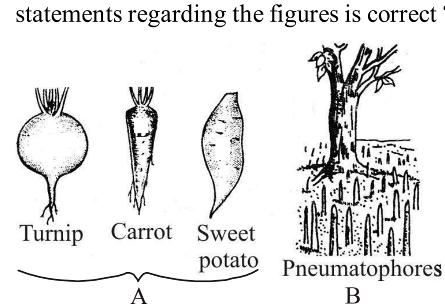
7. Pneumatophores are found in –
   (a) the vegetation which is found in marshy and saline lake
   (b) the vegetation which found in saline soil
   (c) xerophytes
   (d) epiphytes
8. Pulses yielding main family of plants is–
   (a) poaceae (Graminae)
   (b) cucurbitaceae
   (c) liliaceae
   (d) papilionaceae
9. Tetradyanamous conditions occur in –
   (a) cruciferae (b) malvaceae
   (c) solanaceae (d) lilliaceae
10. Occurrence of different types of leaves on the same plant is–
   (a) heterophylly (b) heterotrophy
   (c) heteronasty (d) all
11. A modification of bud that can bear leaves, flowers, fruits & branches is
   (a) thorn (b) spine
   (c) prickle (d) trichome
12. Flower is complete when it has
   (a) calyx, corolla, androecium & gynoecium
   (b) calyx & corolla
   (c) androecium & gynoecium
   (d) corolla, androecium & gynoecium
13. A plant with both male & female flowers borne over it is
   (a) monoecious (b) dioecious
   (c) unisexual (d) bisexual
14. Whorled, simple leaves with reticulate venation are present in
   (a) *Calotropis* (b) *Neem*
   (c) *China rose* (d) *Alstonia*
15. Sweet potato is homologous to
   (a) Potato (b) *Colocasia*
   (c) Ginger (d) Turnip
16. Placentation in tomato and lemon is
   (a) Parietal (b) Free central
   (c) Marginal (d) Axile
17. Cymose inflorescence is present in :
   (a) *Solanum* (b) *Sesbania*
   (c) *Trifolium* (d) *Brassica*
18. Phyllode is present in :
   (a) *Asparagus* (b) *Euphorbia*
   (c) *Australian Acacia* (d) *Opuntia*
19. The gynoecium consists of many free pistils in flowers of
   (a) *Aloe* (b) *Tomato*
   (c) *Papaver* (d) *Michelia*
20. The coconut water and the edible part of coconut are equivalent to :
   (a) Endosperm (b) Endocarp
   (c) Mesocarp (d) Embryo

Diagram Based Questions :

1. The given figure shows the region of root tips with their region marked as A, B and C. Choose the option which shows the correct labelling of A, B and C.

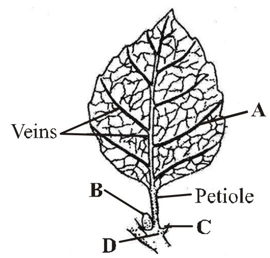


   (a) A - Zone of elongation; B - Zone of meiosis; C - Zone of mitosis.
   (b) A - Zone of maturation; B - Zone of meristematic activity; C - Zone of elongation.
   (c) A - Zone of mitosis; B - Zone of elongation; C - Zone of root cap.
   (d) A - Region of maturation; B - Region of elongation; C - Zone of meristematic activity.
2. The given figures (A and B) shows the modificaiton of roots. Which of the following statements regarding the figures is correct ?



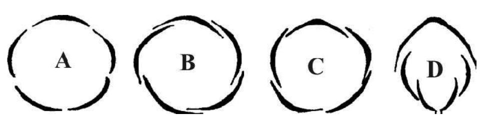
(a) Tap roots of carrot, turnip and adventitious root of sweet potato, get swollen and store food.
(b) Pneumatophores conducts water, minerals & photosynthesis
(c) Pneumatophore is found in the plants that grow in sandy soil.
(d) Turnip & carrot shows adventitious roots and sweet potato shows tap root.

3. Which of the following option shows the correct labelling of the parts of leaf marked as A, B, C and D.



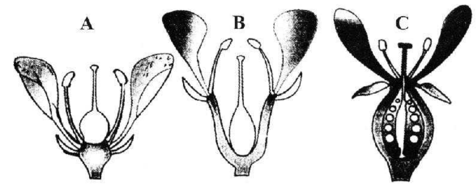
	A	B	C	D
(a)	Lamina	Axillary bud	Stipule	Leaf base
(b)	Lamina	Stipule	Axillary bud	Leaf base
(c)	Lamina	Axillary bud	Stipule	Pedicel
(d)	Leaflet	Axillary bud	Stipule	Leaf base

4. Identify the different types of aestivation (A, B, C and D) in corolla and select the correct option.



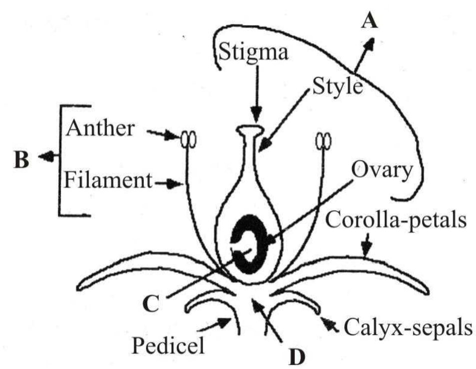
(a) A-Valvate; B-Twisted; C-Imbricate; D-Vexillary
(b) A-Vexillary; B-Valvate; C-Twisted; D-Imbricate
(c) A-Imbricate; B-Vexillary; C-Valvate; D-Twisted
(d) A-Twisted; B-Imbricate; C-Vexillary; D-Valvate

5. Given figures (A, B and C) shows the position of floral parts on thalamus. (given as I, II and III) Select the correct combination.



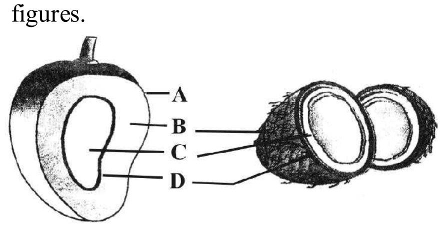
I. Hypogynous flower II. Perigynous flower
III. Epigynous flower
(a) A-I; B-II; C-III (b) A-I; B-III; C-II
(c) A-III; B-II; C-I (d) A-III; B-I; C-II

6. Which one of the following option shows the correct labelling of the structure marked as A, B, C & D?



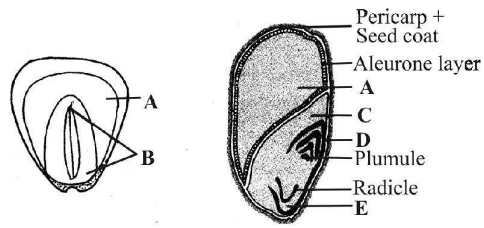
	A	B	C	D
(a)	Gynoecium	Megasporophyll	Ovule	Thalamus
(b)	Gynoecium	Stamen	Seed	Thalamus
(c)	Microsporophyll	Stamen	Ovule	Thalamus
(d)	Gynoecium	Stamen	Ovule	Thalamus

7. The given figure shows the parts of mango and coconut. Choose the option which shows the correct labelling of A, B, C and D marked in the figures.



	A	B	C	D
(a)	Epicarp,	Mesocarp,	Seed,	Endocarp
(b)	Epicarp,	Mesocarp,	Ovule,	Endocarp
(c)	Epicarp,	Mesocarp,	Ovary,	Endocarp
(d)	Epicarp,	Mesocarp,	Embryo,	Endocarp

8. The given figure shows a typical structure of monocotyledonous seeds. Identify A, B, C, D and E parts marked in the given figures.



(a) A - Endosperm; B - Embryo; C - Scutellum; D - Coleorhiza; E - Coleoptile
(b) A- Embryo; B - Endosperm; C - Scutellum; D - Coleoptile; E - Coleorhiza
(c) A - Endosperm; B - Embryo; C - Scutellum; D - Coleoptile; E - Coleorhiza
(d) A - Embryo; B - Endosperm; C - Scutellum; D - Coleorhiza; E - Coleoptile

Assertion/ Reason :

DIRECTIONS (Qs. 1-9): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** *Adiantum caudatum* is a walking fern.
Reason : *Adiantum* grows vegetatively by their leaf tips.

2. **Assertion :** In corymb, all the flowers lie at the same level.
Reason : Pedicels of all the flowers are of same length.

3. **Assertion :** An incomplete flower can be perfect.
Reason : Perfect flowers (incomplete) are called neuter.

4. **Assertion :** A plant having unisexual flowers are called dioecious.
Reason : Mango is a polygamous plant.

5. **Assertion :** Bud may form leaves and flowers.
Reason : Bud is a condensed shoot.

6. **Assertion :** A simple leaf has undivided lamina.
Reason : Leaves showing pinnate and palmate venations have various type of incisions.

7. **Assertion :** Citrus is a palmate compound leaf.
Reason : Citrus has single functional leaflet.

8. **Assertion :** Whole compound leaf of *Clematis* converts into tendril.
Reason : *Gloriosa superba* shows whole leaf tendril.

9. **Assertion :** Leaves of *Bryophyllum, Begonia* help in vegetative multiplication.
Reason : Leaves of these plants possess adventitious buds.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column - I (Type of aestivation)		**Column-II (Examples)**
(A)	Valvate	I.	Cotton
(B)	Twisted	II.	*Calotropis*
(C)	Imbricate	III.	Bean
(D)	Vexillary	IV.	Gulmohar

(a) A – I; B – II; C – IV; D – III
(b) A – II; B – I; C – IV; D – III
(c) A – II; B – IV; C – I; D – III
(d) A – II; B – I; C – III; D – IV

2.

Column-I		**Column-II**	
(Placentation Types)		**(Examples)**	
(A)	Basal	I.	*Dianthus*
(B)	Free central	II.	Pea
(C)	Parietal	III.	Lemon
(D)	Axile	IV.	Marigold
(E)	Marginal	V.	*Argemone*

(a) A – I; B – II; C – III; D – IV; E – V
(b) A – II; B – III; C – IV; D – V; E – I
(c) A – IV; B – I; C – V; D – III; E – II
(d) A – IV; B – III; C – V; D – I; E – II

3.

Column-I (Stem Modifications)		Column-II (Found in)	
(A)	Underground stem	I.	*Euphorbia*
(B)	Stem tendril	II.	*Opuntia*
(C)	Stem thorns	III.	Potato
(D)	Flattened stem	IV.	*Citrus*
(E)	Fleshy cylindrical stem	V.	Cucumber

(a) A – I; B – II; C – III; D – V; E – IV
(b) A – II; B – III; C – IV; D – V; E – I
(c) A – III; B – IV; C – V; D – I; E – II
(d) A – III; B – V; C – IV; D – II; E – I

4. **Column-I (Family)** **Column-II (Androecium formula)**
(A) Brassicaceae I. A_{3+3}
(B) Fabaceae II. $A_{(5)}$
(C) Solanaceae III. $A_{(9)+1}$
(D) Liliaceae IV. A_{2+4}
(a) A – IV; B – III; C – II; D – I
(b) A – I; B – II; C – III; D – IV
(c) A – II; B – III; C – IV; D – I
(d) A – III; B – IV; C – I; D – II

5. **Column-I (Position of floral parts on thalamus)** **Column-II (Represented in)**
(A) Hypogynous I. Ray florets of sunflower
(B) Perigynous II. Brinjal
(C) Epigynous III. Peach
(a) A – II, B – I, C – III (b) A – I, B – II, C – III
(c) A – III, B – II, C – I (d) A – II, B – III, C – I

6. **Column-I** **Column-II**
(A) Bud in the axil of leaf I. Pitcher plant and venus fly trap
(B) Outer layer of seed coat II. Cacti
(C) Spines (modified leaves) III. Testa
(D) Leaves modified to catch insects IV. Simple leaf
(E) Fleshy leaves with stored food V. Garlic and onion
(a) A – I; B – II; C – III; D – IV; E – V
(b) A – V; B – IV; C – III; D – II; E – I
(c) A – IV; B – III; C – II; D – I; E – V
(d) A – IV; B – II; C – III; D – I; E – V

7. **Column-I** **Column-II**
(A) Gamosepalous I. Flower of lily
(B) Polysepalous II. Sterile anther
(C) Gamopetalous III. Free petals
(D) Polypetalous IV. Free sepals
(E) Epiphyllous V. Fused petals
(F) Staminode VI. Fused sepals
(a) A – IV; B – V; C – III; D – I; E – VI; F – II
(b) A – IV; B – III; C – V; D – I; E – II; F – VI
(c) A – VI; B – IV; C – III; D – V; E – I; F – II
(d) A – VI; B – IV; C – V; D – III; E – II; F – I

8. **Column I** **Column II**
(A) Coleorhiza I. Grapes
(B) Food storing tissue II. Mango
(C) Parthenocarpic fruit III. Maize
(D) Single seeded fruit developing from monocarpellary superior ovary IV. Radicle
(E) Membranous V. Endosperm seed coat
(a) A – III; B – I; C – IV; D – II; E – V
(b) A – IV; B – II; C – V; D – I; E – III
(c) A – V; B – I; C – III; D – IV; E – II
(d) A – IV; B – V; C – I; D – II; E – III

9. **Column-I (Members of Fabaceae)** **Column-II (Economic importance)**
(A) Gram, sem, moong, soyabean I. Medicine
(B) Soyabean, groundnut II. Ornamental
(C) *Indigofera* III. Fodder
(D) Sunhemp IV. Fibres
(E) *Sesbania, Trifolium* V. Dye
(F) Lupin, sweet potato VI. Edible oil
(G) *Mulethi* VII. Pulses
(a) A–I, B–II, C–III, D–IV, E–V, F–VI, G–VII
(b) A–VII, B–VI, C–V, D–IV, E–III, F–II, G–I
(c) A–II, B–IV, C–VI, D–I, E–III, F–V, G–VII
(d) A–I, B–III, C–V, D–VII, E–II, F–IV, G–VI

Critical Thinking Type Questions :

1. Floral features are chiefly used in angiosperms identification because
(a) flowers are of various colours.
(b) flowers can be safely pressed.

(c) reproductive parts are more stable and conservative than vegetative parts.
(d) flowers are good materials for identification.

2. Aleurone layer helps in
(a) storage of food in endosperm.
(b) protection of embryo.
(c) utilization of stored food.
(d) all of the above.

3. Rearrange the following zones seen in the regions of root tip and choose the correct option.
(A) Root hair zone (B) Zone of meristems
(C) Root cap zone (D) Zone of maturation
(E) Zone of elongation
(a) C, B, E, A, D (b) A, B, C, D, E
(c) D, E, A, C, B (d) E, D, C, B, A

4. Which is not a stem modification ?
(a) Rhizome of ginger (b) Corm of *Colocasia*
(c) Pitcher of *Nepenthes* (d) Tuber of potato

5. Most prominent function of inflorescence is
(a) dispersal of seeds.
(b) formation of more fruits.
(c) formation of pollen grains.
(d) dispersal of pollens.

6. The character of flower which is represented by floral formula but not by floral diagram is
(a) aestivation
(b) placentation
(c) position of gynoecium
(d) adhesion of stamen

7. The mature seeds of plants such as gram and peas, possess no endosperm, because
(a) these plants are not angiosperms.
(b) there is no double fertilization in them.
(c) endosperm is not formed in them.
(d) endosperm gets used up by the developing embryo during seed development.

8. Which of the following is correct with reference to floral character of family solanaceae?
(a) Racemose, zygomorphic, unisexual, floral characters
(b) Racemose, zygomorphic, bisexual, polypetalous
(c) Axillary, bisexual, actinomorphic, epipetalous
(d) Axillary, actinomorphic, bisexual, epipetalous

9. Which of the following represents the floral characters of liliaceae?
(a) Six tepals, zygomorphic, six stamens, bilocular ovary, axile placentation.
(b) Actinomorphic, polyphyllous, unilocular ovary, axile placentation.
(c) Tricorpellary, actinomorphic, polyandrous, superior ovary, axile placentation.
(d) Bisexual, zygomorphic, gamophyllous, inferior ovary, marginal placentation.

10. Which one of the following is correct explanation for the given floral formula ?

$$\% ⚥ K_{(5)} C_{1+2+(2)} A_{(9)+1} \underline{G}_1$$

(a) Zygomorphic, bisexual, sepals five and gamosepalous, petals five and papilionaceous, anthers ten and monadelphous, ovary superior and monocarpellary.
(b) Zygomorphic, unisexual, sepals five and gamosepalous, petals five and polypetalous, anthers nine united and one free, ovary superior and monocarpellary.
(c) Zygomorphic, bisexual, sepals five and gamosepalous, petals five and papilionaceous, anthers ten and diadelphous, ovary superior and monocarpellary.
(d) Zygomorphic, bisexual, sepals five and united, petals five and united, anthers ten and diadelphous, ovary superior and monocarpellary.

11. The region of the root-tip which is involved in the formation of root hairs by epidermal cells is called the
(a) region of maturation.
(b) region of meristematic activity.
(c) region of elongation.
(d) none of the above.

12. The X is small and situated in a groove at one end of the endosperm. It consists of one large and shield shaped cotyledon known as Y and a short axis with a plumule and a Z. Identify X, Y and Z.

	X	Y	Z
(a)	Scutellum	Embryo	Radicle
(b)	Embryo	Scutellum	Radicle
(c)	Scutellum	Radicle	Embryo
(d)	Radicle	Embryo	Scutellum

13. "X" is the outermost whorl of the flower and contains "Y". Y is green, leaf like and protect the other whorls of the flower.
Identify X and Y.
(a) X - Calyx; Y - Sepals
(b) X - Corolla; Y - Petals
(c) X - Gynoecium; Y - Fruit
(d) X - Androecium; Y - Ovary

14. It is a proteinous layer and the outer covering of endosperm which separates the embryo. Identify the layer.
(a) Tegmen (b) Scutellum
(c) Hyaline layer (d) Aleurone layer

6

Anatomy of Flowering Plants

Fill in the Blanks :

1. Various functions like photosynthesis, storage, excretion performed by _____________.
2. Sclerenchyma usually______ and _________ protoplasts.
3. The __________ occurs in layers below the epidermis in dicotyledonous plants.
4. Xylem functions as a conducting tissue for water and minerals from ______to the ______ and __________.
5. Cork cambium and vascular cambium are______.
6. Phellogen and phellem respectively denote______.
7. Bast fibres are made up of __________ cells.
8. An organised and differentiated cellular structure having cytoplasm but no nucleus is called______.
9. A vascular bundle in which the protoxylem is pointing to the periphery is called __________.

True / False :

1. Guard cells invariably possess chloroplasts and mitochondria.
2. In flowering plants, tracheids and vessels are the main water transporting elements.
3. Xylem parenchyma store food materials in the form of starch or fat and other substances like tannins.
4. In Xylem cells, the cell wall is composed of cellulose and has pits through which plasmodesmatal connections exist between the cells.
5. The companion cells are specialised parenchymatous cells which are closely associated with phloem parenchyma.
6. Phloem parenchyma is absent, and water-containing cavities are present within the vascular bundles in dicotyledonous root.
7. Uneven thickening of cell wall is characteristic of sclerenchyma.
8. Tracheids are the chief water transporting elements in gymnosperms.

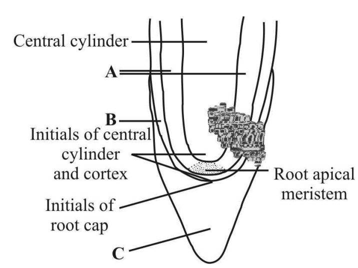
Conceptual MCQs :

1. What is true about a monocot leaf?
   (a) Reticulate venation
   (b) Absence of bulliform cells from epidermis
   (c) Mesophyll not differentiated into palisade and spongy tissues
   (d) Well differentiated mesophyll
2. Which is correct about transport or conduction of substances?
   (a) Organic food moves up through phloem
   (b) Inorganic food moves up through phloem
   (c) Inorganic food moves upwardly and downwardly through xylem
   (d) Organic food moves upwardly and downwardly through phloem
3. What is not true about sclereids?
   (a) These are parenchyma cells with thickened lignified walls
   (b) These are elongated and flexible with tapered ends
   (c) These are commonly found in the shells of nuts and in the pulp of guava, pear, etc
   (d) These are also called the stone cells
4. Vessels are found in
   (a) all angiosperms and some gymnosperms
   (b) most of angiosperms and few gymnosperms
   (c) all angiosperms, all gymnosperms and some pteriodophyta
   (d) all pteridophyta
5. Which of the following statements is true?
   (a) Vessels are multicellular with narrow lumen
   (b) Tracheids are multicellular with narrow lumen
   (c) Vessels are unicellular with wide lumen
   (d) Tracheids are unicellular with wide lumen

6. In barley stem vascular bundles are:
   (a) closed and scattered
   (b) open and in a ring
   (c) closed and radial
   (d) open and scattered
7. Heartwood differs from sapwood in:
   (a) presence of rays and fibres
   (b) absence of vessels and parenchyma
   (c) having dead and non -conducting elements
   (d) being susceptible to pests and pathogens
8. The cork cambium, cork and secondary cortex are collectively called:
   (a) phelloderm (b) phellogen
   (c) periderm (d) phellem
9. Function of companion cells is
   (a) providing energy to sieve elements for active transport
   (b) providing water to phloem
   (c) loading of sucrose into sieve elements by passive transport
   (d) loading of sucrose into sieve elements
10. A tissue is a group of cells which are –
   (a) similar in origin, but dissimilar in form and function.
   (b) dissimilar in origin, form and function.
   (c) dissimilar in origin, but similar in form and function.
   (d) similar in origin, form and function.
11. Root apex is subterminal because it is –
   (a) covered by root hairs
   (b) covered by root cap
   (c) covered by epidermis
   (d) under the soil
12. When xylem and phloem are on same radii, the vascular bundles are said to be –
   (a) radial
   (b) conjoint/Collateral
   (c) concentric
   (d) exarch/centripetal
13. Apical, intercalary and lateral meristems are differentiated on the basis of–
   (a) origin
   (b) function
   (c) position
   (d) development
14. Wood is-
   (a) primary phloem
   (b) primary xylem
   (c) secondary xylem
   (d) secondary phloem
15. Trees at sea do not have annual rings because –
   (a) soil is sandy
   (b) there is climatic variation
   (c) there is no marked climatic variation
   (d) there is enough moisture in the atmosphere
16. In Kranz anatomy, the bundle sheath cells have
   (a) thin walls, many intercellular spaces and no chloroplasts
   (b) thick walls, no intercellular spaces and large number of chloroplasts
   (c) thin walls, no intercellular spaces and several chloroplasts
   (d) thick walls, many intercellular spaces and few chloroplasts
17. Water containing cavities in vascular bundles are found in
   (a) Sunflower (b) Maize
   (c) *Cycas* (d) *Pinus*
18. Gymnosperms are also called soft wood spermatophytes because they lack :
   (a) Cambium
   (b) Phloem fibres
   (c) Thick-walled tracheids
   (d) Xylem fibres
19. In land plants, the guard cells differ from other epidermal cells in having :
   (a) cytoskeleton (b) mitochondria
   (c) endoplasmic reticulum (d) chloroplasts
20. Which one of the following is wrongly matched?
   (a) Root pressure - Guttation
   (b) *Puccinia* - Smut
   (c) Root - Exarch protoxylem
   (d) *Cassia* - Imbricate aestivation

Diagram Based Questions :

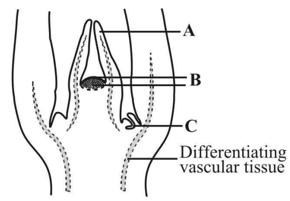
1. The given figure shows apical meristem of root apex with few part marked as A, B and C. Identify the correct labelling of A, B and C.



   (a) A – Vascular structure; B – Protoderm; C – Root cap

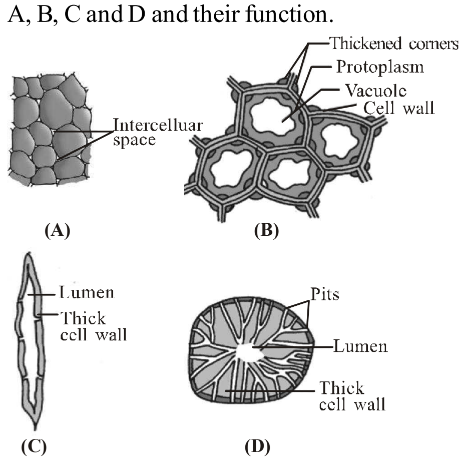
(b) A – Cortex; B – Endodermis; C – Root cap
(c) A – Cortex; B – Protoderm; C – Root cap
(d) A – Tunica; B – Protoderm; C – Root cap

2. Identify A, B and C in the given figure of shoot apical meristem



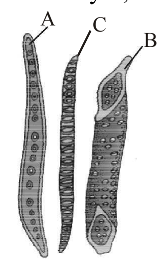
(a) A – Leaf primordium; B – Shoot apical meristem; C – Axillary bud
(b) A – Leaf primordium; B – Shoot apical meristem; C – Apical bud
(c) A – Root hair primordium; B – Root apical meristem; C – Axillary bud
(d) A – Root hair primordium; B – Root apical meristem; C – Terminal bud

3. Identify the types of simple tissue indicated by A, B, C and D and their function.



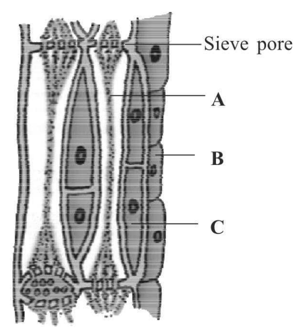
(a) A – Parenchyma; Photosynthesis; Storage and Secretion.
(b) B – Sclerenchyma Scleriods; Transport food material
(c) C – Collenchyma; Provides mechanical support to organs.
(d) D – Sclerenchyma Fibres; Provide Mechanical support to the growing parts of the plant such as young stem and petiole of a leaf.

4. The given figures are types of elements (A and B) which constitute one type of complex tissue (c) of a plant . Identify A, B and C.



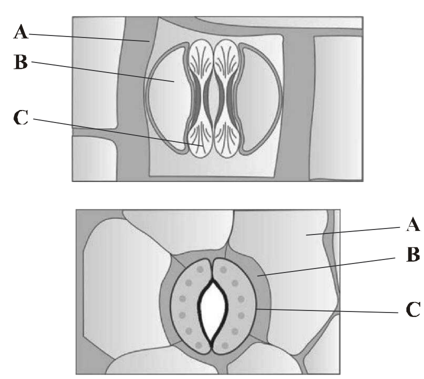
(a) A – Tracheid; B – Vessel; C – Xylem
(b) A – Vessel; B – Tracheild; C – Phloem
(c) A – Fibre; B – Tracheid; C – Bark
(d) A – Fibre; B – Sclereid; C – Casparian strips

5. In the given figure of phloem tissue, identify the marked part (A, B and C) which help in maintaining the pressure gradient in the sieve tubes.



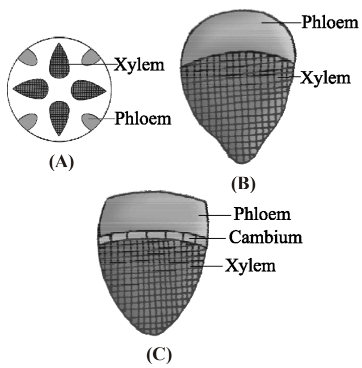
(a) A (b) B
(c) C (d) None of the above

6. The given diagrams show stomatal apparatus in dicots and monocots. Which one is correct option for A, B and C?



(a) A – Epidermal cells; B – Subsidiary cells; C – chloroplast
(b) A – Guard cells; B – Subsidiary cells; C – Stomatal pore
(c) A – Guard cells; B – Epidermal cells; C – Guard cells
(d) A – Epidermal cells; B – Subsidiary cells; C – Guard cells

7. Identify types of vascular bundles in given figures A, B and C.



	A	B	C
(a)	Radial	Conjoint closed	Conjoint open
(b)	Conjoint closed	Conjoint open	Radial
(c)	Conjoint open	Conjoint closed	Radial
(d)	Bicollateral	Concentric	Radial

Assertion/ Reason :

DIRECTIONS (Qs. 1-9): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Thick cuticle is mostly present in disease resistant plants.
Reason : Disease causing agents cannot grow on cuticle and cannot invade the cuticle.

2. **Assertion:** Cambium is a lateral meristem and cause growth in width.
Reason: Cambium is made up of fusiform and ray initials in stem.

3. **Assertion :** Higher plants have meristematic regions for indefinite growth.
Reason : Higher plants have root and shoot apices.

4. **Assertion :** In collateral vascular bundles, phloem is situated towards inner side.
Reason : In monocot stem, cambium is present.

5. **Assertion :** Collenchyma is thick walled dead tissue.
Reason : Collenchymatous cells show thickenings of pectin.

6. **Assertion:** The two cotyledons in seed are embryonic leaves.
Reason: The embryo contains radicle and plumule.

7. **Assertion :** In angiosperms the conduction of water is more efficient because their xylem has vessels.
Reason : Conduction of water by vessel elements is an active process with energy supplied by xylem parenchyma rich in mitochondria.

8. **Assertion :** In woody stems, the amount of heart wood continues to increase year after year.
Reason : The cambial activity continues uninterrupted.

9. **Assertion :** Petroplants produce large amount of latex.
Reason : The latex contains long chain hydrocarbons.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I		Column-II
(A)	Xylem vessels	I.	Store food materials
(B)	Xylem tracheids	II.	Obliterated lumen
(C)	Xylem fibres	III.	Perforated plates
(D)	Xylem parenchyma	IV.	Chisel-like ends

(a) A – IV; B – III; C – II; D – I
(b) A – III; B – II; C – I; D – IV
(c) A – II; B – I; C – IV; D – III
(d) A – III; B – IV; C – II; D – I

2.

Column -I	**Column -II**
(A) Bulliform cells	I. Initiation of lateral roots
(B) Pericycle	II. Root
(C) Endarch xylem	III. Grasses
(D) Exarch xylem	IV. Dicot leaf
E. Bundle sheath cells	V. Stem

(a) A – III; B – V; C – IV; D – I; E – II
(b) A – II; B – V; C – I; D – III; E – IV
(c) A – II; B – IV; C – I; D – III; E – V
(d) A – III; B – I; C – V; D – II; E – IV

3.

Column-I (Term)	**Column-II (Functions)**
(A) Meristem	I. Photosynthesis, storage
(B) Parenchyma	II. Mechanical support
(C) Collenchyma	III. Actively dividing cells
(D) Sclerenchyma	IV. Stomata
E. Epidermal tissue	V. Sclereids

(a) A – I; B – III; C – V; D – II; E – IV
(b) A – III; B – I; C – II; D – V; E – IV
(c) A – II; B – IV; C – V; D – I; E – III
(d) A – V; B – IV; C – III; D – II; E – I

4.

Column-I	**Column-II**
(A) Cuticle	I. Guard cells
(B) Bulliform cells	II. Outer layer
(C) Stomata	III. Waxy layer
(D) Epidermis	IV. Empty colourless cell

(a) A – III; B – IV; C – I; D – II
(b) A – I; B – II; C – III; D – IV
(c) A – III; B – II; C – IV; D – I
(d) A – III; B – II; C – I; D – IV

5.

Column-I (Structure)	**Column-II (Function)**
(A) Stomata	I. Protection of stem
(B) Bark	II. Plant movement
(C) Cambium	III. Secondary growth
(D) Cuticle	IV. Transpiration
	V. Prevent the loss of water

(a) A – V; B – III; C – I; D – IV
(b) A – I; B – IV; C – V; D – III
(c) A – II; B – IV; C – I; D – III
(d) A – IV; B – I; C – III; D – V

6.

Column-I	**Column-II**
(A) Spring wood or early wood	I. Lighter in colour
(B) Autumn wood or late wood	II. High density
	III. Low density
	IV. Darker in colour
	V. Larger number of xylem elements
	VI. Vessels with wider cavity
	VII. Lesser number of xylem elements
	VIII. Vessels with small cavity

Which of the following combination is correct ?
(a) A – II, IV, VII, VIII; B – I, III, V, VI
(b) A – I, II, VII, VIII; B – III, IV, V, VI
(c) A – I, III, V, VI; B – II, IV, VII, VIII
(d) A – I, III, VII, VIII; B – II, IV, V, VI

7.

Column-I	**Column-II**
(A) Stele	I. Innermost layer of cortex
(B) Endodermis	II. Suberin
(C) Casparian strips	III. All the tissues exterior to vascular cambium
(D) Bark	IV. All the tissues inner to endodermis

(a) A – IV; B – I; C – II; D – III
(b) A – III; B – II; C – I; D – IV
(c) A – I; B – II; C – III; D – IV
(d) A – IV; B – II; C – I; D – III

8.

Column-I (Terms)	**Column-II (Features)**
(A) Fibres	I. Cells are living and thin walled with cellulosic cell wall, store food materials in the form of starch or fat
(B) Sclereids	II. Main water conductive cells of the pteridophytes and the gymnosperms
(C) Tracheids	III. Thick walled, elongated and pointed cells, generally occurring in groups
(D) Vessels	IV. Long cylindrical tube like structure and cells are devoid of protoplasm. Characteristic feature of angiosperms

E	Xylem parenchyma	V.	Reduced form of sclerenchyma cells with highly thickened lignified cellular walls that form small bundles of durable layers of tissue in most plants.

	A	B	C	D	E
(a)	I	II	III	IV	V
(b)	III	V	II	IV	I
(c)	III	I	V	II	IV
(d)	V	IV	III	I	II

9.

	Column-I		**Column-II**
(A)	Lateral meristem	I.	Fascicular vascular cambium, interfascicular cambium and cork cambium.
(B)	Apical meristem	II.	Produces dermal tissue, ground tissues and vascular tissue.
(C)	Bast fibres	III.	Generally absent in primary phloem but found in secondary phloem.
(D)	Sap wood	IV.	Involved in the conduction of water and minerals from the root to leaf.

	A	B	C	D
(a)	I	II	III	IV
(b)	III	I	II	IV
(c)	I	IV	III	II
(d)	II	IV	III	I

Critical Thinking Type Questions :

1. One of the primary function of the ground tissue in a plant is
(a) photosynthesis.
(b) to protect the plant.
(c) to anchor the plant.
(d) water and sugar conduction.

2. When we peel the skin of a potato tuber, we remove
(a) periderm (b) epidermis
(c) cuticle (d) leaves

3. Why grafting is successful in dicots ?
(a) In dicots vascular bundles are arranged in a ring.
(b) Dicots have cambium for secondary growth.
(c) In dicots vessels with elements are arranged end to end.
(d) Cork cambium is present in dicots

4. The length of different internodes in a culm of sugarcane is variable because of
(a) size of leaf lamina at the node below each internode
(b) intercalary meristem
(c) shoot apical meristem
(d) position of axillary buds

5. As secondary growth proceeds, in a dicot stem, the thickness of
(a) sapwood increases.
(b) heartwood increase.
(c) both sapwood and heartwood increases.
(d) both sapwood and heartwood remains the same.

6. The trees growing in desert will
(a) show alternate rings of xylem and sclerenchyma.
(b) have only conjunctive tissue and phloem is formed by the activity of cambium.
(c) show distinct annual rings.
(d) not show distinct annual rings.

7. Some vascular bundles are described as open because these
(a) are surrounded by pericycle but not endodermis.
(b) are capable of producing secondary xylem and phloem.
(c) possess conjunctive tissue between xylem and phloem.
(d) are not surrounded by pericycle.

8. Apical and intercalary meristems are primary meristems because
(a) they occur in the mature region of roots and shoots of many plants.
(b) they made up of different kinds of tissues.
(c) they involved in secondary growth.
(d) they appear early in life of a plant and contribute to the formation of the primary plant body.

9. Sieve tubes are suited for translocation of food because they possess
(a) bordered pits.
(b) no ends walls.
(c) broader lumen and perforated cross walls.
(d) no protoplasm.

10. A piece of wood having no vessels (trachea) must be belonged to
(a) teak (b) mango
(c) pine (d) palm

7 STRUCTURAL ORGANISATION IN ANIMALS

Fill in the Blanks :

1. The kind of epithelium which forms the inner walls of blood vessels is _________ .
2. The only type of cell seen in a tendon is _________ .
3. The chondrocytes of connective tissue are _________ .
4. The supportive skeletal structures in the human external ears and in the nose tip are examples of _________ .
5. Cockroaches are brown or black bodied animals that are included in class _______ of phylum _______.
6. Intercalated discs are the communication junctions between the cells of _________ .

True/ False :

1. There are 16 very long malpighian tubules present at the junctions of midgut and hindgut in periplaneta americana.
2. Nervous system is located ventrally in periplaneta and consists of segmentally arranged ganglia joined by a pair of longitudinal connectives.
3. Muscle fibres contract (shorten) in response to stimulation, then relax (lengthen) and return to their uncontracted state in a coordinated fashion.
4. Neuroglial cells protect and support neurons.
5. Tight junctions help to stop substances from leaking across a tissue.
6. Loose connective tissue contains fibroblasts, macrophages and mast cells.
7. Cartilage, bones and blood are various types of specialized connective tissue.
8. Heart of cockroach consists of elongated muscular tube lying along mid dorsal line of thorax and abdomen.

Conceptual MCQs :

1. The type of muscles present in our :
   (a) heart are involuntary and unstriated smooth muscles
   (b) intestine are striated and involuntary
   (c) thigh are striated and voluntary
   (d) upper arm are smooth muscle fibres fusiform in shape
2. Which of the following is correctly stated as it happens in the common cockroach ?
   (a) Malpighian tubules are excretory organs projecting out from the colon
   (b) Oxygen is transported by haemoglobin in blood
   (c) Nitrogenous excretory product is urea
   (d) The food is ground by mandibles and gizzard
3. The kind of tissue that forms the supportive structure in our pinna (external ears) is also found in:
   (a) nails (b) ear ossicles
   (c) tip of the nose (d) vertebrae
4. If a live earthworm is pricked with a needle on it outer surface without damaging its gut, the fluid that comes out is :
   (a) coelomic fluid (b) haemolymph
   (c) slimy mucus (d) excretory fluid
5. A piece of bone such as femur of frog if kept in dilute HCl for about a week will
   (a) assume black colour
   (b) shrink in size
   (c) turn flexible
   (d) crack into pieces

6. Simple epithelium is a tissue in which the cells are
(a) hardened and provide support to the organs
(b) cemented directly to one another to form a single layer
(c) continuously dividing to provide form to an organ
(d) loosely connected to one another to form an irregular organ

7. Blood is a –
(a) epithelial tissue (b) muscular tissue
(c) connective tissue (d) supportive tissue

8. Inter-calated discs are present in –
(a) cardiac muscles (b) striped muscles
(c) unstriated muscles (d) ligament

9. Photoreceptor in *Pheretima* are –
(a) on ventral side of skin
(b) on dorsal side of skin
(c) on both
(d) in clitellum

10. The principal function of blood vascular system in cockroach is –
(a) distribution of absorb nutrients
(b) distribution of oxygen
(c) transportation of enzymes
(d) transportation of heat

11. Diagnostic feature of insects in –
(a) three pairs of legs
(b) compound eye
(c) chitinous body
(d) two pairs of wings

12. Male and female cockroaches can be distinguished externally through
(a) anal styles in male
(b) anal cerci in female
(c) anal style and antennae in female
(d) both (b) and (c)

13. Which of the following is correctly stated as it happens in the common cockroach ?
(a) Malpighian tubules are excretory organs projecting out from the colon
(b) Oxygen is transported by haemoglobin in blood
(c) Nitrogenous excretory product is urea
(d) The food is ground by mandibles and gizzard

14. The cells lining the blood vessels belong to the category of:
(a) smooth muscle tissue
(b) squamous epithelium
(c) columnar epithelium
(d) connective tissue

15. The breakdown of detritus into smaller particles by earthworm is a process called
(a) humification (b) fragmentation
(c) mineralisation (d) catabolism

16. Consider the following four statements (A-D) related to the common frog *Rana tigrina*, and select the correct option stating which ones are true (T) and which ones are false (F)

Statements :
(A) On dry land it would die due to lack of O_2 its mouth is forcibly kept closed for a few days
(B) It has four- chambered heart
(C) On dry land it turns uricotelic from ureotelic
(D) Its life-history is carried out in pond water

Options :

	(A)	(B)	(C)	(D)
(a)	T	F	F	T
(b)	T	T	F	F
(c)	F	F	T	T
(d)	F	T	T	F

17. The type of muscles present in our :
(a) heart are involuntary and unstriated smooth muscles
(b) intestine are striated and involuntary
(c) thigh are striated and voluntary
(d) upper arm are smooth muscle fibres fusiform in shape

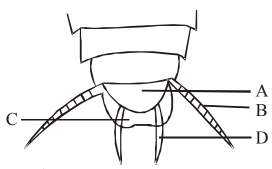
18. Select the correct statement from the ones given below with respect to *Periplaneta americana*.
(a) Nervous system located dorsally, consists of segmentally arranged ganglia joined by a pair of longitudinal connectives.
(b) Males bear a pair of short thread like anal styles.
(c) There are 16 very long Malpighian tubules present at the junctions of midgut and hindgut.
(d) Grinding of food is carried out only by the mouth parts.

19. Which of the following statements are wrong?
(i) Leucocytes disintegrate in the spleen and liver.
(ii) RBC, WBC and blood platelets are produced by bone marrow.
(iii) Neutrophils bring about destruction and detoxification of toxins of protein origin.
(iv) The important function of lymphocytes is to produce antibodies.
(a) (i) and (ii) only (b) (i) and (iv) only
(c) (i) and (iii) only (d) (ii) and (iii) only

20. Cells that maintain marrow cells are called
(a) osteocytes (b) chondrocytes
(c) osteoclasts (d) none of these.

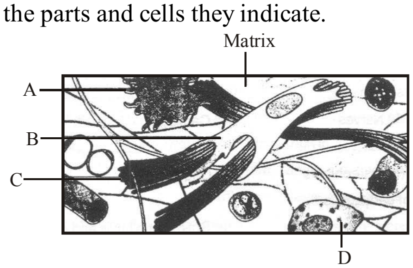
Diagram Based Questions :

1. The diagram given below represents the reproductive organ of male cockroach. Choose the correct labelling of the part of marked as A, B, C and D.



(a) A – 8th sternum; B - Anal cercus; C - 10th tergum; D - Anal style
(b) A - 10th tergum; B - Anal cercus; C - Anal style; D - 8th sternum
(c) A - Anal style; B - Anal cercus; C - 10th tergum; D- 8th sternum
(d) A - Anal cercus; B - 8th sternum; C - 10th tergum; D - Anal style.

2. In the given diagram of areolar connective tissue, the different cells and parts have been marked by alphabets (A, B, C & D). Choose the answer in which these alphabets correctly match with the parts and cells they indicate.



(a) A-Adipocyte; B-Collagen fibres; C-Microfilament; D-Mast cells
(b) A-Macrophage; B-Collagen fibres; C Microfilament; D-Mast cells
(c) A-Macrophage; B-Collagen fibres; C Microtubule; D-RBC
(d) A-Macrophage; B-Fibroblast; C-Collagen fibres; D-Mast cells

3. Identify figures-I and II.

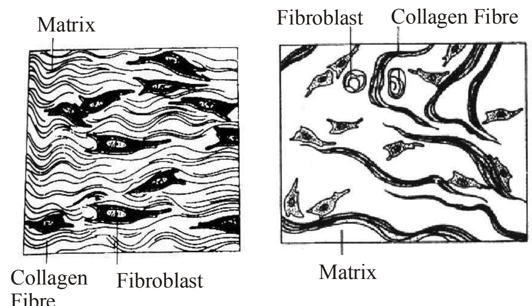
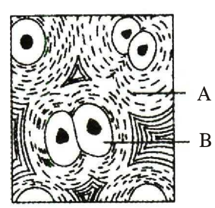


Fig-I Fig-II

	Figure I	Figure II
(a)	Dense regular connective tissue,	Dense irregular connective tissue
(b)	Loose irregular connective tissue,	Loose regular connective tissue
(c)	Adipose tissue,	Specialized connective tissue
(d)	Connective tissue proper	Areolar tissue

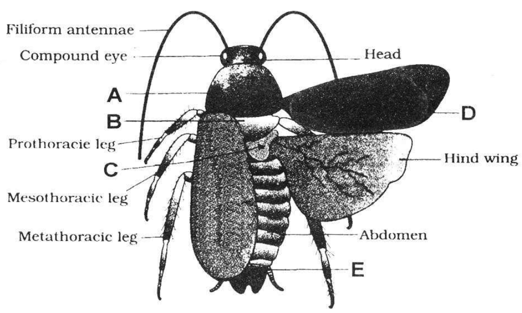
4. The intercellular material of the given figure is solid and resists compression. Identify the figure and the label marked as A & B.



Fig

	Fig.	A	B
(a)	Cartilage	Collagen	Chondrocyte
(b)	Cartilage	Collagen	Chondroclast
(c)	Bone	Microtubule	Chondroclast
(d)	Bone	Collagen fibres	Osteoblast

5. The following figure shows the extarnal features of cockroach with few structures labelled as A, B, C, D, & E.



Identify A to E .

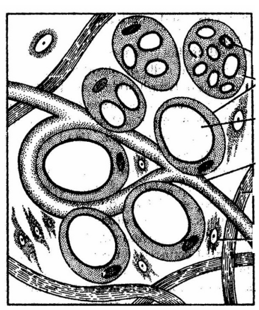
(a) A- Mesothorax; B-Pronotum; C Metathorax; D-Tegmina; E-Anal style

(b) A- Pronotum; B-Metathorax; C Mesothorax; D-Tegmina; E-Sterna

(c) A- Pronotum; B-Mesothorax; C Metathorax; D-Tegmina; E-Anal cerci

(d) A- Pronotum; B-Mesothorax; C Metathorax; D-Tegmina; E-Anal style

6. Identify the figure with its correct function



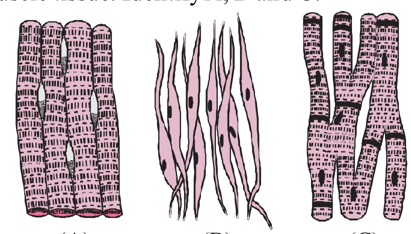
(a) Areolar connective tissue – Serves as a support framework for epithelium.

(b) Adipose tissue – Store fats and act as heat insulators.

(c) Dense regular tissue – Provide flexibility.

(d) Dense irregular tissue – Provide strength and elasticity.

7. The following figures A, B and C are types of muscle tissue. Identify A, B and C.



(A) (B) (C)

(a) A – Smooth muscle; B – Cardiac muscle; C – Skeletal muscle

(b) A – Skeletal muscle; B – Smooth muscle; C – Cardiac muscle

(c) A – Cardiac muscle; B – Smooth muscle; C – Skeletal muscle

(d) A – Smooth muscle; B –Skeletal muscle; C – Cardiac muscle

Assertion/ Reason :

DIRECTIONS (Qs. 1-9): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.

(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.

(c) If the assertion is true but reason is false.

(d) If both the assertion and reason are false

(e) If the assertion is false but the reason is true.

1. **Assertion :** Cartilage and bone are rigid connective tissues.

Reason : Blood is a connective tissue

2. **Assertion :** Intercalated discs are important regions of cardiac muscle cells.

Reason : Intercalated discs function as boosters for muscle contraction waves.

3. **Assertion :** Typhlosole increases the effective area of absorption in the intestine.

Reason : Typhlosole, present in the intestine is the characteristic feature of cockroach.

4. **Assertion :** Urinary bladder can considerably expand to accommodate urine.

Reason : It is lined by stretchable squamous epithelium.

5. **Assertion :** Specialization of cells is advantageous for the organisms.

   Reason : It increases the operational efficiency of an organism.

6. **Assertion :** WBCs accumulate at site of wounds by diapedesis.

   Reason : It is squeezing of leucocytes from endothelium.

7. **Assertion :** Mast cells in the human body release excessive amounts of inflammatory chemicals which cause allergic reactions.

   Reason : Allergens in the environment on reaching human body stimulate mast cells in certain individuals.

8. **Assertion :** Surface of skin is impervious to water.

   Reason : Surface of skin is covered by stratified cuboidal epithelium.

9. **Assertion :** Mast cells help in body defence.

   Reason : Mast cells phagocytose & destroy microbes.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column I (Epithelial tissue)		Column II (Location)
(A)	Cuboidal	I.	Epidermis of skin
(B)	Ciliated	II.	Inner lining of blood vessels
(C)	Columnar	III.	Inner surface of gall bladder
(D)	Squamous	IV.	Inner lining of fallopian tube
(E)	Keratinized	V.	Lining of pancreatic duct squamous

(a) A – V; B – IV; C – II; D – III; E – I
(b) A – III; B – IV; C – V; D – II; E – I
(c) A – V; B – IV; C – III; D – II; E – I
(d) A – III; B – IV; C – V; D – I; E – II

2.

	Column-I (Types of epithelium)		Column-II (Description)
(A)	Squamous epithelium	I.	It is composed of a single-layer of cube-like cells
(B)	Cuboidal epithelium	II.	Having cilia on their free surface
(C)	Columnar epithelium	III.	It is composed of a single layer of tall and slender cells
(D)	Ciliated epithelium	IV.	It is made up of a single thin layer of flattened cells with irregular boundaries

(a) A – IV; B – I; C – III; D – II
(b) A – I; B – IV; C – III; D – II
(c) A – IV; B – I; C – II; D – III
(d) A – IV; B – III; C – I; D – II

3.

	Column-I (Types of connective)		Column-II (Examples)
(A)	Loose connective tissue	I.	Tendons and ligaments
(B)	Dense regular tissue	II.	Skin
(C)	Dense irregular tissue	III.	Cartilage, bones, blood
(D)	Specialized connective tissue	IV.	Fibroblasts, macrophages and mast cells

(a) A – I; B – IV; C – II; D – III
(b) A – I; B – IV; C – III; D – II
(c) A – IV; B – I; C – II; D – III
(d) A – IV; B – II; C – I; D – III

4.

	Column-I (Terms)		Column-II (Features)
(A)	Exocrine gland	I.	They help to stop substances from leaking across a tissue
(B)	Endocrine gland	II.	Hormones are secreted directly into the fluid bathing the gland
(C)	Tight junctions	III.	They perform cementing to keep neighbouring cells together.
(D)	Adhering junctions	IV.	Secretes mucus, saliva, earwax, oil, milk, digestive enzymes and other cell products

(a) A – IV; B – II; C – I; D – III
(b) A – II; B – IV; C – I; D – III
(c) A – IV; B – II; C – III; D – I
(d) A – IV; B – I; C – II; D – III

5.

	Column-I		Column-II
(A)	*Periplaneta*	I.	Hepatic caecae *americana*
(B)	A ring of 6-8 blind	II.	Phylum arthropoda tubules
(C)	Vascular system	III.	Spiracles
(D)	10 pairs of small	IV.	Malpighian tubules holes
(E)	Excretion	V.	Open type

(a) A – I; B – II; C – III; D – IV; E – V
(b) A – II; B – I; C – V; D – III; E – IV
(c) A – II; B – I; C – III; D – V; E – IV
(d) A – III; B – IV; C – II; D – V; E – I

6.

	Column I (Description)		Column II (Example)
(A)	Aquatic respiratory organ	A.	Skin
(B)	Organ which acts urogenital duct and opens into the cloaca	B.	Ureter
(C)	A small median chamber that is used to pass faecal matter, urine and sperms to the exterior	C.	Cloaca
(D)	A triangular structure which joins the right atrium and receives blood through vena cava	D.	Sinus venosus

	1	2	3	4
(a)	A	B	C	D
(b)	C	A	D	B
(c)	B	A	C	D
(d)	C	B	D	A

Critical Thinking Type Questions :

1. The blood of cockroach contains no respiratory pigment. It means that
(a) cockroach does not respire.
(b) respiration is anaerobic.
(c) oxygen goes directly into tissues by diffusion.
(d) oxygen goes directly into tissues by intracellular capillary system.

2. If the head of cockroach is cut off, it will still alive for as long as one week. It is because of
(a) the body which is covered with a hard chitinous exoskeleton.
(b) head which holds a bit of nervous system.
(c) head which is of no use.
(d) food capturing appratus which is found elsewhere.

3. What will happen if ligaments are cut or broken?
(a) No movements at joints.
(b) Bones will become fixed.
(c) Bones will become unfixed.
(d) Bone will move freely at joints.

4. Four healthy people in their twenties got involved in injuries resulting in damage and death of a few cells of the following. Which of the cells are **least** likely to be replaced by new cells?

(a) Liver cells
(b) Neurons
(c) Malpighian layer of the skin
(d) Osteocytes

5. In cockroach head can move in all directions due to
(a) absence of neck.
(b) fusion of all 6 segments of head.
(c) flexible neck.
(d) head is small and light weight.

6. What external changes are visible after the last moult of a cockroach nymph?
(a) Development of anal cerci.
(b) Development of both forewings and hind wings.
(c) Development labium.
(d) Mandibles become harder.

7. Choose the correct sequence of alimentary canal of Cockroach
(a) Gizzard $\rightarrow$ Crop $\rightarrow$ Malphigian tubules $\rightarrow$ Hepatic caeca $\rightarrow$ Rectum.
(b) Gizzard $\rightarrow$ Hepatic caeca $\rightarrow$ Crop $\rightarrow$ Rectum $\rightarrow$ Malphigian tubules.
(c) Crop $\rightarrow$ Gizzard $\rightarrow$ Hepatic caeca $\rightarrow$ Malphigian tubules $\rightarrow$ Rectum.
(d) Crop $\rightarrow$ Hepatic caeca $\rightarrow$ Gizzard $\rightarrow$ Rectum $\rightarrow$ Malphigian tubules.

8. Lack of blood supply and presence of the noncellular basement membrane are the characteristics of the
(a) muscular tissue
(b) fluid connective tissue
(c) epithelial tissue
(d) nervous tissue

9. The secretions of endocrine glands are released directly
(a) into the skin surface
(b) into the blood stream
(c) into a gland duct
(d) into the brain tissue

10. Cartilage tissues are likely to be slow in healing following an inj ury because
(a) cartilage cells cannot reproduce.
(b) they lack direct blood supplies.
(c) the intercellular material is missing.
(d) cartilage cells are surrounded by fluids.

8 CELL : THE UNIT OF LIFE

Fill in the Blanks :

1. Difference between the prokaryotic and eukaryotic cells in having __________.
2. Polysome is a chain of __________.
3. Extension of plasma membrane in prokaryotic cell is __________.
4. ________________ is the important site of formation of glycoproteins and golycolipids.
5. Plastids storing fat are called __________.
6. An organelle devoid of membrane covering is _________.
7. The membrane of the erythrocytes has approximately___% of proteins and ___% lipids.
8. The lipid component of the membrane mainly consists of __________.

True / False :

1. Human RBC is about 7.0 μm in diameter.
2. Various chemical reactions occur in cytoplasm to keep the cell in the living state.
3. Cilia are smaller which work like oars, causing the movement of either the cells or surrounding fluid.
4. Contractile vacuole takes part in osmoregulation and excretion.
5. The middle lamella is a layer mainly of calcium carbonate which holds the different neighbouring cells together.
6. ER helps in the transport of substances, synthesis of proteins, lipoproteins and glycogen.
7. Mitochondria help in oxidative phosphorylation and generation of ATP.
8. Glycocalyx is the outermost envelope in bacteria.
9. Small bristle like fibres sprouting out of the bacterial cell are called fimbriae.
10. RuBisCO is the most abundant protein in the whole biosphere.
11. Na^+/K^+ pump is an example of passive transport.

Conceptual MCQs :

1. According to fluid mosaic model, plasma membrane is composed of
   (a) phospholipids and oligosaccharides
   (b) phospholipids and hemicellulose
   (c) phospholipids and integral proteins
   (d) phospholipids, extrinsic proteins and intrinsic proteins
2. Electron microscope has a high resolution power. This is due to
   (a) electromagnetic lenses
   (b) very low wavelength of electron beam
   (c) low wavelength of light source used
   (d) high numerical aperture of glass lenses used
3. Element necessary for middle lamella is
   (a) Ca (b) Zn
   (c) K (d) Cu
4. Flagella of prokaryotic and eukaryotic cells differ in
   (a) type of movement and placement in cell
   (b) location in cell and mode of functioning
   (c) microtubular organization and type of movement
   (d) microtubular organization and function
5. Centromere is required for
   (a) movement of chromosomes towards poles
   (b) cytoplasmic cleavage
   (c) crossing over
   (d) transcription

6. Vacuole in a plant cell
(a) is membrane-bound and contains storage proteins and lipids
(b) is membrane-bound and contains water and excretory substances
(c) lacks membrane and contains air
(d) lacks membrane and contains water and excretory substances

7. Hereditary characters are due to
(a) chromosomes (b) gene
(c) blood (d) placenta

8. Cell wall is made up of
(a) several layers of microfibrils
(b) several micelle
(c) cellulose molecules
(d) glucose molecules

9. Protein synthesis in an animal cell occurs
(a) on ribosomes present in cytoplasm as well as in mitochondria
(b) on ribosomes present in the nucleolus as well as in cytoplasm
(c) only on ribosomes attached to the nuclear envelope and endoplasmic reticulum
(d) only on the ribosomes present in cytosol

10. Which structure is present in chromosomes?
(a) Nucleus (b) Centromere
(c) Centrosome (d) Golgi body

11. Chromosome with centromere at one end?
(a) Metacentric (b) Sub-metacentric
(c) Telocentric (d) Acrocentric

12. Three of the following statements regarding cell organelles are correct while one is wrong. Which one is wrong ?
(a) Lysosomes are double membraned vesicles budded off form golgi apparatus and contain digestive enzymes.
(b) Endoplasmic reticulum consists of a network of membranous tubules and helps in transport, synthesis and secretion.
(c) Leucoplasts are bound by two membranes lack pigment but contain their own DNA and protein synthesizing machinery.
(d) Spheárosomes are single membrane bound and are associated with synthesis and storage of lipids.

13. Golgi body is concerned with –
(a) respiration (b) secretion
(c) excretion (d) degradation

14. Similarity between plant and animal flagella microtubules is
(a) 9 + 3 (b) 9 + 2
(c) 9 + 6 (d) 9 + 1

15. Sedimentation coefficient of mitochondrial ribosomes of higher plants is :
(a) 80S (b) 70S
(c) 65S (d) 55S

16. Middle lamella is composed mainly of:
(a) muramic acid
(b) calcium pectate
(c) phosphoglycerides
(d) hemicellulose

17. Which one of the following structures between two adjacent cells is an effective transport pathway?
(a) Plasmodesmata
(b) Plastoquinones
(c) Endoplasmic reticulum
(d) Plasmalemma

18. Which one of the following has its own DNA?
(a) Mitochondria
(b) Dictyosome
(c) Lysosome
(d) Peroxisome

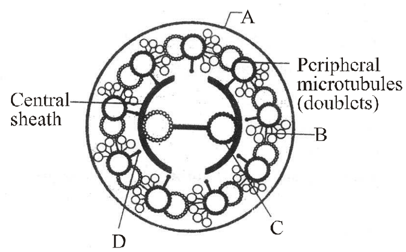
19. Important site for formation of glycoproteins and glycolipids is
(a) vacuole
(b) golgi apparatus
(c) plastid
(d) lysosome

20. Given below is a sample of a portion of DNA strand. What is so special shown in it?
5’ —— GAATTC —— 3’
3’ —— CTTAAG —— 5’
(a) Replication completed
(b) Deletion mutation
(c) Start codon at the 5’ end
(d) Palindromic sequence of base pairs

21. Ribosomal RNA is actively synthesized in
(a) Lysosomes
(b) Nucleolus
(c) Nucleoplasm
(d) Ribosomes

Diagram Based Questions :

1. Identify the components labelled A, B, C and D in the given section of cilia/flagella showing different parts. Choose the option which shows the correct labelling of parts.



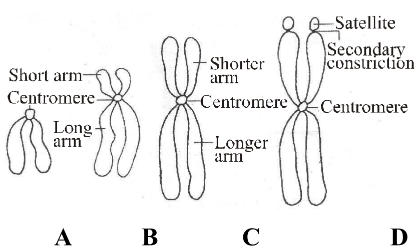
(a) A – Plasma membrane; B – Interdoublet bridge; C – Central microtubule; D – Radial spoke

(b) A – Plasma membrane; B – Arm; C – Central microtubule; D – Radial spoke

(c) A – Plasma membrane; B – Interdoublet bridge; C – Hub; D – Radial spoke

(d) A – Plasma membrane; B – Interdoublet bridge; C– Hub; D – Arm

2. The given diagram shows the types of chromosomes (labelled as A, B, C & D) based on the position of centromere. Which one is the correct option for the labelled chromosomes. A, B, C and D ?



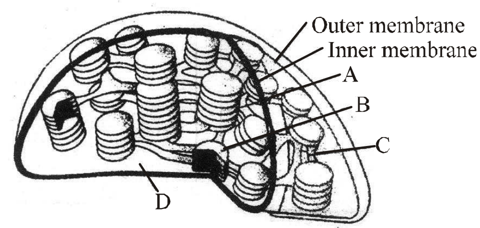
(a) A – Telocentric chromosome; B – Acrocentric chromosome; C – Submetacentric chromosome; D – Metacentric chromosome

(b) A – Acrocentric chromosome; B – Telocentric chromosome; C – Metacentric chromosome; D – Submetacentric chromosome

(c) A – Submetacentric chromosome; B – Metacentric chromosome; C – Telocentric chromosome; D – Acrocentric chromosome

(d) A – Metacentric chromosome; B – Submetacentric chromosome; C– Acrocentric chromosome; D – Telocentric chromosome.

3. Which of the following option correctly match A, B, C, and D indicated in the given sectional view of chloroplasts.



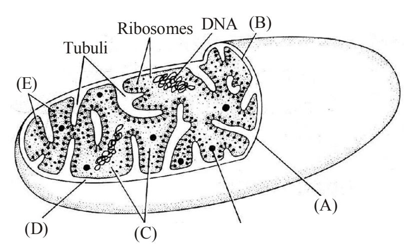
(a) A - Thylakoid; B-Stromal lamella; C - Stroma; D - Granum

(b) A - Granum; B - Thylakoid; C - Stromal lamella; D - Stroma

(c) A - Thylakoid; B - Granum; C - Stromal lamella; D - Stroma

(d) A - Granum; B - Thylakoid; C - Stroma; D - Stromal lamella

4. The given diagram shows the sectional view of a mitochondrion.



Identify the parts labelled as A, B, C, D & E

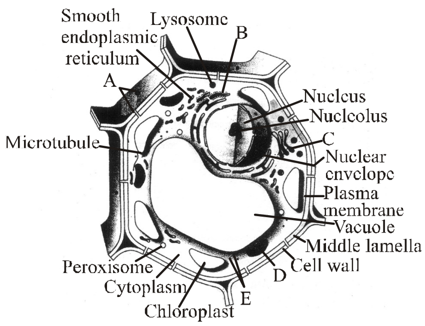
(a) A - Outer membrane; B - Inner membrane; C - Matrix; D - Inter- membrane space; E - Crista

(b) A - Outer membrane; B - Inner membrane; C - Inter-membrane space; D - Matrix; E - Crista

(c) A - Outer membrane; B - Inner membrane; C - Matrix; D - Crista; E - Inter - membrane space

(d) A - Outer membrane; B - Inner membrane; C- Crista; D - Matrix; E - Inter-membrane space

5. The following diagram shows some of the missing structures in a plant cell marked as A, B, C, D E. Choose the option with their correct names.



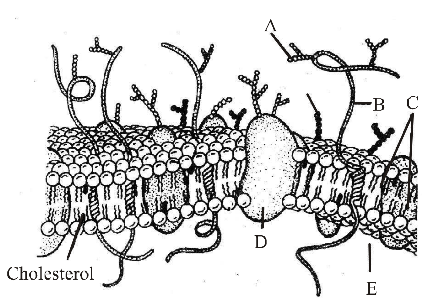
(a) A - Plasmodesmata; B - Rough endoplasmic reticulum; C - Golgi apparatus; D - Mitochondrion; E - Ribosomes

(b) A - Desmosome; B - Rough endoplasmic reticulum; C - Golgi apparatus; D - Mitochondrion; E - Ribosomes

(c) A - Plasmodesmata; B - Smooth endoplasmic reticulum; C - Golgi apparatus; D - Mitochondrion; E - Ribosomes

(d) A - Tight junction; B - Rough endoplasmic reticulum; C - Golgi apparatus; D - Mitochondrion; E -Ribosomes

6. The diagram given below represent a filuid mosaic model of plasma membrance. Match the components marked as A, B, C, D and E in the diagram below from the list (i) to (vii).



(i) Sugar (ii) Protein

(iii) Lipid bilayer (iv) Integral protein

(v) Cytoplasm (vi) Cell wall

(vii) External protein

(a) A - (i); B - (ii); C - (iii); D - (iv); E - (v)

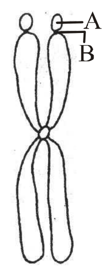
(b) A - (ii); B - (i); C - (iii); D - (iv); E - (v)

(c) A - (i); B - (ii); C - (iii); D - (iv); E - (vi)

(d) A - (i); B - (ii); C - (iii); D - (vii); E - (v)

7. The following diagram represents a structure chromosome.

Identify the structures marked as A, B and C.



Chromosome - C

(a) A - Satellite; B - Primary constriction; C - Acrocentric

(b) A - Satellite; B - Secondary constriction; C - Metacentric

(c) A - Satellite; B - Centromere; C - Telocentric

(d) A - Satellite; B - Centromere; C - Submetacentric

Assertion/ Reason :

DIRECTIONS (Qs. 1-11): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.

(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.

(c) If the assertion is true but reason is false.

(d) If both the assertion and reason are false

(e) If the assertion is false but the reason is true.

1. **Assertion:** Cell membrane is semipermeable.

Reason: The constituent molecules can freely move in the membrane.

2. **Assertion:** Plasmids are double-stranded extra chromosomal DNA.
Reason: Plasmids are possessed by eukaryotic cells.
3. **Assertion:** Living organisms possess specific individuality with the definite shape and size.
Reason: Both living and non living entities resemble each other at the lower level of organisation.
4. **Assertion:** Mitochondria is known as power house of cell.
Reason: ATP production takes place here.
5. **Assertion:** Cell wall is not found in animal cell.
Reason: Animal cells are covered by cell membrane.
6. **Assertion:** It is important that the organisms should have cell.
Reason: A cell keeps its chemical composition steady within its boundary.
7. **Assertion:** A cell membrane shows fluid behaviour.
Reason: A membrane is a mosaic or composite of diverse lipids and proteins.
8. **Assertion:** Mitochondria and chloroplasts are semi autonomous organelles.
Reason: They are formed by division of pre-existing organelles as well as contain DNA but lack protein synthesizing machinery
9. **Assertion:** Na^+– K^+ ATPase is an important membrane associated enzyme.
Reason: It helps in ion transfer across the membrane.
10. **Assertion:** DNA is associated with proteins.
Reason: DNA binds around histone proteins that form a pool and the entire structure is called a nucleosome.
11. **Assertion:** Lysosomes help in photorespiration.
Reason: Lysosome have basic enzyme.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I		Column-II
(A)	Tonoplast	I.	Contain digestive enzyme
(B)	Contractile vacuole	II.	Store metabolic gases
(C)	Food vacuole	III.	Excretion
(D)	Air vacuole	IV.	Transport of ions in plants

(a) A – IV; B – III; C – I; D – II
(b) A – II; B – III; C – IV; D – I
(c) A – IV; B – II; C – III; D – I
(d) A – I; B – III; C – II; D – IV

2.

	Column-I (Chromosome)		Column-II (Position of Centromere)
(A)	Metacentric	I.	At the tip
(B)	Submetacentric	II.	Almost near the tip
(C)	Acrocentric	III.	At the middle
(D)	Telocentric	IV.	Slightly away from the middle

(a) A – III; B – IV; C – II; D – I
(b) A – IV; B – III; C – II; D – I
(c) A – I; B – II; C – III; D – IV
(d) A – IV; B – III; C – I ; D – II

3.

	Column-I		Column-II
(A)	SER	I.	Increase the surface area
(B)	Golgi apparatus	II.	Store oils or fats
(C)	Cristae	III.	Excretion
(D)	Peroxisome	IV.	Photorespiration
E.	Elaioplasts	V.	Synthesis of lipid

(a) A – V; B – III; C – I; D – IV; E – II
(b) A – V; B – III: C – II; D – IV; E – I
(c) A – II; B – III; C – I; D – IV; E – V
(d) A – III; B – IV; C – I; D – V; E – II

4.

	Column-I		Column-II
(A)	Leeuwenhoek	I.	First saw and described a living cell
(B)	Robert Brown	II.	Presence of cell wall is unique to plant cells
(C)	Schleiden	III.	Discovered the nucleus
(D)	Schwann	IV.	All plants are composed of different kind of cells

(a) A – I; B – III; C – IV; D – II
(b) A – I; B – III; C – II; D – IV
(c) A – III; B – I; C – IV; D – II
(d) A – I; B – IV; C – II; D – III

5.

Column-I (Cell type)		Column-II (Size)
(A) Viruses	I.	1-2 µm
(B) PPLO	II.	10-20 µm
(C) Eukaryotic cell	III.	About 0.1 µm
(D) Bacterium	IV.	0.02 - 0.2 µm

(a) A – I; B – II; C – III; D – IV
(b) A – IV; B – III; C – II; D – I
(c) A – I; B – III; C – II; D – IV
(d) A – IV; B – II; C – III; D – I

6.

Column-I		Column-II
(A) Mitochondria	I.	Without membrane
(B) Lysosomes	II.	Single membrane
(C) Ribosomes	III.	Double membrane

	A	B	C
(a)	I	II	III
(b)	III	I	II
(c)	III	II	I
(d)	II	III	I

7.

Column - I		Column - II
(A) Golgi apparatus	I.	Storage
(B) Mitochondria	II.	Photosynthesis
(C) Vacuoles	III.	Transport
(D) Grana	IV.	Secretion
	V.	Respiration

	A	B	C	D
(a)	IV	V	I	II
(b)	I	II	IV	III
(c)	IV	I	II	III
(d)	I	II	III	IV

8.

Column - I		Column - II
(A) RER	I.	Intracellular and extracellular digestion
(B) Cell wall	II.	Provide structural support to the cell
(C) Flagella	III.	Protein synthesis and secretion
(D) Lysosomes	IV	Responsible for cell movement

(a) A – III; B – II; C – IV; D – I
(b) A – II; B – III; C – IV; D – I
(c) A – I; B – III; C – II; D – IV
(d) A – IV; B – II; C – III; D – I

9.

Column-I		Column-II
(A) Bacteria without walls	I.	Lysosome
(B) Small circular DNA	II.	Mycoplasma cells
(C) Flattened sacs in a chloroplast	III.	Thylakoid
(D) A vesicle in which hydrolytic enzymes are stored	IV.	Plasmid

(a) A – III; B – IV; C – II; D – I
(b) A – II; B – IV; C – III; D – I
(c) A – I; B – II; C – III; D – IV
(d) A – IV; B – III; C – I ; D – II

Critical Thinking Type Questions :

1. Golgi apparatus is absent in
(a) higher plants
(b) yeast
(c) bacteria and blue-green algae
(d) None of the above
2. Most of water, in mature plant cells occurs in
(a) nucleus (b) cell wall
(c) vacuoles (d) cytoplasm
3. Which of the following lacks cell wall?
(a) Gametes (b) *Amoeba*
(c) *Mycoplasma* (d) All of these
4. What would happen if lysosomes get ruptured in a cell?
(a) Cell dies
(b) Cell shrinks
(c) Cell swell up
(d) Nothing would happen
5. Cell sap is a
(a) living content of cytoplasm.
(b) nonliving content of cytoplasm.
(c) nonliving content of vacuole.
(d) living content of vacuole.
6. The fluidity of membranes in a plant in cold weather may be maintained by
(a) increasing the number of phospholipids with unsaturated hydrocarbon tails.

(b) increasing the proportion of integral proteins.
(c) increasing concentration of cholesterol in membrane.
(d) increasing the number of phospholipids with saturated hydrocarbon tail.

7. Which of the following is absent in prokaryotes?
(a) DNA (b) RNA
(c) Plasma membrane (d) Mitochondria

8. In which method of transport, plasma membrane does not require carrier molecule?
(a) Active transport (b) Facilitated diffusion
(c) Simple diffusion (d) $Na^+ - K^+$ pump

9. pH of vacuolar cell sap is
(a) neutral and isotonic.
(b) alkaline and isotonic.
(c) acidic and hypertonic.
(d) equal to cytoplasm and isotonic.

10. Microtubules, motor proteins, and actin filaments are all part of the
(a) mechanism of photosynthesis that occurs in chloroplasts.
(b) rough ER in prokaryotic cells.
(c) cytoskeleton of eukaryotic cells.
(d) process that moves small molecules across cell membranes.

9

Biomolecules

Fill in the Blanks :

1. The simplest amino acid is _________.
2. The charged molecule which is electrically neutral is known as _________.
3. Primary structure of protein is due to the presence of ______.
4. Building block of nucleic acid is ________.
5. Quaternary structure is present in ________.
6. The bond between phosphate and hydroxyl group of sugar in nucleic acid is _______.
7. The Km value of the enzyme is the value of the substrate concentration at which the reaction reaches to ________.
8. Inorganic catalyst work efficiently at ________temperature and ________ pressure.

True/ False :

1. The amino group and carboxylic group of an amino acid are attached to both amino and carboxylic groups to alpha carbon.
2. In lipid, R group may be $–CH_3$ group, $–C_2H_5$ group or higher number of $–CH_2$ group (1 to 19 carbon).
3. Lysine is a neutral amino acid.
4. Proteins are homopolymer made of amino acids.
5. Abrin and ricin are secondary metabolities used as a drugs.
6. Enzymes require optimum pH for maximal activity.
7. Nitrogen bases are open chain hydrocarbons.
8. Chitin, a complex or heteropolysaccharide occuring in exoskeleton consists of NAG.
9. Glucosamine and N-acetyl glucosamine are modified sugar.

Conceptual MCQs :

1. RNA does not possess
   (a) uracil (b) thymine
   (c) adenine (d) cytosine
2. Which is wrong about nucleic acids ?
   (a) DNA is single stranded in some viruses
   (b) RNA is double stranded occasionally
   (c) Length of one helix is 45Å in B-DNA
   (d) One turn of Z-DNA has 12 bases
3. Adenine is
   (a) purine (b) pyrimidine
   (c) nucleoside (d) nucleotide
4. An enzyme brings about
   (a) decrease in reaction time
   (b) increase in reaction time
   (c) increase in activation energy
   (d) reduction in activation energy
5. In which one of the following groups, all the three are examples of polysaccharides?
   (a) Starch, glycogen, cellulose
   (b) Sucrose, maltose, glucose
   (c) Glucose, fructose, lactose
   (d) Galactose, starch, sucrose
6. The enormous diversity of protein molecules is due mainly to the diversity of
   (a) amino groups on the amino acids
   (b) R groups on the amino acids
   (c) amino acid sequences within the protein molecule
   (d) peptide bonds
7. Lipids are insoluble in water because lipid molecules are
   (a) hydrophilic (b) hydrophobic
   (c) neutral (d) zwitter ions
8. If base order in one chain of DNA is "ATCGA" then how many no. of H-bond found in DNA duplex –

(a) 20 (b) 12
(c) 10 (d) 11

9. Which of the following is the example of acidic amino acid?
(a) Lysine (b) Glutamic acid
(c) Aspartic acid (d) (b) and (c) both

10. Bond between nitrogenous bases in a nucleotide is –
(a) H-bond
(b) covalent bond
(c) phosphodiester bond
(d) sulphide bond

11. Ligase enzyme is used for –
(a) denaturation of DNA
(b) splitting DNA into small bits
(c) joining bits of DNA
(d) digestion of lipids

12. Fats in the body are formed when –
(a) glycogen is formed from glucose
(b) sugar level becomes stable in blood
(c) extra glycogen storage in liver and muscles is stopped
(d) all of them

13. Chemically enzymes are –
(a) fats (b) carbohydrates
(c) hydrocarbons (d) proteins

14. Characteristic feature of haemoglobin –
(a) reversible union with oxygen
(b) red Colour
(c) presence of Cu
(d) presence of globulin protein

15. Which one is the most abundant protein in the animal world ?
(a) Trypsin (b) Haemoglobin
(c) Collagen (d) Insulin

16. Which one of the following biomolecules is correctly characterized?
(a) Lecithin - A phosphorylated glyceride found in cell membrane.
(b) Palmitic acid - An unsaturated fatty acid with 18 carbon atoms.
(c) Adenylic acid - Adenosine with a glucose phosphate molecule.
(d) Alanine amino acid - Contains an amino group and an acidic group anywhere in the molecule.

17. A phosphoglycerate is always made up of :
(a) only an unsaturated fatty acid esterified to a glycerol molecule to which a phosphate group is also attached
(b) a saturated or unsaturated fatty acid esterified to a glycerol molecule to which a phosphate group is also attached
(c) a saturated or unsaturated fatty acid esterified to a phosphate group which is also attached to a glycerol molecule.
(d) only a saturated fatty acid esterified to a glycerol molecule to which a phosphate group is also attached

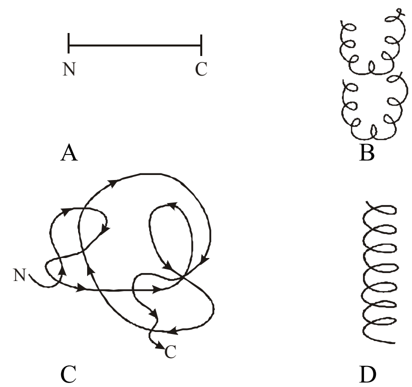
18. An example of competitive inhibition of an enzyme is the inhibition of
(a) succinic dehydrogenase by malonic acid
(b) cytochrome oxidase by cyanide
(c) hexokinase by glucose -6- phosphate
(d) carbonic anhydrase by carbon dioxide

19. Macro molecule chitin is :
(a) Phosphorus containing polysaccharide
(b) Sulphur containing polysaccharide
(c) Simple polysaccharide
(d) Nitrogen containing polysaccharide

20. Which vitamin should not be stored?
(a) Calciferol (b) Retinol
(c) Niacin (d) Ascorbic acid

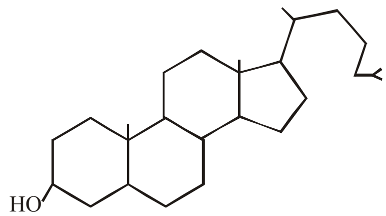
Diagram Based Questions :

1. What kinds of the structures of proteins are shown in the given figure (A, B, C and D)?



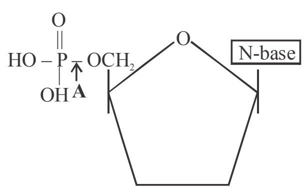
(a) A = 1º structure, B = 2º structure, C = 3º structure, D = 4º structure
(b) A = 4º structure, B = 2º structure, C = 3º structure, D = 1º structure
(c) A = 1º structure, B = 4º structure, C = 3º structure, D = 2º structure
(d) A = 4º structure, B = 3º structure, C = 2º structure, D = 1º structure

2. Identify the following molecule.



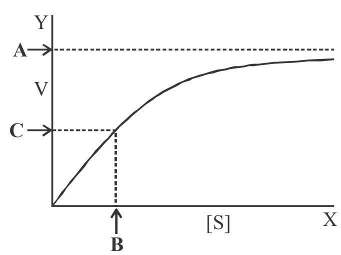
(a) Phospholipid (b) Lecithin
(c) Cholesterol (d) Oleic acid

3. Refer the given structure of adenylc acid. In this identify A.



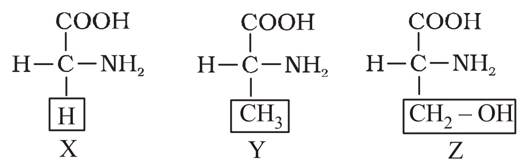
(a) Glycosidic bond
(b) Phosphate bond
(c) Ester bond
(d) Ionic bond

4. The adjoining graph shows change in concentration of substrate on enzyme activity. Identify A, B and C.



	A	B	C
(a)	Ki	K_m	V_{max}
(b)	$\frac{V_{max}}{2}$	K_m	Ki
(c)	V_{max}	K_m	$\frac{V_{max}}{2}$
(d)	K_m	V_{max}	$\frac{V_{max}}{2}$

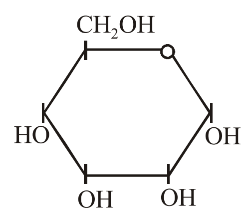
5. The given structural formulas represent amino acids (labelled by as X, Y and Z)



Identify the correct name of X, Y and Z.

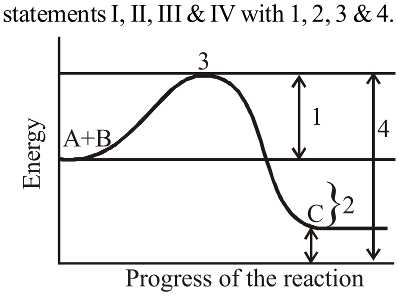
(a) Alanine, serine and glycine respectively.
(b) Tyrosine, cysteine and glutamic acid respectively.
(c) Glycine, alanine and serine acid respectively.
(d) Cysteine, glutamic acid and tyrosine respectively.

6. The structural formula given below belongs to



(a) glucose (b) ribose
(c) sucrose (d) deoxyribose

7. The given graph shows concept of activation energy with labelled 1, 2, 3, & 4. Co-relate the statements I, II, III & IV with 1, 2, 3 & 4.



I. Segment representing the energy of activation.
II. Segment representing the amount of free energy released by the reaction.
III. Transition state.
IV. Segment would be the same regardless of whether the reaction were uncatalysed or catalysed.

	I	II	III	IV
(a)	1	3	2	4
(b)	1	2	3	2
(c)	1	3	2	4
(d)	1	2	4	3

Assertion/ Reason :

DIRECTIONS (Qs. 1-8): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Enzymes have active sites and substrates reactive sites, on their surfaces respectively.
Reason : Active and reactive sites push the enzyme and substrate molecules away from each other.

2. **Assertion :** Enzyme substrate complex does not remain throughout the reaction.
Reason : The greater the affinity of the enzyme for a substrate, the higher is the catalytic activity.

3. **Assertion :** Desmolysing enzymes are those which catalyse the reactions by hydrolysis.
Reason : Digestive enzymes are hydrolysing in nature.

4. **Assertion :** Coenzymes serve as co-factors in a number of different enzyme catalyzed reactions.
Reason : Coenzymes and prosthetic groups are cofactors.

5. **Assertion :** Enzymes are defined as biological proteins.
Reason : Chemically all enzymes are globular proteins.

6. **Assertion :** DNA molecules and RNA molecules are found in the nucleus of cell.
Reason : On heating, enzymes do not lose their specific activity.

7. **Assertion :** The higher the turn-over number the more efficient an enzyme is.
Reason : It is not dependent upon the number of active sites present over an enzyme.

8. **Assertion :** Enzyme becomes inactive below minimum temperature.
Reason : The inactivity of the enzymes is due to denaturation.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I (Organic Compounds)		Column-II (Examples)
(A)	Fatty acid	I.	Glutamic acid
(B)	Phospholipid	II.	Tryptophan
(C)	Aromatic amino acid	III.	Lecithin
(D)	Acidic amino acid	IV.	Palmitic acid

(a) A – I; B – II; C – III, D – IV
(b) A – IV; B – III; C – II, D – I
(c) A – II; B – III; C – IV, D – I
(d) A – III; B – IV; C – I, D – II

2.

	Column I (Biomolecules)		Column II (Examples)
(A)	Carbohydrates	I.	Trypsin
(B)	Protein	II.	Cholesterol
(C)	Nucleic acid	III.	Insulin
(D)	Lipid	IV.	Adenylic acid

(a) A – III; B – I; C – IV, D – II
(b) A – II; B – III; C – IV, D – I
(c) A – III; B – IV; C – I, D – II
(d) A – IV; B – I; C – II, D – III

3.

	Column I (Proteins)		Column II (Functions)
(A)	Collagen	I.	Glucose transport
(B)	Trypsin	II.	Hormone
(C)	Insulin	III.	Intercellular ground substance
(D)	GLUT-4	IV.	Enzyme

(a) A – III; B – IV; C – II; D – I
(b) A – IV; B – I; C – II; D – III
(c) A – II; B – IV; C – I; D – III
(d) A – III; B – IV; C – I; D – II

4.

	Column-I (Component)	Column-II (% of the total cellular mass)
(A)	Water	I. 3
(B)	Proteins	II. 70-90
(C)	Carbohydrates	III. 2
(D)	Lipids	IV. 5-7
(E)	Nucleic acids	V. 10-15

(a) A – V; B – II; C – III; D – IV; E – I
(b) A – II; B – V; C – I; D – III; E – IV
(c) A – III; B – I; C – IV; D – V; E – II
(d) A – V; B – IV; C – III; D – II; E – I

5.

	Column I (Category)	Column II (Secondary metabolites)
(A)	Pigments	I. Concanavalin A
(B)	Terpenoides	II. Monoterpenes, Diterpenes
(C)	Alkaloids	III. Morphine, Cadeine
(D)	Lectins	IV. Carotenoids, Anthocyanin

(a) A – IV; B – II; C – III; D – I
(b) A – IV; B – III; C – II; D – I
(c) A – I; B – IV; C – III; D – II
(d) A – I; B – III; C – II; D – IV

6.

	Column-I	Column-II
(A)	Cotton fibre	I. Chitin
(B)	Exoskeleton of cockroach	II. Glycogen
(C)	Liver	III. Starch
(D)	Peeled potato	IV. Cellulose

(a) A – I; B – IV; C – III; D – II
(b) A – IV; B – I; C – II; D – III
(c) A – IV; B – I; C – III; D – II
(d) A – I; B – IV; C – II; D – III

7.

	Column I (Function)	Column II (Types of enzymes)
(A)	Enzymes catalysing breakdown without addition of water.	I. Isomerases
(B)	Enzyme catalyzes the conversion of an aldose sugar to a ketose sugar.	II. Oxidore-ductase
(C)	Enzyme where catalysis involves transfer of electrons.	III. Ligases
(D)	Enzyme catalysing bonding of two components with the help of ATP.	IV. Lyases

(a) A – I; B – IV; C – III; D – II
(b) A – I; B – IV; C – II; D – III
(c) A – IV; B – I; C – II; D – III
(d) A – IV; B – I; C – III; D – II

Critical Thinking Type Questions :

1. According to weight percentage, the first three elements in human body are
(a) $C > H > O$ (b) $C > O > N$
(c) $O > N > C$ (d) $O > C > H$

2. If all the peptide bonds of a protein are broken down, then what would remain?
(a) Amino acids (b) Peptides
(c) Polypeptides (d) Oligopeptides

3. Relation between amino acid and protein is similar to the one found between
(a) glucose and fructose
(b) thymine and uracil
(c) nucleosides and nucleic acid
(r) nucleotides and nucleic acid

4. Nucleotides are building blocks of nucleic acids. Each nucleotide is a composite molecule formed by
(a) base-sugar-phosphate.
(b) base-sugar-OH.
(c) (base-sugar-phosphate)$_n$.
(d) sugar-phosphate.

5. Antiparallel strands of a DNA molecule means that
(a) the phosphate groups of two DNA strands, at their ends share the same position.
(b) the phosphate groups at the start of two DNA strands are in opposite position (pole).

(c) one strand turns clockwise.
(d) one strand turns anti-clockwise.

6. Which of the following is not an attribute of enzymes ?
(a) They are substrate specific in nature.
(b) They are proteinaceous in nature.
(c) They are used up in the reaction.
(d) They speed up rate of biochemical reaction.

7. "All enzymes are proteins." This statement is now modified because an apparent exception to this biological truth is
(a) arylsulfatase
(b) dehydrogenase
(c) ribozyme
(d) nitroreductase

8. Carbohydrates, the most abundant biomolecule on earth, are produced by
(a) some bacteria, algae and green plant cells.
(b) fungi, algae and green plant cells.
(c) all bacteria, fungi and algae.
(d) viruses, fungi and bacteria.

9. Which one of the following biomolecules is correctly characterized?
(a) Lecithin - A phosphorylated glyceride found in cell membrane.
(b) Palmitic acid - An unsaturated fatty acid with 18 carbon atoms.
(c) Adenylic acid - Adenosine with a glucose phosphate molecule.
(d) Alanine amino acid - Contains an amino group and an acidic group anywhere in the molecule.

10. The effectiveness of an enzyme is affected least by
(a) temperature.
(b) concentration of the substrate.
(c) original activation energy of the system.
(d) concentration of the enzyme.

11. Which of the following set is correctly match to the category mentioned against them ?
(a) Lysine, glycine, thiamine – amino acids.
(b) Arachidonic acid, acetic acid, palmitic acid – Fatty acids
(c) Thymidine, uridine, cytidilic acid – Nucleosides
(d) Cellulose, inulin, glycogen – Polysaccharides

12. The stored form of sugar in animal is a
(a) homopolysaccharide (b) heteropolysaccharide
(c) oligosaccharide (d) diasaccharide

13. Select the type of enzyme involved in the following reaction.

$$\boxed{S - G + S' \rightarrow S + S' - G}$$

(a) Dehydrogenase (b) Transferase
(c) Hydrolase (d) Lyase

14. Transition state structure of the substrate formed during an enzymatic reaction is.
(a) permanent but unstable.
(b) transient and unstable.
(c) permanent and stable.
(d) transient but stable.

15. For a protein to have a quaternary structure, it must
(a) have four amino acids.
(b) consist of two or more polypeptide subunits.
(c) consist of four polypeptide subunits.
(d) have at least four disulphide bridges.

16. The quaternary structure of human haemoglobin is best described as a
(a) dimer of identical subunits.
(b) dimer of different subunits.
(c) tetramer of four different subunits.
(d) tetramer of two different subunits.

10

Cell Cycle and Cell Division

Fill in the Blanks :

1. In mitosis, nucleolus and nuclear membrane disappear at _______ .
2. During mitosis, nuclear envelope, nucleolus begin to form and ER to reappear at _______ .
3. Chromosome synapsis or bivalent formation occurs in _______ .
4. Crossing over occurs during _______ .
5. Chiasmata are first seen in _______ .
6. Terminalization occurs during _______ .
7. The microtubules of the mitotic spindle attach to a specialized structure in the centromere region of each chromosome called the __________.

True / False :

1. Chromatids separate but remain in the centre of the cell in anaphase during mitosis.
2. (In mitosis) Golgi complex and endoplasmic reticulum are still visible at the end of prophase.
3. Chromosomes move to the spindle equator and get aligned along equatorial plate in metaphase of mitosis.
4. Cell plate represents the middle lamella between the walls of two adjacents cells.
5. Cytokinesis in plant cell is centrifugal and takes place by cell-plate formation while animal cells by furrowing/cleavage and is centripetal.
6. M phase represents the phase when actual cell division occurs and I phase represents the phase between two successive M phase.
7. In the 24 hours, average duration of cell cycle of a human cell, cell division proper lasts for only about an hour.

Conceptual MCQs :

1. Meiosis I is reductional division. Meiosis II is equational division due to
(a) pairing of homologous chromosomes
(b) crossing over
(c) separation of chromatids
(d) disjunction of homologous chromosomes

2. Best stage to observe shape, size and number of chromosomes is
(a) interphase (b) metaphase
(c) prophase (d) telophase

5. Meiosis is evolutionary significant because it result in
(a) genetically similar daughters
(b) four daughter cells
(c) eggs and sperms
(d) recombinations

4. During cell division, the spindle fibres attach to the chromosome at a region called
(a) chromocentre (b) kinetochore
(c) centriole (d) chromomere

5. Synapsis occurs between:
(a) mRNA and ribosomes
(b) spindle fibres and centromere
(c) two homologous chromosomes
(d) a male and a female gamete

6. In cell cycle, DNA replication takes place in
(a) G_1 phase
(b) G_2 phase
(c) mitotic metaphase
(d) S phase

7. A contractile mid body forms during cytokinesis in –
(a) animals (b) higher plants
(c) fungi (d) algae

8. Reason of chromosomal movement in Anaphase –
(a) astral rays
(b) centrioles
(c) kinetochore
(d) kinetochore and spindle fibres

9. Chromosome exhibit high level of coiling at which phase of karyokinesis ?
(a) Prophase (b) Metaphase
(c) Telophase (d) Interphase

10. In meiosis –
(a) division of nucleus twice but replication of DNA only once
(b) division of nucleus twice and replication of DNA twice
(c) division of nucleus once and replication of DNA is also once
(d) division of nucleus once and DNA - replication is twice

11. Gap between meiosis - I and II is called :
(a) interphase (b) interkinesis
(c) diakinesis (d) metakinesis

12. Chiasmata are formed as a result of –
(a) exchange of parts of paired homologous chromosome
(b) exchange of part of unpaired non-homologous chromosome
(c) duplication of parts of paired homologous chromosome
(d) loss of parts of unpaired non-homolog us chromosome

13. Centromere is required for –
(a) movement of chromosomes towards poles
(b) cytoplasmic cleavage
(c) crossing over
(d) transcription

14. Which of the following statement is correct ?
(a) DNA is synthesized through out the cell-cycle.
(b) Cell division is inhibited by cytokinin.
(c) Chromosome are condensed at S-stage.
(d) Only extra chromosomal DNA is replicated at any stage of cell cycle.

15. Select the correct option with respect to mitosis.
(a) Chromatids separate but remain in the centre of the cell in anaphase.
(b) Chromatids start moving towards opposite poles in telophase.
(c) Golgi complex and endoplasmic reticulum are still visible at the end of prophase.
(d) Chromosomes move to the spindle equator and get aligned along equatorial plate in metaphase

16. At metaphase, chromosomes are attached to the spindle fibres by their:
(a) satellites
(b) secondary constrictions
(c) kinetochores
(d) centromere

17. During gamete formation, the enzyme recombinase participates during
(a) Metaphase - I (b) Anaphase - II
(c) Prophase - I (d) Prophase - II

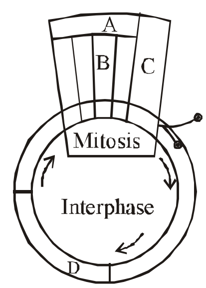
18. The complex formed by a pair of synapsed homologous chromosomes is called
(a) Kinetochore (b) Bivalent
(c) Axoneme (d) Equatorial plate

19. Which chromosome may lost during cell division?
(a) Giant chromosome
(b) Acentric chromosome
(c) Polycentric chromosome
(d) Telocentric chromosome

20. Colchicine prevents the mitosis of cells at which of the following stage ?
(a) Anaphase (b) Metaphase
(c) Prophase (d) Interphase

Diagram Based Questions :

1. Given below is a schematic break-up of the phases / stages of cell cycle with few parts labelled as A, B, C & D.



Which one of the following is the correct indication of the stage/phase in the cell cycle?
(a). C - Karyokinesis (b) D - Synthetic phase
(c) A - Cytokinesis (d) B - Metaphase

2. Which stages of cell division do the following figures A and B represent respectively?

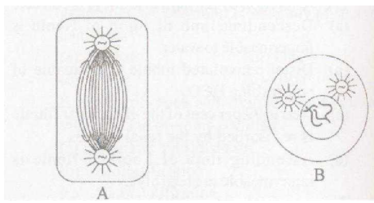
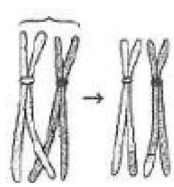


Fig. A **Fig. B**

(a) A - Metaphase ; B - Telophase
(b) A - Telophase ; B - Metaphase
(c) A - Late Anaphase ; B - Prophase
(d) A - Prophase ; B - Anaphase

3. Given below is the representation of a certain event at a particular stage of a type of cell division. Which stage is shown by the given figure?

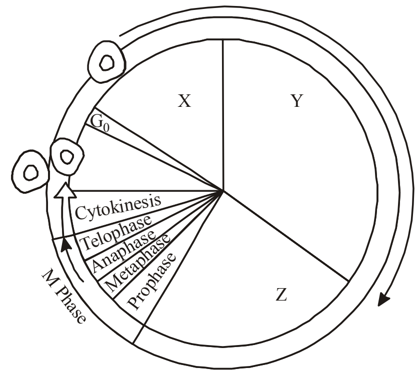


(a) Prophase I during meiosis.
(b) Prophase II during meiosis.
(c) Prophase of mitosis.
(d) Both prophase and metaphase of mitosis.

4. A stage in cell division is shown in the figure. Select the answer which gives correct identification of the stage with its characteristics.

(a)	Late anaphase	Chromosomes move away from equatorial plate, Golgi complex is not present.
(b)	Cytokinesis	Cell plate is formed, mitochondria distributed between two daughter cells.
(c)	Telophase	Endoplasmic reticulum and nucleolus not reformed yet
(d)	Telophase	Nuclear envelop reforms, golgi complex reforms

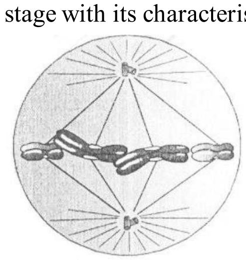
5. The following diagram is of a typical cell cycle indicating formation of two cells from one cell.



Choose the correct option showing the correct identification of X, Y, & Z.

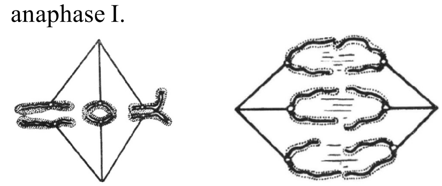
(a) X - G_1; Y - S; Z - G_2
(b) X - G_2; Y - S; Z - G_1
(c) X - G_0; Y - S; Z - G_2
(d) X - G_1; Y - G_0; Z - S

6. A stage of mitosis is shown in the given diagram. Identify stage with its characteristics?

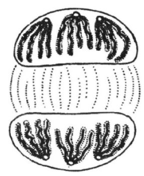


(a) Late prophase – Chromosomes move to spindle equator.
(b) Metaphase – Spindle fibres attached to kinetochores, centromeres split and chromatids separate
(c) Metaphase – chromosomes moved to spindle equator chromosomes made up of two sister chromatids
(d) Anaphase – centromeres split and chromatids separate and start moving away

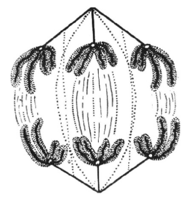
7. Choose the diagram which correctly depicts anaphase I.



(a) (b)



(c)



(d)

Assertion/ Reason :

DIRECTIONS (Qs. 1-11): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Interphase is resting stage.
Reason : The interphase cell is metabolically inactive.

2. **Assertion :** Mitosis maintains the genetic similarity of somatic cells.
Reason : Chromosomes do not undergo crossing over.

3. **Assertion :** Chiasmata is formed during diplotene.
Reason : Chiasmata are formed due to deposition of nucleoproteins.

4. **Assertion :** During zygotene, chromosomes show bivalent stage.
Reason : Bivalent is half the number of chromosomes.

5. **Assertion :** Meiosis takes place in pollen mother cells.
Reason : Each pollen mother cell produce 4 haploid pollen grains.

6. **Assertion :** Plasmids are double - stranded extra - chromosomal DNA.
Reason : Plasmids are possessed by eukaryotic cells.

7. **Assertion :** Meiotic division results in the production of haploid cells.
Reason : Synapsis occurs during zygotene of meiosis.

8. **Assertion :** DNA is associated with proteins.
Reason : DNA binds around histone proteins that form a pool and the entire structure is called a nucleosome.

9. **Assertion :** Histones are basic proteins of major importance in packaging of eukaryotic DNA. DNA and histones comprise chromatin, forming the bulk of eukaryotic chromosome.
Reason : Histones are 5 major types H_1, H_2A, H_2B, H_3 and H_4.

10. **Assertion :** Karyokinesis occurs in M-phase.
Reason : Cell division stops in M-phase.

11. **Assertion :** DNA synthesis occurs in G_1 and G_2 periods of cell cycle.
Reason : During G_1 and G_2 phase the DNA contents become double.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column I		Column II
(A)	Chromosomes are moved to spindle equator	I.	Pachytene
(B)	Centromere splits and chromatids apart	II.	Zygotene
(C)	Pairing between homologous chromosomes takes place	III.	Anaphase
(D)	Crossing between homologous chromosomes	IV.	Metaphase

(a) A – I; B – II; C – III; D – IV
(b) A – II; B – III; C – IV; D – I
(c) A – IV; B – III; C – II; D – I

(d) A – III; B – I; C – IV; D – II

2.

Column I (Terms)	Column II (Explanation)
(A) Terminalization	I. Pairing of homologous chromosomes.
(B) Synapsis	II. Point of attachment between homologous chromosomes.
(C) Chiasmata	III. Nuclear protein complex that helps in adherence of sister chromatid sand then homologous chromosomes.
(D) Synaptonemal complex	IV. Shifting of chiasmata outwards towards the ends of a bivalent.

(a) A – IV; B – I; C – II; D – III

(b) A – II; B – III; C – IV; D – I

(c) A – II; B – IV; C – III; D – I

(d) A – IV; B – I; C – III; D – II

3.

Column-I	Column-II
(A) Initiation of the assembly of mitotic spindle	I. Anaphase
(B) Proteins are synthesized in preparation for mitosis while cell growth continues.	II. Prophase
(C) Spindle fibres attach to kinetochores of chromosomes.	III. Interphase
(D) Movement of chromatids towards opposite poles	IV. Metaphase

The correct match is

(a) A – II; B – III; C – IV; D – I

(b) A – III; B – II; C – I; D – IV

(c) A – I; B – III; C – II; D – IV

(d) A – IV; B – III; C – I; D – II

Critical Thinking Type Questions :

1. In which stage of the cell cycle, histone proteins are synthesized in a eukaryotic cell?

(a) During G_2 stage of prophase.

(b) During S-phase.

(c) During entire prophase.

(d) During telophase.

2. How many mitotic divisions are needed for a single cell to make 128 cells?

(a) 7 (b) 14

(c) 28 (d) 64

3. During which stages (or prophase I substages) of meiosis do you expect to find the bivalents and DNA replication respectively?

(a) Pachytene and interphase (between two meiotic divisions).

(b) Pachytene and interphase (just prior to prophase I).

(c) Pachytene and S phase (of interphase just prior to prophase I).

(d) Zygotene and S phase (of interphase prior to prophase I).

4. Significance of meiosis lies in

(a) reduction of chromosome number to one half.

(b) maintaining consistancy of chromosome number during sexual reproduction.

(c) production of genetic variability.

(d) all of the above.

5. How many meiotic divisions are required to produce 100 pollen grains ?

(a) 25 (b) 50

(c) 100 (d) 125

6. Mitosis and meiosis take place respectively in

(a) meristem and gametangia.

(b) gametangia and meristem.

(c) permanent tissues and secretory tissues.

(d) secretory tissues and permanent tissues.

7. If you are provided with root-tips of onion in your class and are asked to count the chromosomes, which of the following stages can you most conveniently look into?

(a) Metaphase (b) Telophase

(c) Anaphase (d) Prophase

8. Which of the following is the result when karyokinesis is not followed by cytokinesis ?

(a) Synaptonemal complex

(b) Syncytium

(c) Recombination nodules
(d) Terminalization

9. "G_0" state of cells in eukaryotic cell cycle denotes
(a) check point before entering the next phase.
(b) pausing in the middle of a cycle to cope with a temporary delay.
(c) death of a cell.
(d) exit of cells from cell cycle.

10. Mitosis is the process by which eukaryotic cells
(a) expose the genes for protein synthesis.
(b) become specialized in structure and function.
(c) multiply.
(d) grow.

11. The major event that occurs during the anaphase of mitosis, which brings about the equal distribution of chromosomes is
(a) replication of the genetic material.
(b) splitting of the chromatids.
(c) splitting of the centromeres.
(d) condensation of the chromatin.

12. In animal cells, cytokinesis involves
(a) the separation of sister chromatids.
(b) the contraction of the contractile ring of microfilament.
(c) depolymerization of kinetochore microtubules.
(d) a protein kinase that phosphorylates other enzymes.

13. Which of the following will show simple cell division?
(a) Microspore mother cells
(b) Megaspore mother cells
(c) Archesporial cells
(d) All of the above.

14. Four daughter cells formed after meiosis are
(a) genetically similar
(b) genetically different
(c) anucleate
(d) multinucleate

15. In meiosis, the daughter cells differ from parent cell as well as amongst themselves due to
(a) segregation, independent assortment and crossing over.
(b) segregation and crossing over.
(c) independent assortment and crossing over.
(d) segregation and independent assortment.

16. The separation of two chromatids of each chromosome at early anaphase is initiated by
(a) the interaction of centromere with the chromosomal fibres.
(b) the elongation of metaphasic spindle.
(c) the force of repulsion between the divided kinetochores.
(d) All of the above.

17. Cell would normally proceed to mitosis without interruption
(a) once it has entered the S phase.
(b) once it has entered the G_2 phase.
(c) at any time during cell division activity.
(d) none of the above

18. Identify the meiotic stage in which the homologous chromosomes separate while the sister chromatids remain associated at their centromeres.
(a) Metaphase I
(b) Metaphase II
(c) Anaphase I
(d) Anaphase II

11 TRANSPORT IN PLANTS

Fill in the Blanks :

1. The process by which water is absorbed by solids like colloids causing them to increase in volume is called ____ .
2. Movement that is aided by cytoplasmic streaming and occurs from cell to cell through plasmodesmata is called _______ .
3. When a root absorbes minerals from a region of lower concentration to a region of higher concentration, and need energy this type of absorption is called _______ .
4. During fruit development, photosynthesizing leaves would be the ______________ and the fruit would be __________
5. Bidirectional translocation of minerals takes place in _____ .
6. _______is mainly water and sucrose, but other sugars, hormones and amino acids are also _______ through phloem.
7. The hypothesis accepted for the translocation of sugar from source to sink is__________.
8. The process of loading at the source produces a _________ condition in the phloem.
9. Water in the adjacent xylem moves into the phloem by the process of _______ .

True/ False :

1. Mycorrhizal fungi form a network around the young root and they penetrate the root cells.
2. Ions are absorbed from soil by both passive and active transport.
3. Xylem translocates organic and inorganic solutes, mainly from roots to the aerial parts of the plants.
4. Phloem translocates water, mineral salts, some organic nitrogen and hormones, from the leaves to other parts of the plants.
5. The apoplastic movement of water occurs exclusively through the cell wall without crossing any membranes.
6. Endodermis, is pervious to water because of a band of suberised matrix.
7. Apoplastic movement may be aided by cytoplasmic streaming which occurs in hydrilla leaf and chloroplast.
8. Elements most readily mobilised are P, S, N and K.

Conceptual MCQs :

1. Water potential is equal to
   (a) $\Psi_s + O.P.$ (b) $\Psi_s = T.P.$
   (c) $\Psi_p + Y_w$ (d) $\Psi_s + Y_p$
2. Stomata open and close due to
   (a) circadian rhythm
   (b) genetic clock
   (c) pressure of gases inside the leaves
   (d) turgor pressure of guard cells
3. An adaptation for better gaseous exchange in plant leaves is
   (a) hair on lower surface
   (b) multiple epidermis
   (c) waxy cuticle
   (d) stomata on lower surface away from direct sun rays
4. Active and passive transports across cell membrane differ in
   (a) passive transport is nonselective

(b) passive transport is along the concentration gradient while active transport is due to metabolic energy
(c) active transport is more rapid
(d) passive transport is confined to anions while active transport in confined to cations

5. Bidirectional translocation of minerals takes place in
(a) xylem (b) phloem
(c) parenchyma (d) cambium

6. Plants die from prolonged water-logging because
(a) soil nutrients become very dilute
(b) root respiration stops
(c) cell sap in the plants becomes too dilute
(d) nutrients leach down due to excess water

7. If a plant cell is immersed in water, the water continues to enter the cell until the:
(a) concentration of the salts is the same inside the cell as outside
(b) cell bursts
(c) concentration of water is the same inside the cell as out side
(d) diffusion pressure deficit is the same inside the cell as out side

8. Which of the following statement is not correct?
(a) Plants absorb excess quantity of water
(b) Plants take small quantity of mineral salts through soil water
(c) Water and inorganic salts may also simultaneously by root hair
(d) Plant absorb only one thing at a time water or inorganic salts

9. Transpiration from plants would be most rapid when :
(a) there is lot of humidity in atmosphere
(b) the air is more humid
(c) there is excess rain fall
(d) environmental conditions are dry

10. Increase in CO_2 concentration around leaf results in :
(a) rapid opening of stomata
(b) partial closure of stomata
(c) complete closure of stomata
(d) no effect on stomatal opening

11. The pathway of water from soil upto the secondary xylem:
(a) Soil $\rightarrow$ root hair $\rightarrow$ cortex $\rightarrow$ endodermis $\rightarrow$ pericycle $\rightarrow$ protoxylem $\rightarrow$ Meta xylem
(b) Metaxylem $\rightarrow$ protoxylem $\rightarrow$ pericycle $\rightarrow$ cortex $\rightarrow$ endodermis $\rightarrow$ soil $\rightarrow$ root hair
(c) Cortex $\rightarrow$ root hair $\rightarrow$ endodermis $\rightarrow$ pericycle $\rightarrow$ protoxylem $\rightarrow$ metaxylem
(d) Pericycle $\rightarrow$ soil $\rightarrow$ root hair $\rightarrow$ cortex $\rightarrow$ endodermis $\rightarrow$ protoxylem $\rightarrow$ metaxylem

12. Which of the following wall of guard cells is thick?
(a) Outer (b) Inner
(c) Sidewall (d) All the three

13. When the stomata are opening; we observe following changes in the guard cells :
(a) OP increase, TP decreases
(b) OP & TP increases
(c) OP decreases, TP increases
(d) OP & TP decreases

14. Guard cells help in:
(a) transpiration
(b) guttation
(c) fighting against infection
(d) protection against grazing

15. Guttation is the result of :
(a) diffusion (b) transpiration
(c) osmosis (d) root pressure

16. Which of the following criteria does not pertain to facilitated transport?
(a) High selectivity
(b) Transport saturation
(c) Uphill transport
(d) Requirement of special membrane proteins

17. Water potential of pure water and its solution are
(a) 0 and 1
(b) 0 and 0
(c) 0 and more than one
(d) 0 and less than 1.

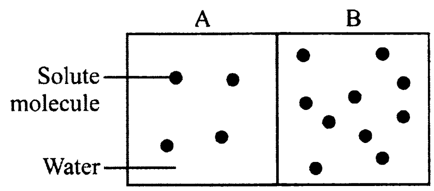
18. A cell, when kept in sugar solution, gets dehydrated. Then solution is
(a) hypotonic (b) hypertonic
(c) isotonic (d) none of these

19. Two cells A and B are contigous. Cell A has osmotic pressure 10 atm, turgor pressure 7 atm and diffusion pressure deficit 3 atm. Cell B has osmotic pressure 8 atm, turgor pressure 3 atm and diffusion pressure deficit 5 atm. The result will be
(a) movement of water from cell B to A
(b) no movement of water
(c) equilibrium between the two
(d) movement of water from cell A to B

20. Cohesion theory of water movement in plants was put forth by
(a) Melvin Calvin (b) F. F. Blackman
(c) T. W. Englemann (d) Henry Dixon

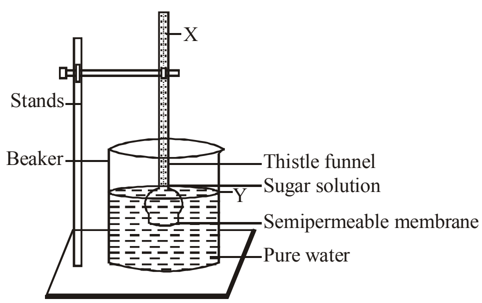
Diagram Based Questions :

1. Chamber A and B are separated by a semipermeable membrane. Study the given figure and choose the right option.



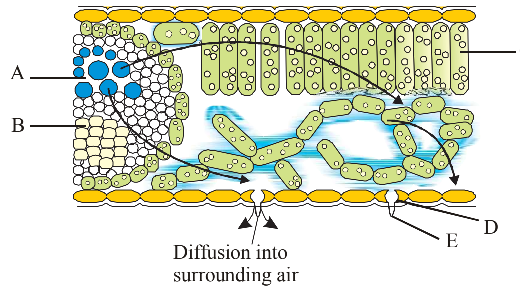
(a) Chamber A has higher water potential and water will move from A to B.
(b) Chamber B has lower solute potential and water will move from A to B.
(c) Chamber A has higher solute potential and water will move from B to A.
(d) Chamber B has lower water potential and water will move from B to A.

2. Study the experiment shown below :



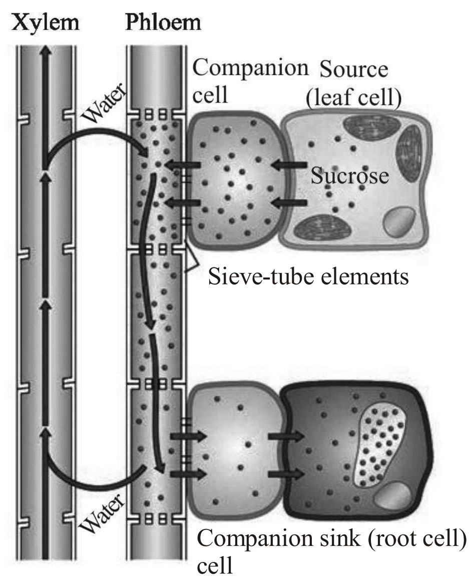
After a few days, which of the following will have occured ?
(a) A rise in level X and Y
(b) A drop in level X and level Y
(c) A rise in level X and a drop in level Y
(d) A drop in level X and a rise in level Y

3. Choose the correct combination of labelling of water movement in the leaf.



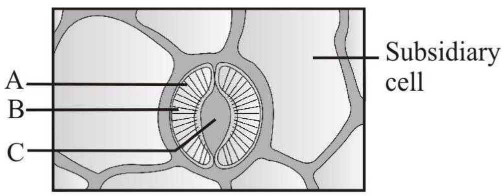
(a) A - tracheids; B - Phloem; C - Mesophyll; D - Stomatal pore, E - Guard cell
(b) A - Phloem; B - Xylem; C - Palisade; D - Guard Cell; E - Water pore
(c) A - Xylem; B - Phloem; C - Palisade; D - Guard cell; E - Stomatal pore
(d) A - Phloem; B - Xylem; C - Mesophyll cell; D - Subciliary cell; E - Water pore

4. Based on Munch's pressure-flow hypothesis, which of the following conditions would increase the rate of translocation?



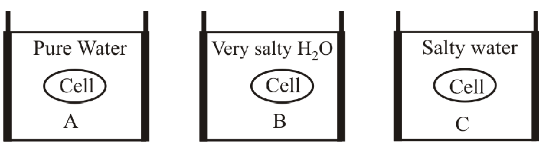
(a) An increase in the humidity in the outside air.
(b) A decrease in phloem unloading at the sink.
(c) An increase in sucrose production at the source.
(d) A decrease in photosynthesis.

5. Given below is the diagram of stomatal apparatus. In which of the following all of the three parts labelled as A, B and C are correctly identified?



(a) A - Microfibril; B - Stomatal aperture; C - Guard cell
(b) A - Microfibril; B - Guard cell; C - Stomatal aperture
(c) A - Stomatal aperture; B - Guard cell; C - Microfibril
(d) A - Guard cell; B - Stomatal aperture; C - Microfibril

6. Which of the following shows the correct explanation of the given figures?



(a) Cell "A" will lose H_2O, Cell "B" will gain H_2O, Cell "C" neither gain nor loses H_2O.
(b) Cell "A" neither gain nor loses H_2O, Cell "B" will gain H_2O, Cell "C" will lose H_2O.
(c) Cell "A" will gain, Cell "B" neither gain nor loses H_2O, Cell "C" lose H_2O.
(d) Cell "A" will gain H_2O, Cell "B" will lose H_2O, Cell "C" neither gain nor loses H_2O.

Assertion/ Reason :

DIRECTIONS (Qs. 1-10): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Long distance flow of photo-assimilates in plants occurs through sieve tubes.
Reason : Mature sieve tubes have parietal cytoplasm and perforated sieve plates.

2. **Assertion :** Water potential is new term for diffusion pressure deficit.
Reason : Both diffusion pressure deficit and water potential have a negative value.

3. **Assertion :** Wilting occurs due to loss in turgidity.
Reason : Turgor pressure checks the excessive entry of water into cells.

4. **Assertion :** Seeds and spores do not lose the viability in unfavourable periods.
Reason : Seeds and spores have high osmotic pressure.

5. **Assertion :** Upward movement of water is called ascent of sap.
Reason : Upward movement of water occurs through xylem and phloem.

6. **Assertion :** Waxy and cutin coating on plant parts reduce the transpiration.
Reason : These adaptations are found in xerophytes.

7. **Assertion :** Guttation liquid is found on the margins of leaves.
Reason : Hydathodes are found on the margins.

8. **Assertion :** Xylem is principal water conducting tissue.
Reason : It has been recognised by girdling or ringing experiment.

9. **Assertion :** Water and mineral uptake by root hairs from the soil occurs through apoplast until it reaches endodermis.
Reason : Casparian strips in endodermis are suberized.

10. **Assertion :** Plant parts become flaccid in wilting condition.
Reason : Temporary and permanent wilting result in plant death.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column - I		Column - II
A.	Isotonic	I.	External solution is more concentrated
B.	Hypotonic	II.	Shrinkage of protoplasm
C.	Hypertonic	III.	solution is more dilute than the cytoplasm
D.	Plasmolysis	IV	Two solutions have the same osmolarity

(a) A – II; B – I; C – IV; D – III
(b) A – IV; B – III; C – I; D – II
(c) A – III; B – I; C – IV; D – II
(d) A – II; B – III; C – IV; D – I

2.

	Column-I		Column-II
A.	Cohesion	I.	The ability to rise in their tubes.
B.	Adhesion	II.	Loss of water vapour from plant parts.
C.	Tensile strength	III.	Mutual attraction between water molecules
D.	Capillarity	IV.	Attraction of water molecules to polar surfaces
		V.	An ability to resist a pulling force.

(a) A – I; B – II; C – III; D – V
(b) A – II; B – I; C – IV; D – III
(c) A – III; B – IV; C – V; D – I
(d) A – IV; B – V; C – II; D – III

3.

	Column-I		Column-II
A.	Transpiration	I.	Anaerobic respiration in yeast
B.	Guttation	II.	Active absorption of water
C.	Exudation	III.	Loss of water vapour from plant parts
D.	Fermentation	IV.	Loss of liquid water from leaves
		V.	Loss of water from injured plant parts

(a) A – I; B – II; C – III; D – V
(b) A – II; B – I; C – IV; D – III
(c) A – III; B – IV; C – V; D – I
(d) A – IV; B – V; C – II; D – III

4.

	Column-I		Column-II
A.	Hypotonic	I.	Water
B.	Hypertonic	II.	Sucrose
C.	Solute	III.	Lower tonicity
D.	Solvent	IV.	Higher tonicity

(a) A – I; B – II; C – III; D – IV
(b) A–III; B – II; C – I; D – IV
(c) A – III; B – IV; C – II; D – I
(d) A – III; B – II; C – IV; D – I

5.

	Column I		Column II
A.	Relay Pump Theory	I.	Stocking
B.	Transpiration Cohesion Theory	II.	Sir J. C. Bose
C.	Mass Flow Theory	III.	Godlewski
D.	Pulsation Theory	IV.	Dixon and Jolly
		V.	Ernest Munch

(a) A $\rightarrow$ (III); B $\rightarrow$ (II); C $\rightarrow$ (V); D $\rightarrow$ (I)
(b) A $\rightarrow$ (II); B $\rightarrow$ (I); C $\rightarrow$ (V); D $\rightarrow$ (III)
(c) A $\rightarrow$ (III); B $\rightarrow$ (IV); C $\rightarrow$ (V); D $\rightarrow$ (II)
(d) A $\rightarrow$ (IV); B $\rightarrow$ (III); C $\rightarrow$ (I); D $\rightarrow$ (II)

Critical Thinking Type Questions :

1. Cell A and cell B are adjacent plant cells. In cell A, $\psi_s = -20$ bars and $\psi_p = 8$ bars. In cell B, $\psi_s = -12$ bars and $\psi_p = 2$ bars. Then
   (a) water moves from cell A to cell B.
   (b) there is no movement of water between cell A and cell B.
   (c) water moves from cell B to cell A.
   (d) equal amount of water is simultaneously exchanged between cell A and cell B.
2. A plant cell placed in pure water will
   (a) expand until the osmotic potential or solute potential reaches that of water
   (b) becomes more turgid until the pressure potential of cell reaches its osmotic potential
   (c) become more turgid until osmotic potential reaches that of pure water
   (d) becomes less turgid until the osmotic potential reaches that of pure water.
3. A boy is studying transport of a certain type of molecules into cell. He finds that transport slows down when the cells are poisoned with a chemical that inhibits energy production. Under normal circumstances the molecules studied by the boy is probably transported by
   (a) Simple diffusion
   (b) Osmosis
   (c) Active transport
   (d) Facilitated diffusion
4. Osmosis is a form of diffusion in which
   (a) the solvent moves through a semipermeable membrane from its region of higher chemical potential to its region of lower chemical potential.
   (b) the solvent moves through a semipermeable membrane from its region of lower chemical potential to its region of higher chemical potential.
   (c) the solute moves through a semipermeable membrane from a region of higher concentration to lower concentration
   (d) the solute moves through a semipermeable membrane from a region of lower concentration to higher concentration
5. Water will move from its region of higher chemical potential to its region of lower chemical potential until
   (a) equilibrium is reached.
   (b) amount of both solvent and solute in both regions become equal.
   (c) solvent amount in both regions become equal.
   (d) solute amount in both regions become equal.
6. "Osmosis is the diffusion of a solution of a weaker concentration when both are separated by semipermeable membrane above". What is the error in the statement ?
   (a) The movement of solvent molecule is not specified.
   (b) There is no mention of DPD.
   (c) Behaviour of semipermeable membrane is not specified.
   (d) The exact concentration of solutions are not indicated.
7. The net direction and rate of osmosis depends on both the 'X' and 'Y'. Identify 'X' and 'Y'.
   (a) X - Solute; Y - Solvent
   (b) X - Pressure potential; Y - Solute potential
   (c) X - Water potential; Y - Pressure gradient
   (d) X - Pressure gradient; Y - Concentration gradient
8. Bacteria cannot survive in a highly salted pickle because
   (a) salt inhibits reproduction of bacteria.
   (b) they become plasmolysed and death occurs.
   (c) nutrients in pickle cannot support life.
   (d) enough light is not available for photosynthesis.
9. A cell is said to be flaccid when
   (a) there is no net flow of water towards the inside or outside.
   (b) the external solution balances the osmotic pressure of the cytoplasm.
   (c) water flows into the cell and out of the cell and are in equilibrium.
   (d) The external solution is more dilute than the cytoplasm.

12 MINERAL NUTRITION

Fill in the Blanks :

1. The essential elements which are required by plants in large amounts are called________ and those required in very small amount by the plants are called _________.
2. _________ is an constituent of the ring structure of chlorophyll and helps to maintain the ribosome structure.
3. Pigment present in the root nodules of legume is ________
4. The enzyme _______ which is capable of nitrogen reduction is present exclusively in prokaryotes. Such microbes are called_____.
5. The process by which mineral absorbed is called ________
6. Denitrification is carried out by________
7. Any mineral ion concentration in tissues that reduces the dry weight of tissues by about _______ is considered toxic.
8. Conversion of N≡N to NH_3 occurs in plant cell by ______

True / False :

1. Macro nutrients are present in plant tissues in excess of 100 m mole per kg of dry matter.
2. Some elements attained from CO_2 and H_2O while the others are absorbed from the soil.
3. C, H & O are mainly obtained from CO_2 and H_2O.
4. *Rhizobium* induces invagination of root hairs.
5. Magnesium competes with iron and manganese for uptake and with Iron for binding with enzymes.
6. Nitrogen is very essential for the sustenance of life.

Conceptual MCQs :

1. Which element is required in comparatively least quantity for the growth of plant?
(a) Zn (b) N
(c) P (d) Ca
2. Which mineral nutrients are called critical element for crops?
(a) N, P, K (b) C, H, O
(c) N, S, Mg (d) K, Ca, Fe
3. Which of the following does NPK denote?
(a) Nitrogen, Potassium, Kinetin
(b) Nitrogen, Protein, Kinetin
(c) Nitrogen, Protein, Potassium
(d) Nitrogen, Phosphorus, Potassium
4. Which one of the following mineral elements plays an important role in biological nitrogen fixation?
(a) Copper (b) Manganese
(c) Zinc (d) Molybdenum
5. All of the following statements concerning the Actinomycetous filamentous soil bacterium *Frankia* are correct except the *Frankia* –
(a) Can induce root nodules on many plant species
(b) Cannot fix nitrogen in the free-living state
(c) Like *Rhizobium*, it usually infects, its host plant through root hair deformation and stimulates cell proliferation in the host's cortex
(d) Forms specialized vesicles in which the nitrogenase is protected from oxygen by a chemical barrier involving triterpene hopanoids
6. Which of the following is not caused by deficiency of mineral nutrition?
(a) Necrosis
(b) Chlorosis
(c) Etiolation
(d) Shortening of internodes

7. Manganese is required in:
(a) plant cell wall formation
(b) photolysis of water during photosynthesis
(c) chlorophyll synthesis
(d) nucleic acid synthesis

8. Which one of the following elements in plants is not remobilised?
(a) Phosphorus (b) Calcium
(c) Potassium (d) Sulphur

9. Nitrifying bacteria :
(a) oxidize ammonia to nitrates
(b) convert free nitrogen to nitrogen compounds
(c) convert proteins into ammonia
(d) reduce nitrates to free nitrogen

10. The function of leg haemoglobin in the root nodules of legumes is :
(a) inhibition of nitrogenase activity
(b) oxygen removal
(c) nodule differentiation
(d) expression of nif gene

11. Minerals absorbed by roots move to the leaf through
(a) xylem (b) phloem
(c) sieve tubes (d) none of the above

12. Which one is an essential mineral, not constituent of any enzyme but stimulates the activity of many enzymes?
(a) Zn (b) Mn
(c) K (d) Mg

13. Passive absorption of minerals depend on
(a) temperature
(b) temperature and metabolic inhibitor
(c) metabolic inhibitor
(d) humidity

14. The major role of minor elements inside living organisms is to act as
(a) binder of cell structure
(b) co-factors of enzymes
(c) building blocks of important amino acids
(d) constituent of hormones

15. Which one of the following pairs is wrongly matched?
(a) Alcohol - nitrogenase
(b) Fruit juice - pectinase
(c) Textile - amylase
(d) Detergents - lipase

16. Which one of the following is not an essential mineral element for plants while the remaining three are
(a) Iron (b) Manganese
(c) Cadmium (d) Phosphorus

17. Which one of the following is essential for photolysis of water ?
(a) Manganese (b) Zinc
(c) Copper (d) Boron

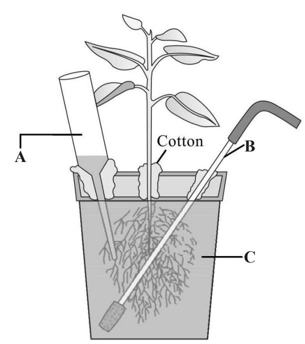
18. Best defined function of Manganese in green plants is :
(a) Photolysis of water
(b) Calvin cycle
(c) Nitrogen fixation
(d) Water absorption

19. Which one of the following is wrong statement?
(a) *Anabaena* and *Nostoc* are capable of fixing nitrogen in free living state also.
(b) Root nodule forming nitrogen fixers live as aerobes under free-living conditions.
(c) Phosphorus is a constituent of cell membranes, certain nucleic acids and cell proteins.
(d) *Nitrosomonas* and *Nitrobacter* are chemoautotrophs.

20. For its activity, carboxypeptidase requires
(a) zinc (b) iron
(c) niacin (d) copper

Diagram Based Questions :

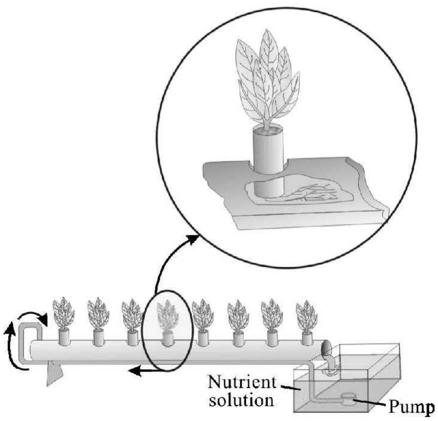
1. Label the following diagram and determine which experiment it is demonstrated?



	A	B	C	D
(a)	Funnel for adding water and nutrients	Aerating tube	Nutrient solution	Hydroponics
(b)	Funnel for adding water only	Aerating tube	Nutrient solution	Aeroponics
(c)	Funnel for adding nutrients only	Aerating tube	Water	Tissue culture

(d) Funnel for adding water and nutrients | Aerating tube | Water | Hydroponics

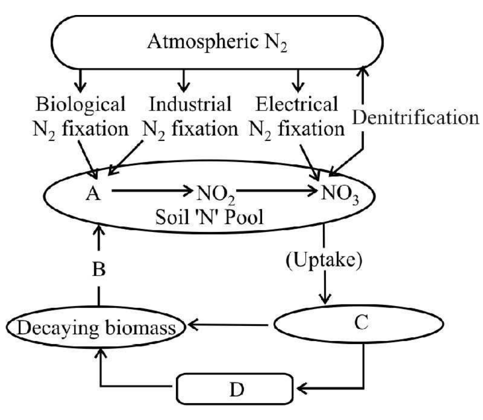
2. The given diagram shows hydroponic/soilless plant production. Plants are grown in a tube or trough placed on a slight incline. The arrows indicate the direction of flow of nutrient solution.



Nutrient solution is sent to the elevated end of the tube from the reservoir by ___________ and it flows back to the reservoir due to __________.

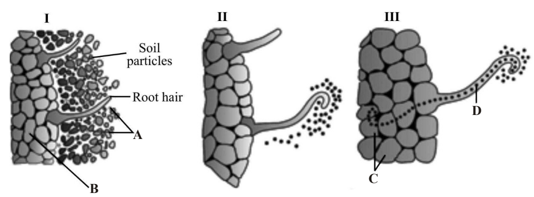
(a) pump, pump (b) gravity, gravity
(c) pump, gravity (d) gravity, pump

3. Refer the figure given below and select the option which gives correct words for all the four blanks A, B, C and D.



	A	B	C	D
(a)	K	Ammonification	Animal biomass	Plant biomass
(b)	NH_3	Ammonification	Plant biomass	Animal biomass
(c)	CO_2	Denitrification	Animal biomass	Plant biomass
(d)	CHO	Nitrification	Plant biomass	Animal biomass

4. The given diagram shows the development of root nodule in soyabean. Thus structures are marked as A, B, C and D.



Identify the correct labelling of A, B, C & D.

(a) A-*Rhizobial* bacteria; B-Cortex cell; C-Outer cortex; D-Infection thread containing virus.
(b) A-*Rhizobial* bacteria; B-Cortex cell; C-Inner cortex and pericycle cells; D-Infection thread containing bacteria
(c) A-*Rhizobial* bacteria; B-Endodermal cell; C-Inner endodermis; D-Infection thread containing virus
(d) A-*Nitrosomonas* bacteria; B-Cortex cell; C-Inner cortex and pericycle cells; D-Infection thread containing bacteria.

Assertion/ Reason :

DIRECTIONS (Qs. 1-7): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Calcium is a constituent of cell wall.
Reason : Calcium is required in mitotic division.

2. **Assertion :** Hydroponics is used for solution culture.
Reason : A balanced nutrient solution contains both essential and nonessential elements.

3. **Assertion :** Magnesium is important in photosynthesis and carbohydrate metabolism.
Reason : Mg^{++} is involved in the synthesis of nucleic acids.

4. **Assertion :** Manganese is an activator of enzyme nitrite reductase.
Reason : Manganese deficient cells prefer ammonia over nitrate.

5. **Assertion :** Deficiency of sulphur causes chlorosis in plants.
Reason: Sulphur is a constituent of chlorophyll, proteins and nucleic acids.

6. **Assertion :** Iron is a microelement.
Reason : Microelements are required in traces only, less than 1mg/gm of dry matter.

7. **Assertion :** In solution culture of plants, iron is added in the form of Fe-EDTA.
Reason : Hydroponics setup is costly.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column - I		Column -II
(A)	Mg^{2+}	I.	activator of dehydrogenase
(B)	Zn^{2+}	II.	activator for both RuBP carboxylase oxygenase and PEP are
(C)	K^{+}	III.	required for all Phosphorylation reactions
(D)	$H_2PO_4^{-}$	IV.	plays an important role in opening and closing of stomata

(a) A – II; B – IV; C – I; D – III
(b) A – II; B – I; C – IV; D – III
(c) A – III; B – I; C – IV; D – II
(d) A – III; B – I; C – II; D – IV

2.

	Column-I		Column-II
(A)	Free living aerobic nitrogen fixers	I.	*Anabaena* and *Nostoc*
(B)	Anaerobic nitrogen fixers	II.	*Pseudomonas* and *Thiobacillus*
(C)	Nitrogen fixing cyanobacteria	III.	*Nitrosomonas* and *Nitrococcus*
(D)	Denitrifying bacteria	IV.	*Azotobacter* and *Beijernickia*
(E)	Nitrifying bacteria.	V.	*Rhodospirillum*

(a) A – IV; B – V; C – I; D – II; E – III
(b) A – V; B – IV; C – I; D – III;E – II
(c) A – IV; B – V; C – II; D – III; E – I
(d) A – IV; B – III; C – I; D – II; E – V

3.

	Column-I		Column-II
(A)	Manganese	I.	Component of various enzymes, and participate in nitrogen metabolism.
(B)	Zinc	II.	Required for poller germination and carbohydrate translocation
(C)	Molybdenum	III.	Helps in splitting of water to liberate oxygen during photosynthesis
(D)	Boron	IV.	Needed in the synthesis of auxin

(a) A – I; B – IV; C – III; D – IV
(b) A – III; B – II; C – I; D – IV
(c) A – III; B – IV; C – I; D – II
(d) A – IV; B – III; C – II; D – I

4.

	Column-I		Column-II
(A)	K	I.	Stomatal opening
(B)	Mo	II.	Constituent of cell membrane
(C)	P	III.	Photolysis of water
(D)	Mn	IV.	Free ion
		V.	Component of nitrogenase and nitrate reductase

	A	B	C	D
(a)	I, IV	V	II	III
(b)	I, V	IV	III	II
(c)	I, V	IV	II	III
(d)	IV	I	III	II, V

5.

	Column -I		Column-II
A.	Zinc	I.	Chlorophyll
B.	Sulphur	II.	IAA
C.	Magnesium	III.	Nitrate reductase
D.	Molybdenum	IV.	Cysteine

(a) A – I; B – II; C – III; D – IV
(b) A – III; B – IV; C – I; D – II
(c) A – III; B – I; C – II; D – IV
(d) A – II; B – IV; C – I; D – III

Critical Thinking Type Questions :

1. Plants absorb nitrogen from soil mainly in the form of
(a) N_2-gas (b) Nitric acid
(c) Nitrite (d) Nitrate
2. An important essential element which is required by plants in the greatest amount is
(a) Nitrogen (b) Iron
(c) Sulphur (d) Copper
3. The mineral involved in the synthesis of DNA and RNA, the mineral required for maintenance of the turgidity of cells and the one required for the activation of the enzyme catalase are respectively
(a) Potassium, Magnesium, Chlorine
(b) Sulphur, Potassium, Iron
(c) Phosphorus, Potassium, Chlorine
(d) Magnesium, Potassium, Iron
4. The term critical concentration means
(a) essential element concentration below which plant remains in the vegetative phase.
(b) essential element concentration below which the plant growth is retarded.
(c) essential element concentration above which the plant growth is stunted.
(d) Non-essential element concentration below which plant growth is retarded.
5. Which one of these do plants require for the formation of Adenosine triphosphate?
(a) N, Cu (b) N, Ca
(c) N, P (d) N, K
6. In an active process, the entry or exit of ions to and from the symplast requires
(a) ATP (b) Cyclic AMP
(c) NADH (d) NADPH
7. A small aquatic plant was put in each of the petridishes -X, Y & Z, containing different culture solutions. After six weeks the plant in dish X had the same number of leaves as it had previously & were all small and yellowish. Plant in dish Y had more leaves of normal size and dark green colour. Plants in dish Z had more leaves of normal size but very pale. Which of the following show the element missing in the culture?

	X	Y	Z
(a)	Magnesium	Phosphorus	Nitrogen
(b)	Phosphorus	Magnesium	Nitrogen
(c)	Phosphorus	Nitrogen	Magnesium
(d)	Magnesium	Nitrogen	Phosphorus

8. Which of the following is an anaerobic N_2 fixing bacterium?
(a) *Azotobacter* (b) *Bacillus*
(c) *Rhodospirillum* (d) *Beijernickia*
9. Nitrogen fixation by organisms requires conditions that are
(a) aerobic
(b) anaerobic
(c) saturated with sunlight
(d) free of water
10. At physiological pH, for the formation of ammonium ion, Ammonia is
(a) protonated (b) deprotonated
(c) carbonylated (d) decarbonylated
11. Glutamate dehydrogenase enzyme is used to convert
(a) α-Ketoglutaric acid into glutamate
(b) Glutamate into α-ketoglutaric acid
(c) Citric acid to α-ketoglutaric acid
(d) Succinic acid to glutamic acid
12. Which of the following expression describes nitrogen fixation?
(a) $N_2 + 3H_2 \rightarrow 2NH_3$
(b) $2NH_4^+ + 2O_2 + 8e^- \rightarrow N_2 + 4H_2O$
(c) $2NH_3 \rightarrow N_2 + 3H_2$
(d) $2N_2$ + glucose $\rightarrow$ 2 amino acids
13. A gardner purchases a commercial fertilizer. The label says that it is 10-20-10. This label refers to the
(a) percentage of nitrogen, phosphate and potassium.
(b) percentage of nitrogen, carbon and oxygen.
(c) rate at which nitrogen is released from the fertilizer.
(d) ratio of organic to inorganic matter in the fertilizer.

13 Photosynthesis

Fill in the Blanks :

1. The experiment material used by Van Neil, to prove that O_2 comes out from water was _____ .
2. In PS-I the reaction centre Chl *a* has absorption maxima at _____________, while in PS-II the reaction centre Chl *a* has absorption maxima at ____________.
3. An energy diagram for the transfer of electrons in the light reactions of photosynthesis in plants is _______ .
4. The primary CO_2 acceptor in C_4 plant is _____ .
5. Chloroplast movement is influenced by ______ .
6. Fixation of CO_2 molecule through Hatch and Slack pathway requires an enzyme called ____ .
7. In the leaves of C_4 plants, malic acid formation during CO_2 fixation occurs in the cells of _______ .
8. A process that creates an important difference between C_3 & C_4 plants is _____ .
9. The principle of limiting factors was proposed by _____ .

True/ False :

1. Water is oxidised in PS - II, but not PS - I.
2. Production of NADPH + H^+ is associated with PS - II, nor PS - I.
3. Site of photosynthesis is mesophyll cells of chloroplast.
4. In Z-scheme of photosynthesis, the electrons flow from H_2O to $NADP^+$.
5. Pigments are substances that have an ability to absorb light, at specific wavelengths.
6. Reaction center of Photosystem I is P_{700}.
7. H_2S, not H_2O, is involved in photosynthesis of purple sulphur bacteria.
8. Tropical plants have a higher temperature optimum than the plants adapted to temperate climates.

Conceptual MCQs :

1. $NADP^+$ is reduced to NADPH in
   (a) PS I
   (b) PS II
   (c) calvin cycle
   (d) noncyclic photophosphorylation
2. Greatest producers of organic matter are
   (a) crop plants (b) forests
   (c) plants of the land area
   (d) phytoplankton of oceans
3. Kranz anatomy is typical of
   (a) C_4 plants (b) C_3 plants
   (c) C_2 plants (d) CAM plants
4. Which enzyme is most abundantly found on earth?
   (a) Catalase (b) Rubisco
   (c) Nitrogenase (d) Invertase
5. Which one of the following is wrong in relation to photorespiration ?
   (a) It is a characteristic of C_3 plants
   (b) It occurs in chloroplasts
   (c) It occurs in daytime only
   (d) It is a characteristic of C_4 plants
6. Photosynthesis in C_4 plants is relatively less limited by atmospheric CO_2 levels because:
   (a) effective pumping of CO_2 into bundle sheath cells.
   (b) RuBisCo in C_4 plants has higher affinity for CO_2.
   (c) four carbon acids are the primary initial CO_2 fixation products.
   (d) the primary fixation of CO_2 is mediated via PEP carboxylase.

7. C_4 plants are more efficient in photosynthesis than C_3 plants due to:
(a) higher leaf area
(b) presence of larger number of chloroplasts in the leaf cells
(c) presence of thin cuticle
(d) lower rate of photorespiration

8. PSI occurs in –
(a) appressed part of granal thylakoids
(b) appressed and non appressed part of grana thylakoids
(c) stroma
(d) stroma thylakoids and non-appressed part of grana thylakoids.

9. Conditions necessary for photosynthesis are –
(a) light and suitable temperature
(b) chlorophyll and water
(c) carbon dioxide
(d) all of the above

10. Splitting of water in photosynthesis is called :
(a) dark reaction (b) photolysis
(c) electron transfer (d) phototropism

11. During photosynthesis when PGA is changed into phosphoglyceraldehyde, which of the following reaction occur?
(a) Oxidation (b) Reduction
(c) Electrolysis (d) Hydrolysis

12. The enzyme which catalyzes the photosynthetic C_4 cycle is –
(a) RuDP carboxylase
(b) PEP carboxylase
(c) Carbonic anhydrase
(d) None of these

13. The rate of photosynthesis does not depend upon –
(a) light duration
(b) light intensity
(c) light quality (colour)
(d) temperature

14. Chlorophyll is present –
(a) in the grana of chloroplasts
(b) on the surface of chloroplasts
(c) dispersed through out the chloroplasts
(d) in the stroma of chloroplasts

15. C_4 plants are found among –
(a) only gramineae
(b) only monocots
(c) only dicots
(d) monocots as well as dicots

16. Pigment-containing membranous extensions in some cyanobacteria are :
(a) Basal bodies
(b) Pneumatophores
(c) Chromatophores
(d) Heterocysts

17. The family in which many plants are C_4 type
(a) Malvaceae (b) Solanaceae
(c) Crucifereae (d) Graminae

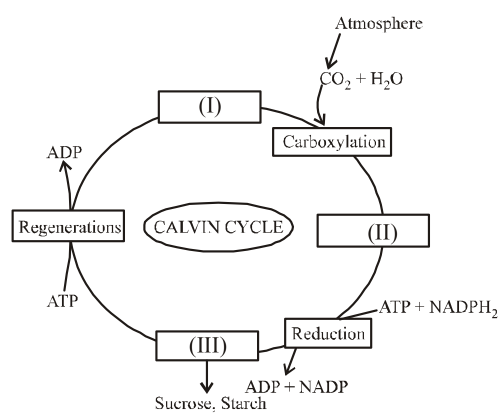
18. Which one does not differ between a C_3 and a C_4 plant?
I. Initial CO_2 acceptor.
II. Extent of photorespiration.
III. Enzyme catalyzing reaction that fixes CO_2.
IV. Presence of Calvin cycle.
V. Leaf anatomy.
(a) I and V (b) IV
(c) II and III (d) II

19. In sugarcane plant $14CO_2$ is fixed in malic acid, in which the enzyme that fixes CO_2 is
(a) *fructose phosphatase*
(b) *ribulose biphosphate carboxylase*
(c) *phosphoenol pyruvic acid carboxylase*
(d) *ribulose phosphate kinase*

20. The reactions of pentose phosphate pathway (PPP) take place in
(a) mitochondrion
(b) cytoplasm
(c) chloroplast, peroxisome and mitochondrion
(d) chloroplast, glyoxysome and mitochondrion

Diagram Based Questions :

1. Choose the correct combinations of labelling the carbohydrate molecule involved in the Calvin cycle



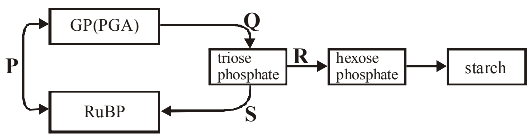
(a) (I) RuBP (II) Triose phosphate (III) PGA

(b) (I) PGA (II) RuBP (III) Triose phosphate

(c) (I) PGA (II) Triose phosphate (III) RuBP

(d) (I) RuBP (II) PGA (III) Triose phosphate

2. The diagram represents the Calvin cycle.

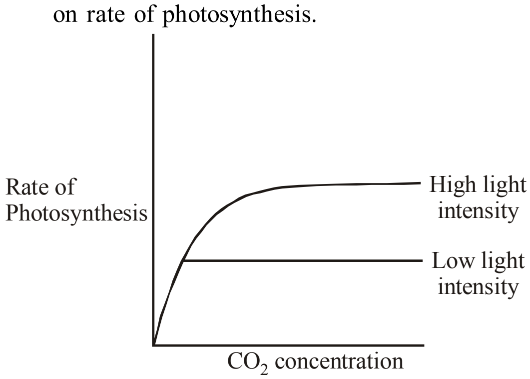


At which stage is CO_2 incorporated?

(a) P (b) Q

(c) R (d) S

3. The diagram given below shows the relation between light intensity and CO_2 concentration on rate of photosynthesis.



Which of the following explains the diagram correctly?

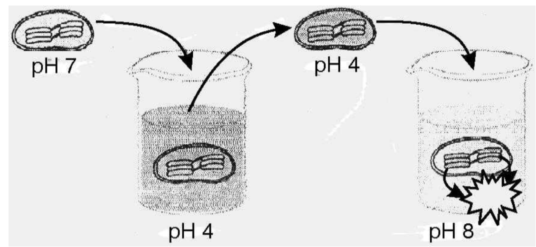
(a) At higher light intensity, gradually the rate does not show further increase as the light independent reaction involving CO_2 becomes rate limiting

(b) light is rarely a limiting factor in nature

(c) Photosynthesis is independent of light intensity

(d) Increase in incident light beyond a point causes the breakdown of chlorophyll & a decrease in photosynthesis.

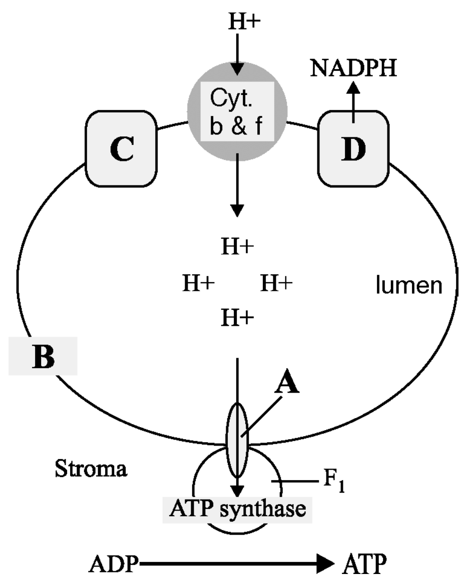
4. The diagram below represents an experiment with isolated chloroplasts. The chloroplasts were first made acidic by soaking them in a solution at pH 4. After the thylakoid space reached pH 4, the chloroplasts were transferred to a basic solution at pH 8. The chloroplasts are then placed in the dark. Which of these compounds would you expect to be produced?



(a) ATP (b) NAD

(c) G_3P (d) $C_6H_{12}O_6$

5. The diagram below shows ATP synthesis through chemiosmosis.



Which option shows the correct labelling of A, B, C and D in the diagram ?

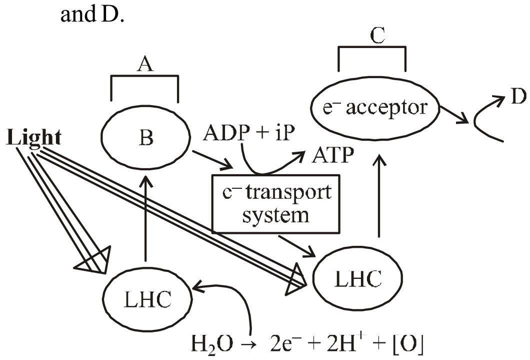
(a) A - F_1; B - Thylakoid membrane, C - Photosystem (I); D - Photosystem (II)

(b) A - F_0; B - Thylakoid membrane, C - Photosystem (I); D - Photosystem (II)

(c) A - F_1; B - Thylakoid membrane,
C - Photosystem (II); D - Photosystem (I)

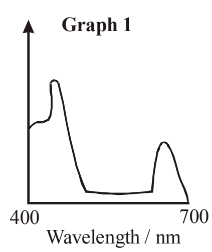
(d) A - F_0; B - Thylakoid membrane,
C - Photosystem (II); D - Photosystem (I)

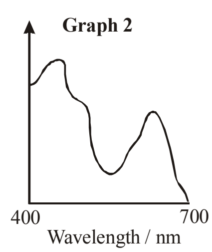
6. Given below is the pathway of light reaction. Identify the given blanks indicated by A, B, C and D.

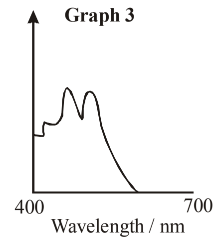


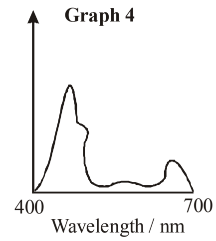
	A	B	C	D
(a)	P 700	H^+ acceptor	P680	$NADP^+$
(b)	Photosystem I	e^- acceptor	Photosystem II	$NADPH_2$ + ATP
(c)	Photosystem II	H^+ acceptor	P700	NADPH
(d)	Photosystem II	e^- acceptor	Photosystem I	NADPH + H^+

7. Three of the graphs below show the absorption spectra of photosynthetic pigments. One graph shows the action spectrum of photosynthesis for a plant containing the pigments. All the X axis show wavelength. Three of Y axis show light absorption. One Y axis shows the rate photosynthesis.



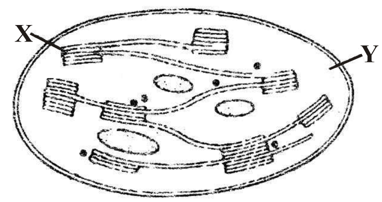






	Chlorophyll *a*	Absorption Chlorophyll *b*	Spectra Carotenoids	Action Spectrum
(a)	1	4	3	2
(b)	2	1	3	4
(c)	2	4	3	1
(d)	3	2	4	1

8. Which one of the following correctly identifies X and Y and and their functions in the given figure of chloroplast ?



	X		Y	
	Structure	**Function**	**Structure**	**Function**
(a)	Grana	Photolysis of water	Stroma	CO_2 fixation
(b)	Grana	CO_2 fixation	Stroma	Photolysis of water
(c)	Stroma	Photolysis of water	Grana	CO_2 fixation
(d)	Stroma	CO_2 fixation	Lamellae	Photolysis of water

Assertion/ Reason :

DIRECTIONS (Qs. 1-12): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.

(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.

(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** 6 molecules of CO_2 and 12 molecules of $NADPH^+ + H^+$ and 18 ATP are used to form one hexose molecule.
Reason : Light reaction results in formation of ATP and $NADPH_2$.

2. **Assertion :** There is a decrease in photosynthesis, if the photosynthetic cells are illuminated by light of P680 nm or more wavelength.
Reason : In red drop phenomenon the rate of photosynthesis decreases.

3. **Assertion :** Cyclic pathway of photosynthesis first appeared in some eubacterial species.
Reason : Oxygen started accumulating in the atmosphere after the non-cyclic pathway of photosynthesis evolved.

4. **Assertion :** Cyclic photophosphorylation synthesizes ATP.
Reason : ATP synthesize in cyclic photophosphorylation is not associated with NADPH formation.

5. **Assertion :** Each molecule of ribulose-1, 5-bisphosphate fixes one molecule of CO_2.
Reason : Three molecules of NADPH and two ATP are required for fixation of one molecule of CO_2.

6. **Assertion :** C_4 Photosynthetic pathway is more efficient than the C_3 pathway.
Reason : Photorespiration is suppressed in C_4 plants.

7. **Assertion :** The movement of photosynthates is unidirectional.
Reason : Movement of photosynthates occurs with the water.

8. **Assertion :** The concentration of O_2 in the atmosphere is inhibitory to photosynthesis.
Reason : Oxygen inhibitory effect is due to Warburg effect.

9. **Assertion :** CAM plants lack structural compartmentation of leaf, as found in C_4 plants.
Reason : Stomata of CAM plants are open during the day.

10. **Assertion :** Plants utilizing first RuBP in CO_2 fixations are called C_3 plants.
Reason : Plants utilizing first PEP in CO_2 fixations are called C_4 plants.

11. **Assertion :** CO_2 is transported from mesophyll cells to bundle sheath of chloroplasts in C_4 plants.
Reason : RuBP is called initial acceptor of CO_2 in C_2 plants.

12. **Assertion :** Plants utilize 5-10 of the absorbed water in photosynthesis.
Reason : Reduced leaf hydration decrease the photosynthesis

Matching Based Questions :

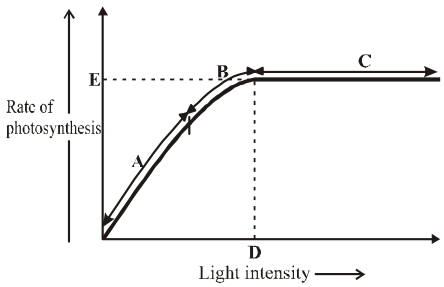
DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column-I	Column-II
(A) Priestley	I.. determined the action spectrum of chlorophyll
(B) Jan Ingenhousz	II. provided evidence that in green parts of plant glucose is made & stored as starch
(C) Sachs	III. plants purify air only in presence of light
(D) Engelmann	IV. demonstrated that photosynthesis is essentially a light-dependent reaction
(E) Niel	V. revealed the essential role of air in the growth of plants

(a) A – V; B – III; C – II; D – I; E – IV
(b) A – V; B – I; C – II; D – III; E – IV
(c) A – V; B – I; C – IV; D – III; E – II
(d) A – V; B – I; C – III; D – IV; E – II

2.



	Column-I		Column-II
(A)	Limiting factor in region A	I.	Some factor other than light intensity is becoming the limiting factor
(B)	B represents to	II.	Light is no longer limiting factor
(C)	C represents to	III.	Light intensity
(D)	D represents to	IV.	Maximum rate of photosynthesis
(E)	E represents to	V.	Saturation point for light intensity

The correct option is

(a) A – I; B – II; C – III; D – IV; E – V
(b) A – III; B – I; C – II; D – V; E – IV
(c) A – IV; B – II; C – V; D – III; E – I
(d) A – V; B – IV; C – III; D – II; E – I

3.

	Column-I		Column-II
(A)	Emerson effect	I.	C_4 Cycle
(B)	Hill reaction	II.	Photolysis
(C)	Calvin Cycle	III.	C_3 Cycle
(D)	Hatch & Slack cycle	IV.	Photosystem I & II

(a) A - I; B - II; C - III; D - IV
(b) A - I; B - III; C - IV; D -I
(c) A - III; B - IV; C - I; D- II
(d) A -IV; B - II; C- III; D - I

4.

	Column-I		Column-II
(A)	Grana of chloroplast	I.	Kreb's cycle
(B)	Stroma of chloroplast	II.	Light reaction
(C)	Cytoplasm	III.	Dark reaction
(D)	Mitochondrial matrix	IV.	Glycolysis

(a) A – IV; B – III; C – II; D – I
(b) A – I; B – II; C – IV; D – III
(c) A – IV; B – I; C – III; D – II
(d) A – II; B – III; C – IV; D – I

5.

	Column - I		Column - II
(A)	Oxygen evolving complex ferric oxalate	I.	Pigments
(B)	Proton gradient concentration	II.	High oxygen
(C)	Absorb light at specific wavelengths.	III.	ATP synthesis
(D)	Photorespiration	IV.	Photolysis of water

(a) A-IV; B-III; C-I; D-II
(b) A-IV; B-I; C-III; D-II
(c) A-II; B-I; C-IV; D-III
(d) A-II; B-IV; C-III; D-I

Critical Thinking Type Questions :

1. In Non-cyclic reactions of Photosynthesis, electrons from chlorophyll molecules in Photosystem-I are used in the formation of NADPH. What is the source of such electrons?
(a) From light
(b) From NADPH
(c) From Photosystem-I
(d) From Photosystem-II, which splits water molecule

2. To make 100 molecules of glucose, how many molecules of ATP & NADPH are required?
(a) 1800 and 1200 respectively
(b) 1200 and 1800 respectively
(c) 1800 and 600 respectively
(d) 200 and 600 respectively

3. Chloroplasts are disrupted and the stroma separated from the lamellae. The isolated stroma will fix CO_2 if it is supplied with
(a) O_2
(b) RuBisCO
(c) light
(d) ATP + NADPH

4. The correct sequence of Calvin cycle is
(a) Decarboxylation → Oxidation → Regeneration
(b) Decarboxylation → Regeneration → Oxidation
(c) Carboxylation → Reduction → Regeneration
(d) Carboxylation → Reduction → Regeneration

5. The reactions of Calvin cycle not dependent on light, but they usually do not occur at night - Why?
(a) Night is often too cold for these reactions to occur
(b) CO_2 concentration in night is too high for these reactions to occur
(c) Plants usually open stomata at night
(d) Calvin cycle independent on the products of light reaction

6. Which one is correct for C_4 plants?

	Mesophyll		Bundle Sheath	
(a)	PEPcase	C_4-Cycle	RuBisCO	C_3-Cycle
(b)	PEPcase	Calvin Cycle	RuBisCO	C_4-Cycle
(c)	RuBisCO	C_4-Cycle	PEPcase	C_3-Cycle
(d)	RuBisCO	C_2-Cycle	PEPcase	C_3-Cycle

7. In an experiment, the CO_2 available to a C_4 plant was labelled with a radioactive isotope and the amount of radioactivity in the chloroplast was measured. As photosynthesis preceeded, in which of the following molecules did the radioactivity first appear?
(a) Oxaloacetic acid (b) PEP
(c) Malic acid (d) RuBP

8. Which of the following plant species have highest photosynthetic yield?
(a) Species that perform photorespiration
(b) Species possessing C_3 pathway
(c) Species possessing C_4 pathway
(d) Same for all

9. According to Blackman's law of limiting factor, at any given time, Photosynthesis can be limited by
(a) light
(b) CO_2 concentration
(c) both light and CO_2 concentration
(d) either by light or by CO_2

10. During monsoon, the rice crop of eastern states of India shows lesser yield due to limiting factor of
(a) CO_2
(b) light
(c) temperature
(d) water

11. A student sets up an experiment on photosynthesis as follows:
He takes soda water in a glass tumbler and add chlorophyll extracts into the contents and keeps the tumbler exposed to sunlight hoping that he has provided necessary ingredients for photosynthesis to proceed (viz., CO_2, H_2O, chlorophyll and light). What do you think what will happen after, say, a few hours of exposure of light?
(a) Photosynthesis will take place and glucose will be produced.
(b) Photosynthesis will take place and starch will be produced which will turn the mixture turbid.
(c) Photosynthesis will not take place because CO_2 dissolved in soda water escapes into the atmosphere.
(d) Photosynthesis will not take place because intact chloroplasts are needed for the process.

12. The electrons that are released by the Photolysis of water during non-cyclic Photophosp-horylation, ultimately end up in
(a) Glucose
(b) ATP
(c) H_2O
(d) NADPH

14 Respiration in Plants

Fill in the Blanks :

1. Cellular respiration includes the various pathways by which carbohydrates and other metabolites are broken down with the consecutive buildup of __________.
2. Glycolysis occurs in the________ and produces________, which in the presence of O_2 enters the __________.
3. When oxygen is not available to a muscle cell, NADH formed during glycolysis does not pass electrons to the ETS. Instead, it passes hydrogen atoms to __________.
4. In the fermentation of one glucose molecule, there is a net gain of______________ molecules of ATP.
5. Acceptor of Acetyl Co-A in Kreb's cycle is __________.
6. Total number of ATP consume during Kreb's cycle is _____.
7. In the Electron transport system, the final acceptor of proton is __________.
8. Terminal cytochrome of respiratory chain which donates electrons to oxygen is __________.

True / False :

1. Autotrophs can produce their own food but must obtain energy from it by glycolysis & cellular respiration.
2. Fermentation usually occurs under aerobic conditions.
3. The conversion of pyruvic acid to acetyl CoA is catalysed by pyruvic dehydrogenase.
4. ATP can be synthesized through substrate level phosphorylation, photophosphorylation and oxidative phosphorylation.
5. The proton-motive force is the establishment of proton gradients and electrochemical potentials across the inner membrane.
6. Proton-motive force is essential for back flow of H^+ from outer chamber of matrix of mitochondria through proton channel (F_0) of $F_0 - F_1$ particle to produce ATP.
7. Enzymes for glycolysis are found in cytoplasm. It is common in aerobic/anaerobic respiration.
8. The scheme of glycolysis was given by Gustav Embden, Otto Morrison, and J. Parnas and is often referred to as the EMP pathway.

Conceptual MCQs :

1. Out of 36 ATP molecules produced per glucose molecule during respiration
   (a) 2 are produced outside glycolysis and 34 during respiratory chain
   (b) 2 are produced outside mitochondria and 34 inside mitochondria
   (c) 2 during glycolysis and 34 during Krebs cycle
   (d) all are formed inside mitochondria
2. Respiratory substrate yielding maximum number of ATP molecule is
   (a) ketogenic amino acids
   (b) glucose
   (c) amylose
   (d) glycogen
3. RQ is ratio of
   (a) CO_2 produced to substrate consumed
   (b) CO_2 produced to O_2 consumed
   (c) oxygen consumed to water produced
   (d) oxygen consumed to CO_2 produced

4. Fermentation is anaerobic production of
(a) protein and acetic acid
(b) alcohol, lactic acid or similar compounds
(c) ethers and acetones
(d) alcohol and lipoproteins

5. In alcoholic fermentation
(a) oxygen is the electron acceptor
(b) triose phosphate is the electron donor while acetaldehyde is the electron acceptor
(c) triose phosphate is the electron donor while pyruvic acid is the electron acceptor
(d) there is no electron donor

6. The overall goal of glycolysis, Krebs cycle and the electron transport system is the formation of
(a) ATP in one large oxidation reaction
(b) sugars
(c) nucleic acids
(d) ATP in small stepwise units

7. In Krebs cycle FAD participates as electron acceptor during the conversion of
(a) succinyl CoA to succinic acid
(b) α-ketoglutarate to succinyl CoA
(c) succinic acid to fumaric acid
(d) fumaric acid to malic acid

8. The commonest living, which can respire in the absence of O_2 is –
(a) fish (b) yeast
(c) potato (d) chlorella

9. Respiration in plants
(a) occurs only during day
(b) results in the formation of vitamins
(c) is characteristic of all living cells
(d) often requires CO_2

10. What is the energy currency of a cell ?
(a) DNA (b) RNA
(c) ATP (d) Minerals

11. The end product of glycolysis is
(a) citric acid
(b) glyceraldehyde
(c) phosphoglyceraldehyde
(d) pyruvic acid

12. A very important feature of respiration is that –
(a) it liberates energy
(b) it provides O_2
(c) utilize CO_2
(d) synthesize complex compounds

13. Anaerobic respiration takes place in –
(a) ribosome (b) nucleus
(c) cytoplasm (d) vacuole

14. Conversion of pyruvic acid into ethyl alcohol is mediated by -
(a) phosphatase
(b) dehydrogenase
(c) decarboxylase & dehydrogenase
(d) catalase

15. The first compound of TCA cycle is –
(a) oxalo succinic acid (b) oxaloacetic acid
(c) citric acid (d) cis aconitic acid

16. Aerobic respiratory pathway is appropriately termed:
(a) parabolic (b) amphibolic
(c) anabolic (d) catabolic

17. The energy - releasing metabolic process in which substrate is oxidised without an external electron acceptor is called:
(a) glycolysis (b) fermentation
(c) aerobic respiration (d) photorespiration

18. Which of the metabolites is common to respiration mediated breakdown of fats, carbohydrates and proteins?
(a) Fructose 1, 6 - bisphosphate
(b) Pyruvic acid
(c) Acetyl CoA
(d) Glucose - 6 - phosphate

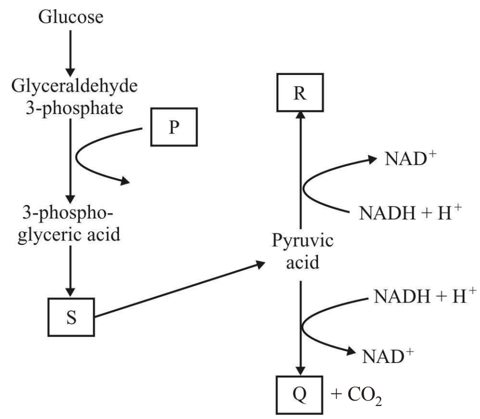
19. In the electron transport chain during terminal oxidation, the cytochrome, which donates electrons to O_2 is
(a) Cytochrome-b (b) Cyto-C
(c) Cyto-a_3 (d) Cyto.-f

20. An enzymes of TCA cycle are located in the mitochondrial matrix except one which is located in inner mitochondrial membrane in eukaryotes and in cytosol in prokaryotes. This enzyme is
(a) Succinate dehydrogenase
(b) Lactate dehydrogenase
(c) Isocitrate dehydrogenase
(d) Malate dehydrogenase

21. $2(C_{51}H_{98}O_6) + 145O_2 \rightarrow 102CO_2 + 98H_2O +$ Energy
The RQ of above reaction is
(a) 1 (b) 0.7
(c) 1.45 (d) 1.62

Diagram Based Questions :

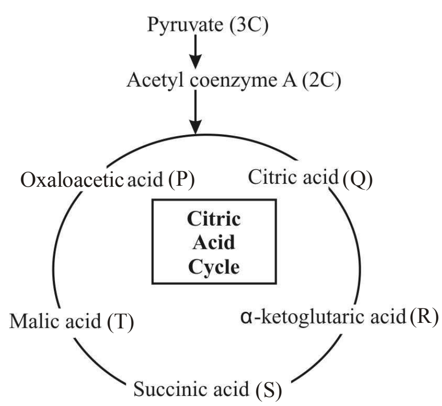
1. The given figure shows the few steps of the pathway are indicated by P, Q, R and S major pathway of anaerobic respiration.



Identify P, Q, R and S.

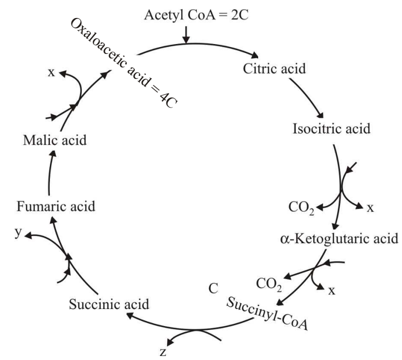
	P	Q	R	S
(a)	NAD^+	Ethanol	Lactic acid	PEP
(b)	Ethanol	NAD^+	Lactic acid	ATP
(c)	Lactic acid	Ethanol	Glucose	ADP
(d)	NAD	Lactic acid	Ethanol	DHAP

2. Refer the figure of citric acid cycle and choose the correct combination of labelling (P, Q, R, S and T) the number of carbon compounds in the substrate molecules, involved in the given figure.



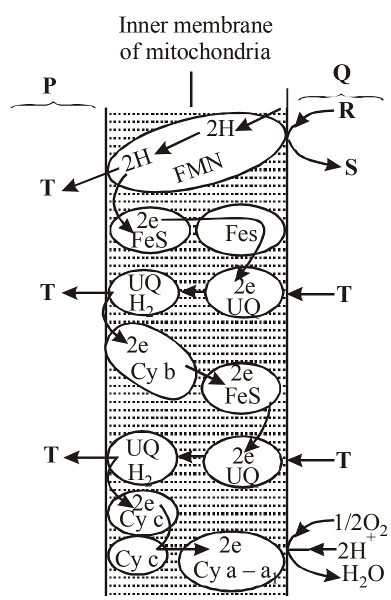
(a) (P) 4C; (Q) 6C; (R) 5C; (S) 4C; (T) 4C
(b) (P) 6C; (Q) 5C; (R) 4C; (S) 3C; (T) 2C
(c) (P) 2C; (Q) 5C; (R) 6C; (S) 4C; (T) 4C
(d) (P) 4C; (Q) 6C; (R) 4C; (S) 4C; (T) 5C

3. Refer the figure and identify X, Y and Z



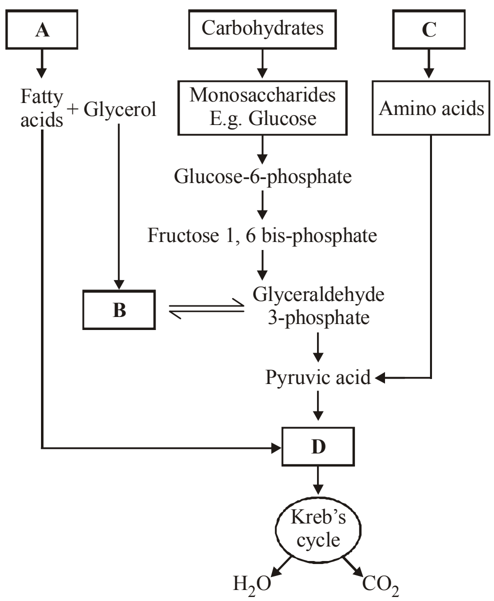
	X	Y	Z
(a)	GTP	$NADH_2$	CO_2
(b)	$FADH_2$	$NADH_2$	GTP
(c)	$NADH_2$	$FADH_2$	GTP
(d)	CO_2	$NADH_2$	ADP

4. In the given figure of electron transport chain - identify P, Q, R and S.



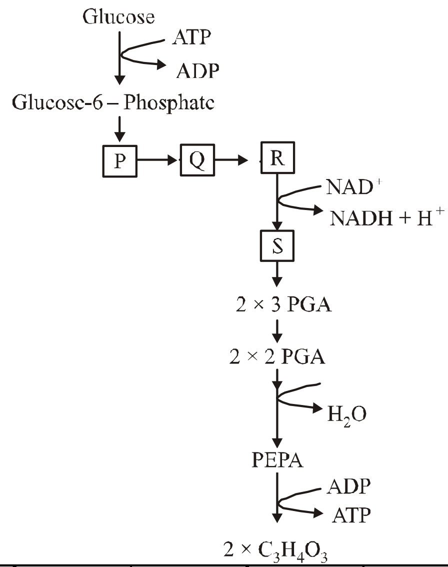
(a) P - Matrix, Q - Outer membrane, R - RMNH$_2$, S - NADH$_2$, T - 2H
(b) P - Inter membrane space, Q - Matrix, R - NADH + H$^+$, S - NAD$^+$, T - 2H$^+$
(c) P - Outer membrane, Q - Cristae, R - NAD, S - NADH + H$^+$, T - H
(d) P - Cristae, Q - Outer chamber, R - NADH+ H$^+$, S - NAD, T - 2H$^+$

5. The given figure represents the interelationship among metabolic pathways showing the respiration mediated breakdown of different organic molecules to CO_2 and H_2O. Now identify A to D.



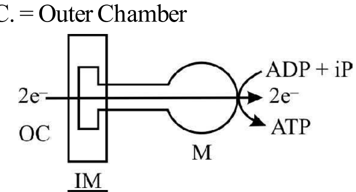
	A	B	C	D
(a)	Protein	Acetyl CoA	Fat	DHAP
(b)	Fat	DHAP	Proteins	Acetyl CoA
(c)	Acetyl CoA	Fat	DHAP	Protein
(d)	Fat	DHAP	Acetyl CoA	Protein

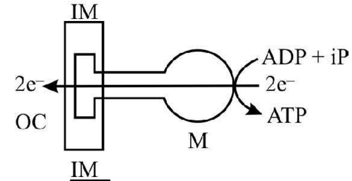
6. Refer the figure of glycolysis and identify the products formed at P, Q, R and S.

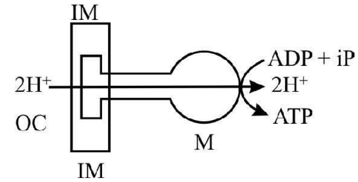


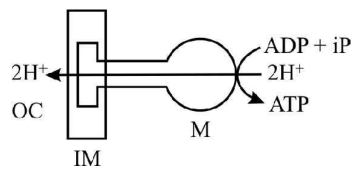
	P	Q	R	S
(a)	1,3 di PGA	3 PGAld	Fr.1,6 di P	Fr. 6 P
(b)	3 PGA1d	1,3 di PGA	Fr. 1,6 di P	Fr.6 P
(c)	Fr. 1,6 di P	Fr. 6 P	3 PGAld	1,3 di PGA
(d)	Fr.6 P	Fr. 1,6 di P	3 PGAld	1,3 di PGA

7. Which of the following diagram represents ATP synthesis in mitochondria through chemiosmosis?
I.M. = Inner membrane;
M = Matrix ;
O.C. = Outer Chamber

(a) 

(b) 

(c) 

(d) 

Assertion/ Reason :

DIRECTIONS (Qs. 1-10): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Glycolysis occurs in cytoplasm.
Reason : Enzymes for glycolysis are found in cytoplasm. It is common in aerobic/anaerobic respiration.

2. **Assertion :** The inner membrane of mitochondria contains systems involving electron transport.
Reason : The mitochondrial matrix contains enzymes of Kreb's cycle.

3. **Assertion :** The product of the first reaction of the Kreb's cycle is citric acid, a six carbon compound.
Reason : The first reaction of the Kreb's cycle is the condensation of acetyl CoA with oxaloacetate.

4. **Assertion :** Substrate level phosphorylation is present in glycolysis.
Reason : Substrate level phosphorylation causes synthesis of ATP.

5. **Assertion :** One way of indicating the ATP yield from oxidative phosphorylation is the P/O ratio.
Reason : The cell stores 40% of the chemical energy.

6. **Assertion :** F_1 particles are present in the inner mitochondrial membrane.
Reason : An electron gradient formed on the inner mitochondrial membrane, forms ATP.

7. **Assertion :** In alcoholic fermentation, the hexose molecule is converted into glucose and fructose.
Reason: Alcoholic fermentation is anaerobic respiration brought about by enzyme zymase.

8. **Assertion :** In electron transport chain, there is a loss of energy at each step.
Reason : At each step of ETC, there are electron carriers.

9. **Assertion :** Both hexokinase and glucokinase require divalent cation Mg^{++} or Mn^{++}.
Reason : The divalent cations act as catalysts.

10. **Assertion :** Cytochromes are a group of copper containing electron transferring proteins.
Reason : The terminal cytochrome reacts with oxygen.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I		Column-II
(A)	Inner mitochondrial membrane	I.	Krebs cycle
(B)	Pyruvic acid is converted into CO_2 and ethanol.	II.	ETC
(C)	Cytoplasm	III.	Fermentation
(D)	Mitochondrial matrix	IV.	Glycolysis

(a) A – IV; B – III; C – II; D – I
(b) A – I; B – II; C – IV; D – III
(c) A – II; B – I; C – III; D – IV
(d) A – II; B – III; C – IV; D – I

2.

	Column - I		Column - II
A.	Complex I	I.	Cytochrome bc_1 complex
B.	Complex II	II.	NADH dehydrogenase
C.	Complex III	III.	ATP synthetase
D.	Complex IV	IV.	$FADH_2$ dehydrogenase
E.	Complex V	V.	Cytochrome c oxidase

	A	B	C	D	E
(a)	III	V	I	IV	II
(b)	II	V	I	IV	III
(c)	II	IV	I	V	III
(d)	IV	I	II	V	III

3.

	Column - I		Column - II
(A)	4C compound	I.	Acetyl CoA
(B)	2C compound	II.	Pyruvate
(C)	5C compound	III.	Citric acid
(D)	3C compound	IV.	α- ketoglutaric acid
		V.	Malic acid

(a) A – II; B – V; C – III; D – I
(b) A – V; B – I; C – IV; D – II
(c) A – III; B – I; C – IV; D – II
(d) A – V; B – III; C – I; D – II

4.

	Column I		Column II
(A)	Grana of chloroplast	I.	Krebs cycle
(B)	Stroma of chloroplast	II.	Light reaction
(C)	Cytoplasm	III.	Dark reaction
(D)	Mitochondrial matrix	IV.	Glycolysis

(a) A $\rightarrow$ (IV); B $\rightarrow$ (III); C $\rightarrow$ (II); D $\rightarrow$ (I)
(b) A $\rightarrow$ (I); B $\rightarrow$ (II); C $\rightarrow$ (IV); D $\rightarrow$ (III)
(c) A $\rightarrow$ (II); B $\rightarrow$ (I); C $\rightarrow$ (III); D $\rightarrow$ (IV)
(d) A $\rightarrow$ (II); B $\rightarrow$ (III); C $\rightarrow$ (IV); D $\rightarrow$ (I)

Critical Thinking Type Questions :

1. Energy accumulate in ATP in
(a) disulphide bond
(b) hydrogen bonds
(c) high energy phosphate bond
(d) ester bond

2. What is the function of molecular oxygen in cellular respiration?
(a) It causes the breakdown of citric acid.
(b) It combines with glucose to produce carbon dioxide.
(c) It combines with carbon from organic molecules to produce carbon dioxide.
(d) It combines with hydrogen from organic molecules to produce water.

3. During glycolysis, glucose split into
(a) two pyruvic acid molecules.
(b) two coenzyme A molecules.
(c) two lactic acid molecules.
(d) one lactic acid plus one ethanol molecule.

4. Which one is correct sequence in glycolysis?
(a) G 6-P $\rightarrow$ PEP $\rightarrow$ 3-PGAL $\rightarrow$ 3-PGA
(b) G 6-P $\rightarrow$ 3-PGAL $\rightarrow$ 3-PGA $\rightarrow$ PEP
(c) G 6-P $\rightarrow$ PEP $\rightarrow$ 3-PGA $\rightarrow$ 3-PGAL
(d) G 6-P $\rightarrow$ 3-PGA $\rightarrow$ 3-PGAL $\rightarrow$ PEP

5. Which of the following is correct sequence in Kreb's cycle?
(a) Isocitric acid $\rightarrow$ Oxalosuccinic acid $\rightarrow$ α-ketoglutaric acid
(b) Oxalosuccinic acid $\rightarrow$ Isocitric acid $\rightarrow$ α-ketoglutaric acid
(c) α-ketoglutaric acid $\rightarrow$ Isocitric acid $\rightarrow$ Oxalosuccinic acid
(d) Isocitric acid $\rightarrow$ α-ketoglutaric acid $\rightarrow$ Oxalosuccinic acid

6. In glycolysis, there is one step where NADH + H^+ is formed from NAD^+, this is when 3-phosphoglyceraldehyde (PGAL) is converted to 1, 3-bisphosphyglycerate (BPGA). This reaction shows
(a) oxidative dehydrogenation
(b) oxidative phosphorylation
(c) oxidative dehydration
(d) oxidation reduction

7. If hexokinase, an enzyme that catalyzes the first step reaction in glycolysis is blocked then what will be its impact on glycolytic pathway ?
(a) Glycolysis will speed up.
(b) Glycolysis will slow down.
(c) Glycolysis will stop.
(d) Glycolysis will occurs normally.

8. How many ATP molecules could maximally be generated from one molecule of glucose, if the complete oxidation of one mole of glucose to CO_2 and H_2O yields 686 kcal and the useful chemical energy available in the high energy phosphate bond of one mole of ATP is 12 kcal ?
(a) Thirty (b) Fifty seven
(c) One (d) Two

9. How many molecules of ATP are produced during glycolysis?
(a) 2 (b) 4
(c) 6 (d) 8

10. The reasons for the involvement of different enzyme in each step of glycolysis is that
(a) each step occurs in a different compartment of a cell.
(b) each step occurs in a different cells.
(c) each step involves a different chemical reaction.
(d) each step involves a different change in potential energy.

11. For bacteria to continue growing rapidly when they are shifted from an environment containing O_2 to an anaerobic environment, they must
(a) produce more ATP per mole of glucose during glycolysis.
(b) produce ATP during oxidation of glucose.
(c) increase the rate of glycolysis.
(d) increase the rate of TCA cycle.

12. In alcoholic fermentation, NAD^+ is produced during the
(a) reduction of acetyldehyde to ethanol.
(b) oxidation of glucose.
(c) oxidation of pyruvate to acetyl coA.
(d) hydrolysis of ATP to ADP.

13. Fermentation takes place
(a) under anaerobic conditions in many prokaryotes and unicellular eukaryotes.
(b) under aerobic conditions in many prokaryotes and unicellular eukaryotes.
(c) under anaerobic conditions in all prokaryotes and unicellular eukaryotes.
(d) under aerobic conditions in all prokaryotes and unicellular eukaryotes.

14. In the conversion of pyruvic acid to acetyl coenzyme A, NAD^+ is
(a) oxidized
(b) reduced
(c) broken into one-carbon units
(d) isomerized

15. Initial step of TCA cycle to yield citric acid starts with the condensation of
(a) acetyl group with OAA & H_2O & catalyzed by the enzyme citrate synthase.
(b) acetyl group with pyruvate & H_2O & catalysed by the enzyme citrates synthase.
(c) acetyl group with OAA & H_2O & is independent of the enzyme.
(d) none of the above.

15

Plant Growth and Development

Fill in the Blanks :

1. The method that renders the seed coat permeable to water so that embryo expansion is not physically retarded is called _______ .
2. In arithmetic growth rate, when length of the organ is plotted against time, the nature of graph curve will be _______ .
3. The ability of plant to follow different pathways and produce different structures in response to environment and phases of life is termed as _______ .
4. The hormones which was first isolated from human urine is _______ .
5. Gibberellin was first extracted from _______ .
6. Dwarfness can be controlled by treating the plant with _______ .
7. Hormone responsible for bolting is _______ .
8. The movement of plant and its parts in response to light is called _______ .
9. Effect of low temperature which shortens vegetative period and hasten flowering is called _______.

True/ False :

1. Oxygen helps in releasing metabolic energy essential for growth activities.
2. IAA, NAA, IAB, 2, 4-D and 2, 4, 5-T are synthetic auxins.
3. Long day plants flower if the night length is shorter than a critical period.
4. Vernalisation refers to the promotion of flowering by a period of low temperature.
5. 17,500 new cells are produced per hour by a single maize root apical meristem.
6. With the help of length, growth of pollen tube is measured.
7. Cells in a watermelon may increase in size by upto 3,50,000 times.
8. Gibberellins are responsible for immature falling of leaves.

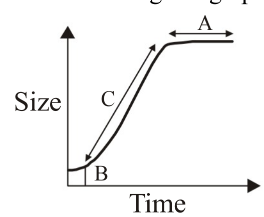
Conceptual MCQs :

1. Phytochrome is involved in
   (a) phototropism
   (b) photorespiration
   (c) photoperiodism
   (d) geotropism
2. What will be the effect on phytochrome in a plant subjected to continuous red light?
   (a) Level of phytochrome decreases
   (b) Phytochrome is destroyed
   (c) Phytochrome synthesis increases
   (d) Destruction and synthesis of phytochrome remain in equilibrium.
3. The method that renders the seed coat permeable to water so that embryo expansion is not physically retarded is
   (a) vernalization
   (b) stratification
   (c) denudation
   (d) scarification
4. What reason will you assign for coconut milk used in tissue culture?
   (a) Gibberellins (b) Cytokinins
   (c) Auxins (d) Ethylene
5. Cut or excised leaves remain green for long if induced to root or dipped in
   (a) gibberellins (b) cytokinins
   (c) auxins (d) ethylene
6. Highest auxin concentration occurs
   (a) in growing tips
   (b) in leaves
   (c) at base of plant organs
   (d) in xylem and phloem

7. In short day plants, flowering is induced by
   (a) photoperiod less than 12 hours
   (b) photoperiod below a critical length and uninterrupted long night
   (c) long night
   (d) short photoperiod and interrupted long night
8. "Foolish seedling" disease of rice led to the discovery of
   (a) ABA (b) 2,4-D
   (c) IAA (d) GA
9. One of the synthetic auxin is:
   (a) IAA (b) GA
   (c) IBA (d) NAA
10. Movement of auxin is
   (a) centripetal (b) basipetal
   (c) acropetal (d) both b and c
11. Apical dominance means –
   (a) suppression of growth of apical bud by axillary buds
   (b) suppression of growth of axillary buds by the presence of apical bud.
   (c) stimulation of growth of axillary buds by removal of apical bud
   (d) inhibition of growth of axillary buds by removal of apical bud.
12. Plant hormone associated with climacteric respiration is
   (a) auxin (b) cytokinin
   (c) ethylene (d) gibberellin
13. The maximum growth rate occurs in
   (a) exponential phase (b) stationary phase
   (c) senescent phase (d) lag phase
14. Phototropic curvature is the result of uneven distribution of:
   (a) gibberellin (b) phytochrome
   (c) cytokinins (d) auxin
15. Coiling of garden pea tendrils around any support is an example of:
   (a) thigmotaxis (b) thigmonasty
   (c) thigmotropism (d) thermotaxis
16. Through their effect on plant growth regulators, what do the temperature and light control in the plants?
   (a) Apical dominance
   (b) Flowering
   (c) Closure of stomata
   (d) Fruit elongation
17. Which one of the following generally acts as an antagonist to gibberellins?
   (a) Zeatin (b) Ethylene
   (c) ABA (d) IAA
18. Vernalization stimulates flowering in
   (a) zamikand (b) turmeric
   (c) carrot (d) ginger
19. Which one of the following is not used for *ex-situ* plant conservation ?
   (a) Seed banks
   (b) Shifting cultivation
   (c) Botanical Gardens
   (d) Field gene banks
20. Which of the following plant is LDP?
   (a) *Xanthium* (b) Soyabean
   (c) Wheat (d) Tobacco

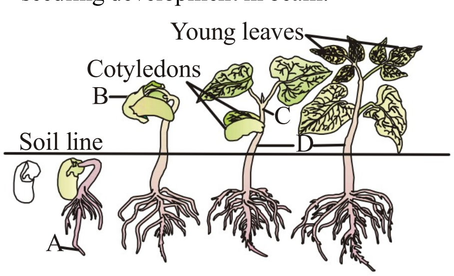
Diagram Based Questions :

1. The picture given below shows a graph drawn on the parameters of growth *versus* time. Identify A, B, C marked in the given graph.



	A	B	C
(a)	Exponential phase	Log phase	Stationary phase
(b)	Stationary phase	Lag phase	Log phase
(c)	Log phase	Stationary phase	Logarithmic phase
(d)	Log phase	Lag phase	Stationary phase

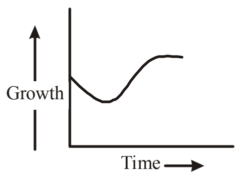
2. The given diagram represents the germination and seedling development in beam.

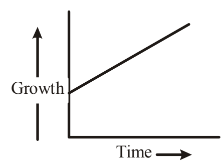


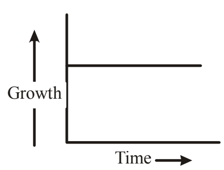
Identify A, B, C and D marked in the given figure.

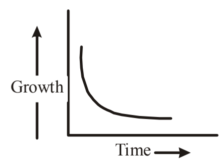
	A	B	C	D
(a)	Plumule	Cotyledons	Hypocotyl	Epicotyl
(b)	Radicle	Seed coat	Epicotyl	Hypocotyl
(c)	Hypocotyl	Cotyledons	Epicotyl	Root hair
(d)	Root hair	Cotyledons	Plumule	Hypocotyl

3. Which of the following shows the correct graph of arithmetic growth?

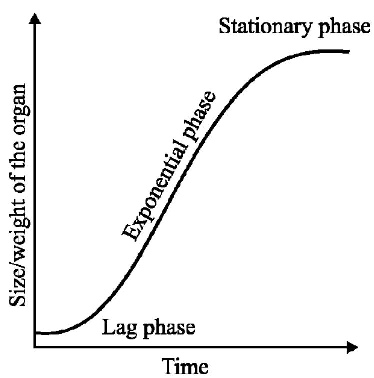
(a)


(b)


(c)


(d)


4. The graph given below shows a geometrical growth rate.



Which of the following statement regarding the above graph is incorrect?

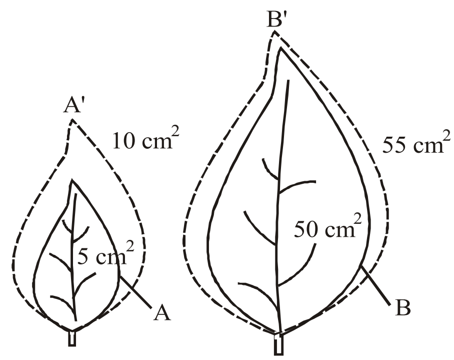
(a) The initial growth is slow, thereafter exponential phase and then stationary phase.

(b) A sigmoidal curve is a characteristic of living organism growing in a natural environment.

(c) With limited nutrient supply, the growth rate increases rapidly leading to a exponential phase.

(d) Geometrical growth is typical for all cells, tissues and organs of a plant.

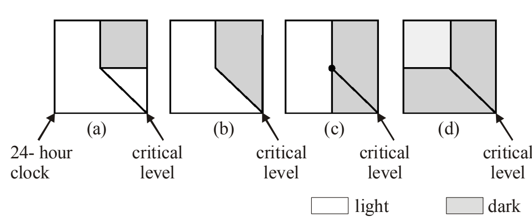
5. The given figure shows the comparison of growth rate of two leaves (A and B) over the period of one day. Both the leaves A and B have increased their area in a given time to produce A' and B' leaves respectively. If AGR = absolute growth rate and RGR = relative growth rate, then select the correct option.



Time = 1 day Time = 1 day

	A-Leaf		B-Leaf	
	AGR	**RGR**	**AGR**	**RGR**
(a)	1%	1	2%	2
(b)	100%	5	10%	5
(c)	5	100%	5	10%
(d)	0.5	100%	1.5	100%

6. Maryland Mammoth Tobacco is a short day plant. Its critical duration of darkness is 10 hours. Under which of the following conditions will Maryland Mammoth tobacco not flower ?



7. The following diagram shows four coleoptiles set up (I, II, III & IV) at the start of an experiment.

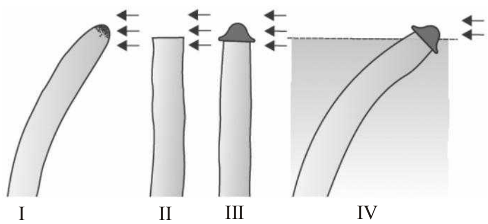


Fig : Experiment used to demonstrate that tip of the coleoptile is the source of auxin. Arrows indicate direction of light

Which two coleoptiles will both bend towards the light source?

(a) I and II (b) I and IV
(c) II and III (d) III and IV

Assertion/ Reason :

DIRECTIONS (Qs. 1-12): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Cytokinism are anti-senescent.
Reason : Effects of cytokinins in antagonistic to ethylene.
2. **Assertion :** Stratification of seeds may promote their germination.
Reason : Stratification promote gibberellin and cytokinins.
3. **Assertion :** The pigment which causes photoperiodic stimulus is called phytochrome.
Reason : Chemically phytochrome is a starch.
4. **Assertion :** Phototropism is a directional growth movement.
Reason : Phototrophic movement occur in the direction of light.
5. **Assertion :** Sigmoid growth curve consists of four parts.
Reason : Lag phase is called as grand phase of growth.
6. **Assertion :** Gibberellins induce flowering in long day plants.
Reason : Genetically tall plant become dwarf by application of Gibberellin.
7. **Assertion :** The apical bud is the only source of auxins.
Reason : Removal of apical bud promotes lateral bud growth.
8. **Assertion :** Ethylene cause climacteric ripening of fruits.
Reason : Climacteric fruits show a rise in respiration at the time of ripening.
9. **Assertion :** Dark period plays more important part in flowering than light period.
Reason : Flowering occurs in short-day plant if the dark period is interrupted by light break.
10. **Assertion :** Phytochrome exists in two forms P_r and P_{fr}.
Reason : P_r form stimulates and P_{fr} form inhibit flowering.
11. **Assertion :** Floral initiation is done by florigen.
Reason : Floring is translocated from flowers to leaves.
12. **Assertion :** Vernalization is a treatment to plant given artifically.
Reason : Vernalization is perceived by whole plant.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of* which *ONLY ONE is correct.*

1.

Column -I (Plant hormone)	Column -II (Function/other name)
(A) Zeatin	I. Flowering hormone
(B) Florigen	II. Synthetic auxin
(C) IBA	III. Cytokinin
(D) NAA	IV. Natural auxin

(a) A – III; B – IV; C – I; D – II
(b) A – II; B – I; C – IV; D – III
(c) A – I; B – II; C – III; D – IV
(d) A – III; B – I; C – IV; D – II

2. **Column -I (Growth Regulator)** — **Column -II (Action)**

Column -I (Growth Regulator)	Column -II (Action)
(A) Abscisic acid	I. Delays leaf senescence
(B) Ethylene	II. Inhibits seed germination
(C) Cytokinin	III. Herbicide
(D) Auxin	IV. Hastens fruit ripening

(a) A-II; B-IV; C-I; D-III.
(b) A-I; B-II; C-III; D-IV
(c) A-II; B-III; C-IV; D-I.
(d) A-II; B-I; C-III; D-IV

3.

Column -I	Column -II
(A) Auxin	I. Fruit ripening
(B) Cytokinins	II. Apical dominance
(C) Abscisic acid	III. Antagonist to GAs
(D) Ethylene	IV. Stomatal opening closing
	V. Growth of lateral buds

(a) A-IV; B-V; C-III; D-I
(b) A-II; B-IV; C-III, IV; D-I
(c) A-II; B-V; C-III, IV; D-I
(d) A-III, IV; B-V; C-II; D-I

4.

Column-I (Growth regulators)	Column-II (Processes)
(A) Auxin	I. Colouring test in lemon
(B) Gibberellin	II. Cell division test in plants
(C) Cytokinin	III. Avena curvature test
(D) Ethylene	IV. Dwarf corn test

(a) A – III; B – IV; C – II; D – I
(b) A – I; B – IV; C – II; D – III
(c) A – IV; B – III; C – I; D – II
(d) A – II; B – I; C – IV; D – III

5.

Column - I (Discovery)	Column - II (Name of scientists)
(A) Foolish seedling disease of rice	I. Cousins
(B) Crystallized the Kinetic	II. F.W. Went
(C) Release of ethylene gas	III. Skoog and Miller
(D) Bioassay of Auxin	IV. E. Kurosawa

(a) A – III; B – IV; C – I; D – II
(b) A – IV; B – III; C – II; D – I
(c) A – IV; B – III; C – I; D – II
(d) A – IV; B – I; C – III; D – II

Critical Thinking Type Questions :

1. Which of the following points is shown by cell at the root or shoot apex ?
(a) Rich in protoplasm, possesses large conspicuous triploid nucleus.
(b) Cell wall is cellulosic, primary in nature and with abundant plasmodesmata.
(c) Rich in protoplasm with large conspicuous nucleus.
(d) Both (b) and (c).

2. Maximal size in terms of wall thickening and protoplasmic modification are achieved by
(a) cells of divisional phase.
(b) cells of maturation phase.
(c) cells of elongation phase.
(d) cells of meristematic tissue.

3. Arithmetic growth is expressed as
(a) $L_t = L_0 + rt$ (b) $L_0 = L_0 + rt$
(c) $W_1 = W_0 e^{rt}$ (d) $W_0 = W_1 e^{rt}$

4. A sigmoidal curve is obtained in geometrical growth because
(a) it has lag, log and then stationary phase.
(b) one daughter cell remains meristematic while the other daughter cell differentiates and matures.
(c) of the effect of environment on mitosis.
(d) none of the above

5. Absolute growth rate is defined as the
(a) synthesis of new intercellular and extracellular materials.
(b) measurement & the comparison of total growth per unit time
(c) growth of the given system per unit time.
(d) increased growth per unit time.

6. The exponential growth can be expressed as $W_1 = W_0e^{rt}$. What is ‘r’ in the expression ?
(a) Relative growth rate and depends on final size.
(b) Absolute growth rate & depends on initial size.
(c) Relative growth and also referred to as efficiency index.
(d) None of the above

7. A primary root grows from 5 cm - 19 cm in a week. Calculate the relative growth rate over the period.
(a) 20% (b) 40%
(c) 60% (d) 80%

8. De-differentiation is
(a) regaining the lost capacity of division by living cells.
(b) the ability of plant to produce different structure in response to environment.
(c) the intrinsic factor affecting plant growth.
(d) none of the above.

9. Which of the following represents the correct sequence of the development process in a plant cell?
(a) Cell division $\rightarrow$ Elongation $\rightarrow$ Senescence $\rightarrow$ Maturation
(b) Meristematic cell $\rightarrow$ Maturation elongation $\rightarrow$ Death
(c) Cell division $\rightarrow$ Elongation $\rightarrow$ Maturation $\rightarrow$ Plasmatic growth
(d) Cell division $\rightarrow$ Differentiation $\rightarrow$ Maturation $\rightarrow$ Senescence

10. A phytohormones is
(a) an ion that alters turgor pressure.
(b) small molecules of diverse chemical composition.
(c) a pigment responds to environmental changes.
(d) a secondary metabolic compound.

11. Experiments done by Charles Darwin and his son on plant phototropism showed that
(a) auxin is produced in the tip of the coleoptile.
(b) the tip of the coleoptile is the light receptor of the plant.
(c) within coleoptiles, auxin moves laterally away from the source of the light.
(d) more cell elongation takes place on the shaded side of the plant.

12. Ethylene is used for
(a) retarding ripening of tomatoes.
(b) ripening of fruits.
(c) slowing down ripening of apples.
(d) both (b) and (c).

13. Skoog and Miller stimulated cell division in tobacco plants with degraded DNA. The active ingredient in stimulants, which resembles cytokinins, was modified
(a) adenine (b) auxin
(c) terpenes (d) carotenoids

14. Which hormone is used to induce rooting from cut end of the stem?
(a) Kinetin (b) Indole butyric acid
(c) GA_3 (d) Abscisic acid

15. Plant hormone which is translocated to other parts for growth of the plant is
(a) indole-3-acetic acid
(b) gibberellins
(c) cytokinins
(d) none of these

16 Digestion and Absorption

Fill in the Blanks :

1. Glucose, some amino acids and sodium are absorbed in to blood by _______ .
2. Enzyme trypsin is secreted by _______ .
3. _______ are needed in the diet as components of teeth and bone, regulators of acid-base balance and water balance, and parts of certain enzymes.
4. The number of salivary glands present in human beings is _______ .
5. Teeth of adult man, not present in milk dentition are _______ .
6. Milk protein is acted upon by a gastric enzyme in infant mammals. The enzyme is _______ .
7. Muscular contraction in alimentary canal is called _______.
8. The _______ is primarily a storage chamber within the digestive system, while the _______ reabsorbs water, ions, and generates the faeces.
9. Most of the chemical digestion of food in humans is completed in the _______ .
10. End product of protein digestion is _______ .
11. pH of saliva is _______ .

True/ False :

1. The nutrients are absorbed from the small intestine into the blood and move through the circulatory system to the body cells.
2. The body cells send nerve impulses indicating a lack of nutrients to the small intestine, and the small intestine sends the nutrients back to the cells.
3. Brunner's glands are submucosal.
4. Glisson's capsule is the connective tissue sheath of hepatic lobule.
5. Oxyntic cells in our stomach secrete the proenzyme pepsinogen.
6. Chylomicrons are small lipoprotein particles that are transported from intestine into blood capillaries.
7. Bile does not contain any digestive enzymes.
8. The large intestine is shorter than the small intestine.
9. Inside the small intestine, most of the water from the undigested food is absorbed by the body.

Conceptual MCQs :

1. Hydrolysis of phospholipids yields –
   (a) glycerol, phosphoric acid and fatty acids
   (b) glycerol, phosphoric acid and nitrogen base
   (c) glycerol & fatty acids
   (d) acetyl Co A
2. The food that gives more calories per unit mass of food is
   (a) protein
   (b) carbohydrates
   (c) fat
   (d) water
3. The secretions that mix with food in the small intestine are
   (a) saliva, gastric juice & bile
   (b) gastric juice, bile & pancreatic juice
   (c) bile, pancreatic juice & intestinal juice
   (d) pancreatic juice, intestinal juice and gastric juice
4. Essentially digestion means
   (a) breaking food for energy
   (b) building of proteins from amino acids
   (c) changing organic molecules
   (d) breaking complex organic molecules into smaller ones

5. The work of HCl present in gastric juice is to –
(a) convert pepsinogen to pepsin
(b) convert pro-rennin to rennin
(c) kill pathogens present along with food
(d) All the above

6. Two friends are eating together on a dining table. One of them suddenly starts coughing while swallowing some food. This coughing would have been due to improper movement of:
(a) epiglottis (b) diaphragm
(c) neck (d) tongue

7. A person who is one along hunger strike and is surviving only on water, will have
(a) less amino acids in his urine
(b) more glucose in his blood
(c) less urea in his urine
(d) more sodium in his urine

8. The enzyme enterokinase helps in the conversion of
(a) pepsinogen into pepsin
(b) trypsinogen into trypsin
(c) caesinogen into caesin
(d) proteins into polypeptides

9. Which one of the following enzymes carries out the initial step in the digestion of milk in humans?
(a) Pepsin (b) Rennin
(c) Lipase (d) Trypsin

10. Which one of the following correctly represents the normal adult human dental formula ?
(a) $\frac{3}{3}, \frac{1}{1}, \frac{3}{2}, \frac{1}{1}$ (b) $\frac{2}{2}, \frac{1}{1}, \frac{3}{2}, \frac{3}{3}$
(b) $\frac{2}{2}, \frac{1}{1}, \frac{2}{2}, \frac{3}{3}$ (d) $\frac{3}{3}, \frac{1}{1}, \frac{3}{3}, \frac{3}{3}$

11. Anxiety and eating spicy food together in an otherwise normal human, may lead to
(a) Indigestion (b) Jaundice
(c) Diarrhoea (d) Vomiting

12. Much developed larynx of human male is called
(a) Aristole's lantern (b) Syrinx
(c) Adam's apple (d) Muller's organ

13. Which of the following type of enzyme is not matched correctly with the molecule that it breaks down?
(a) Amylase–starch
(b) Lipase–starch
(c) Protease–proteins
(d) Disaccharidase–sugars

14. Which of the following pair is characterised by swollen lips, thick pigmented skin of hands and legs and irritability?
(a) Thiamine – Beri-Beri
(b) Protein – Kwashiorkor
(c) Nicotinamide – Pellagra
(d) Iodine – Goitre

15. Glycogenolysis involves
(a) conversion of sugar into glycogen
(b) oxidation of sugar
(c) conversion of glycogen into sugar
(d) conversion of glycogen into fat

16. The layer of cells that secrete enamel of tooth is
(a) dentoblast (b) ameloblast
(c) osteoblast (d) odontoblast

17. Secretion of pancreatic juice is stimulated by
(a) gastrin (b) secretin
(c) enterogasteron (d) enterokinase

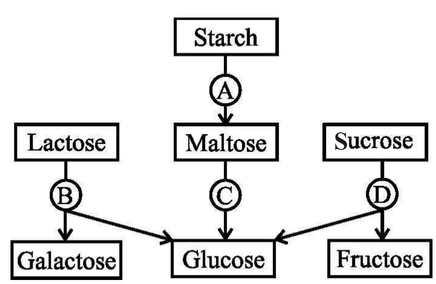
18. The vitamin essential for blood coagulation is
(a) vitamin B_6 (b) vitamin A
(c) vitamin K (d) vitamin E

19. Dentition in man is
(a) acrodont and homodont
(b) thecodont, homodont and polyphyodont
(c) thecodont, heterodont and polyphyodont
(d) thecodont, heterodont and diphyodont

20. Where do certain symbiotic micro-organisms normally occur in human body?
(a) Caecum
(b) Oral lining and tongue surface
(c) Vermiform appendix and rectum
(d) Duodenum

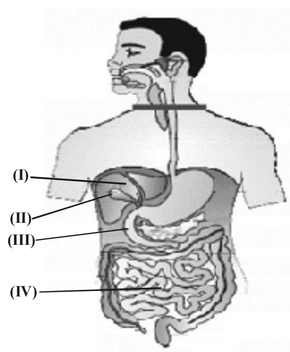
Diagram Based Questions :

1. The given flowchart shows the fate of carbohydrate during digestion in the human alimentary canal. Identify the enzymes acting at stages indicated as A, B, C and D.



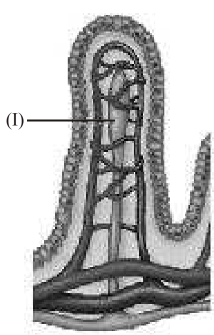
(a) A= amylase, B = maltase, C = lactase, D = invertase
(b) A = amylase, B = maltase, C= invertase, D= lactase
(c) A = amylase, B = invertase, C = maltase, D= lactase
(d) A = amylase, B = lactase, C = maltase, D = invertase.

2. The diagram given below shows the human digestive system. Few structures are marked as I, II, III and IV. Which region of the human digestive system releases bile juice?

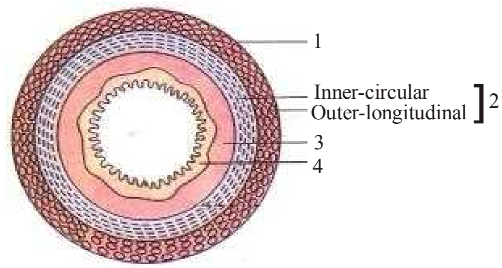


(a) I (b) II
(c) III (d) IV

3. The given figure shows a section of small intestinal mucosa showing villi. What is the function of structure marked as I in the given figure?



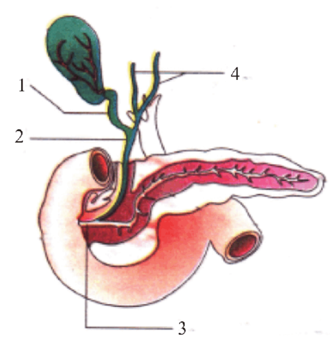
(a) To absorb amino acids.
(b) To carry blood.
(c) To transport fat
(d) To transport glucose



4. Which of the following structure forms glands in the stomach and crypts in between the bases of villi?
(a) 1 (b) 2
(c) 3 (d) 4

5. Which of the following part is made up of a thin mesothelium with some connective tissue?
(a) 1 (b) 2
(c) 3 (d) 4

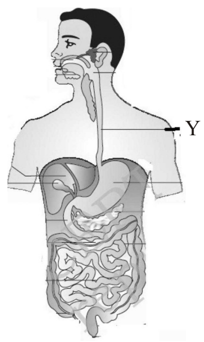
Directions (Qs. 6 and 8): *The given diagram shows the duct systems of liver, gall bladder and pancreas in which few structures are marked as 1.2.3 and 4. On the basis of this figure answer the questions.*



6. Sphincter of Oddi controls the flow of digestive juice by guarding which duct?
(a) 1 (b) 2
(c) 3 (d) 4

7. Which two ducts are responsible for the formation of a duct that carry bile from the gall bladder and conduct it into the first section of the small intestine?
(a) 1 and 2 (b) 2 and 3
(c) 3 and 4 (d) 4 and 1

8. Which of the following best describes the role of the structure marked as Y in the given figure?



(a) Serves a minor role in the chemical digestion of fats.
(b) Mucus is secreted to protect the oesophagus from the stomach enzymes.
(c) Digestive enzymes are secreted as food passes from the oesophagus to the stomach.
(d) Connects the mouth to the stomach and has no function in chemical digestion.

Assertion/ Reason :

DIRECTIONS (Qs. 1-9): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Starch is hydrolysed by ptyalin to maltose.
Reason : Sucrase hydrolyses sucrose to lactose.

2. **Assertion :** Presence of HCl in stomach is necessary for the process of digestion.
Reason : HCl kills and inhibits the growth of bacteria in the stomach.

3. **Assertion :** Chewing is one of the important process of digestion in animals.
Reason : It helps in enzyme action.

4. **Assertion :** Trypsin helps in blood digestion of predator aimals.
Reason : Trypsin hydrolyses fibrinogen.

5. **Assertion :** The main part of carbohydrate digestion takes place in small intestine.
Reason : Here pancreatic amylase converts carbohydrates into lactose.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of* which *ONLY ONE is correct.*

1.

	Column-I (Organs)		**Column-II (Functions)**
(A)	Mouth	I.	Reclaims water and salts
(B)	Stomach	II.	Carries out most of the digestion and absorption of nutrients.
(C)	Small intestine	III.	Releases amylase enzyme that break down carbohydrates.
(D)	Large intestine	IV.	An acidic compartment that begins to break proteins into larger polypeptides.

(a) A – I; B – II; C – III; D – IV
(b) A – III; B – IV; C – II; D – I
(c) A – II; B – III; C – I; D – IV
(d) A – IV; B – I; C – II; D – III

2.

	Column-I (Food type)		**Column-II (Enzymes)**
(A)	Starch	I.	Nucleases
(B)	Protein	II.	Lipase
(C)	Fats	III.	Amylase
(D)	Nucleic acid	IV.	Trypsin

(a) A – III; B – IV; C – II; D – I
(b) A – I; B – II; C – III; D – IV
(c) A – II; B – III; C – IV; D – V
(d) A – IV; B – I; C – II; D – III

3. **Column-I (Digestive processes)** | **Column-II (Description)**

Column-I (Digestive processes)		Column-II (Description)
(A) Ingestion	I.	Elimination of digestible solids.
(B) Mechanical digestion	II.	Enzymatic degradation of food stuffs into simpler molecules.
(C) Chemical digestion	III.	Taking food into the digestive systems
(D) Defecation	IV.	Chewing, mixing, churning and segmentation of food.

(a) A – I; B – II; C – III; D – IV
(b) A – IV; B – I; C – II; D – III
(c) A – III; B – IV; C – II; D – I
(d) A – I; B – III; C – IV; D – II

4.

Column-I (Organic molecules)		Column-II (Description)
(A) Carbohydrates	I.	It is made of fatty acids and glycerol
(B) Proteins	II.	It is mostly ingested in the form of starch
(C) Nucleic acids	III.	It is built of long chains of amino acids
(D) Lipids	IV.	It is made of ribose or deoxyribose sugars and nitrogenous bases.

(a) A – I; B – II; C – III; D – IV
(b) A – IV; B – I; C – II; D – III
(c) A – III; B – IV; C – I; D – II
(d) A – II; B – III; C – IV; D – I

5.

Column - I		Column - II
(A) Salivary amylase	I.	Proteins
(B) Bile salts	II.	Milk proteins
(C) Rennin	III	Starch
(D) Pepsin	IV.	Lipids

(a) $A \to III; B \to IV; C \to II; D \to I$
(b) $A \to III; B \to IV; C \to I; D \to II$
(c) $A \to IV; B \to III; C \to II; D \to I$
(d) $A \to I; B \to II; C \to III; D \to IV$

6.

Column - I		Column - II
(A) Hepatic lobule	I.	Base of Villi
(B) Crypts of leiberkuhn	II.	Blisson's capsule
(C) Sphincter of Oddi	III.	Gall bladder
(D) Cystic duct	IV.	Hepato-pancreatic duct

(a) $A \to II; B \to I; C \to IV; D \to III$
(b) $A \to I; B \to II; C \to IV; D \to III$
(c) $A \to I; B \to II; C \to III; D \to IV$
(d) $A \to III; B \to IV; C \to II; D \to I$

7.

Column - I		Column - II
(A) Neck cells	I.	HCI, Intrinsic factor
(B) Peptic / Chief cells	II.	Mucus
(C) Parietal / Oxyntic	III.	Pepsinogen

(a) $A \to II; B \to III; C \to I$
(b) $A \to III; B \to II; C \to I$
(c) $A \to I; B \to II; C \to III$
(d) $A \to II; B \to I; C \to III$

Critical Thinking Type Questions :

1. In pancreatic juice, which of the followings are secreted in inactive forms as proenzymes ?
(a) Trypsin, chymotrypsin & carboxypeptidases
(b) Pepsin, trypsin and chymotrypsin
(c) Trypsin only
(d) Trypsin and chymotrypsin only

2. If the bile-pancreatic duct is blocked then which of the following will not be affected ?
(a) Digestion of proteins
(b) Emulsification of fats
(c) Level of blood glucose
(d) Digestion of starch

3. Which of the following is the correct chronological order for flow of food from mouth to anus?
(a) Oesophagus → Stomach → Small intestine → Large intestine

(b) Large intestine $\rightarrow$ Oesophagus $\rightarrow$ Stomach $\rightarrow$ Small intestine
(c) Small intestine $\rightarrow$ Large intestine $\rightarrow$ Oesophagus $\rightarrow$ stomach
(d) Stomach $\rightarrow$ Small intestine $\rightarrow$ Large intestine $\rightarrow$ Oesophagus

4. Which of the following occurs in the duodenum?
(a) Absorption of vitamins and minerals.
(b) Mixing of food with pancreatic juice and bile.
(c) Mastication of food.
(d) Absorption of water.

5. From deep to superficial, what are the tunics of the intraperitoneal portions of the alimentary canal?
(a) Serosa, muscularis, submucosa and mucosa
(b) Mucosa, submucosa, muscularis and serosa
(c) Adventia, muscularis, submucosa and mucosa
(d) Mucosa, submucosa, muscularis and adventia

6. If for some reason our goblet cells becomes non-functional then this will adversely affect
(a) production of somatostatin.
(b) secretion of sebum from the sebaceous glands.
(c) maturation of sperms.
(d) smooth movement of food down the intestine.

7. The digestion of butter begins with
(a) saliva
(b) gastric juice
(c) pancreatic juice
(d) intestinal juice

8. Removal of gall bladder in man would lead to
(a) impairment of digestion of fats.
(b) impairment of digestion of protein.
(c) jaundice
(d) increased acidity in intestine.

9. During prolonged fasting
(a) first fats are used up, followed by carbohydrates from liver and muscles and proteins in the end.
(b) first carbohydrates are used up, followed by fat and proteins towards end.
(c) first lipids, followed by proteins and carbohydrates towards end.
(d) none of the above.

10. A healthy person eats the following diet - 5 gm raw sugar, 4 gm albumin, 10 gm pure buffalo ghee adultrated with 2 gm vegetable ghee (hydrogenated vegetable oil) and 5 gm lignin. How many calories he is likely to get?
(a) 144 (b) 126
(c) 164 (d) 112

11. If pH of stomach is 7 then which component of food would be affected?
(a) Starch (b) Protein
(c) Fat (d) Sucrose

17 Breathing and Exchange of Gases

Fill in the Blanks :

1. The structure which prevents the entry of food into the windpipe is _______ .
2. Carbonic anhydrase is found in high concentration in _______ .
3. Total lungs capacity is approximately _______ .
4. The volume of the air that leaves the lungs in human is measured by _______ .
5. Residual air mostly occurs in _______ .
6. ____ in CO_2 in your blood, which causes ____ in pH, would cause your breathing to speed up.
7. The respiratory centre, which regulates respiration, is located in _______ .
8. As blood becomes fully O_2 saturated, haemoglobin combines with ______ molecule(s) of oxygen.
9. Partial pressure of oxygen in inspired and expired air is _______ and _______ mm of Hg.
10. p_{50} value denotes _______ .

True/ False :

1. Tracheal rings are of hyaline cartilage .
2. Dorsal side of thoracic chamber is formed by sternum.
3. Expiration occurs when there is negative pressure in lungs.
4. Solubility of CO_2 is higher than O_2 by 25 times.
5. High conc. of hydrogen ions favours oxyhaemoglobin formation.
6. Pulmonary ventilation is equal to alveolar ventilation.
7. In all animals oxygen is transported by blood.
8. Haemoglobin is necessary for transport of carbon dioxide and carbonic anhydrase for transport of oxygen.
9. About 90% of carbon dioxide (CO_2) is carried by haemoglobin as carbaminohaemoglobin.
10. Volume of residual air is higher than tidal volume.

Conceptual MCQs :

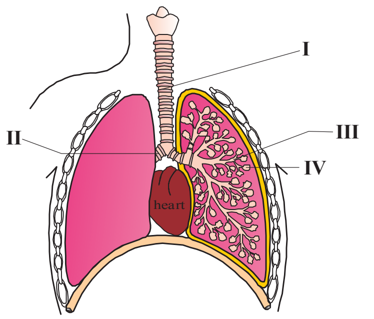
1. Air is breathed through
   (a) trachea — lungs — larynx — pharynx — alveoli
   (b) nose — larynx — pharynx — bronchus — alveoli — bronchioles
   (c) nostrils — pharynx — larynx — trachea — bronchi — bronchioles — alveoli
   (d) nose — mouth — lungs
2. Although much CO_2 is carried in blood, yet blood does not become acidic, because
   (a) it is absorbed by the leucocytes
   (b) blood buffers play an important role in CO_2 transport
   (c) it combines with water to form which is neutralized by $NaCO_3$
   (d) it is continuously diffused through tissues and is not allowed to accumulate
3. Carbon dioxide is transported from tissues to respiratory surface by only
   (a) plasma and erythrocytes
   (b) plasma
   (c) erythrocytes
   (d) erythrocytes and leucocytes
4. Oxygen dissociation curve of haemoglobin is
   (a) sigmoid (b) hyperbolic
   (c) linear (d) hypobolic
5. The function of nasal cavity & nasopharynx is to –
   (a) warm the inspired air
   (b) moisten the inspired air
   (c) filter out the dust particles from the inspired air
   (d) All of the above

6. In expiration, diaphragm becomes –
(a) flattened (b) relaxed
(c) straightened (d) arched
7. Rate of respiration is directly affected by –
(a) concentration of carbon dioxide
(b) oxygen in trachea
(c) concentration of oxygen
(d) diaphragm expansion
8. Body tissues obtain oxygen from haemoglobin because of its dissociation in tissues caused by–
(a) low oxygen concentration and high carbon dioxide concentration
(b) low oxygen concentration
(c) low carbon dioxide concentration
(d) high carbon dioxide concentration
9. The vital capacity of human lung is equal to
(a) 3500 ml (b) 4800 ml
(c) 500 ml (d) 1200 ml
10. During inspiration –
(a) the diaphragm gets raised and ribs get lowered
(b) both diaphragm and ribs get raised
(c) both diaphragm and ribs get lowered
(d) the diaphragm get flattered and ribs get raised
11. Lungs have a large number of alveoli for –
(a) having spongy texture and proper shape
(b) more surface area for diffusion of gases
(c) more space for increasing volume of inspired air
(d) more nerve supply
12. The breathing controlling centre of medulla oblongata is mainly under –
(a) chemical control (b) physical control
(c) neural control (d) all of the above
13. About 97% of oxygen is transported by RBC. The remaining 3% is
(a) dissolved in plasma and transported
(b) retained in lungs
(c) attached to cell membranes
(d) found inside mitochondria
14. Which two of the following changes (a–d) usually tend to occur in the plain dwellers when they move to high altitudes (3,500 m or more)?
(i) Increase in red blood cell size
(ii) Increase in red blood cell production
(iii) Increased breathing rate
(iv) Increase in thrombocyte count

Changes occurring are:
(a) (ii) and (iii) (b) (iii) and (iv)
(c) (i) and (iv) (d) (i) and (ii)
15. Which of the following are the correct statement for respiration in human
(a) Cigarette smoking may lead of inflammation of bronchi
(b) Neural signals from pneumotaxic centre in pons region of brain can increase the duration of inspiration
(c) Workers in grinding and stone - breaking industries may suffer from lung fibrosis
(d) About 90% of carbon dioxide (CO_2) is carried by haemoglobin as carbamino haemoglobin.
16. Volume of air breathed in and out during normal breathing is called
(a) Vital capacity (b) IRV
(c) ERV (d) Tidal volume
17. The presence of CO_2 in blood will lower pH because CO_2 combines with____, with the rate of reaction increased by_____ .
(a) H_2O to form H^+ and HCO_3^-, carbonic anhydrase
(b) H_2O to form only HCO_3^-, carbonic anhydrase
(c) H_2O to form only H^+, carbonic ions
(d) H^+ to form HCO_3^-, oxyhaemoglobin
18. The amount of volume of air that can be inspired/ expired normally is called
(a) tidal volume
(b) vital capacity
(c) residual volume
(d) normal volume.
19. Carbon monoxide is a pollutant because it
(a) reacts with oxygen
(b) inhibits glycolysis
(c) reacts with haemoglobin
(d) makes nervous system inactive
20. Dead space air in man is
(a) 500 ml (b) 150 ml
(c) 250 ml (d) 1.5 L

Diagram Based Questions :

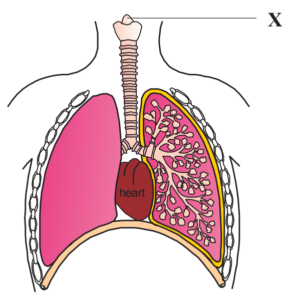
1. The given diagram represents the human respiratory system with few structures labelled as I, II, III and IV.



The exchange of gases takes place in which labelled structure?

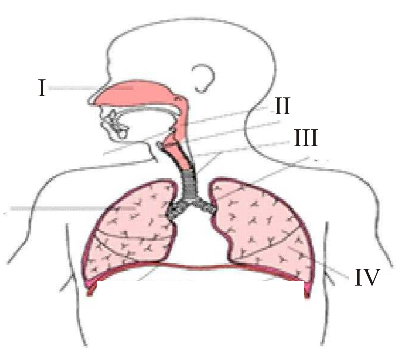
(a) I trachea (b) II Bronchi
(c) III bronchioles (d) IV alveoli

2. In the given diagram of human respiratory system what is the funciton of structure marked as X ?



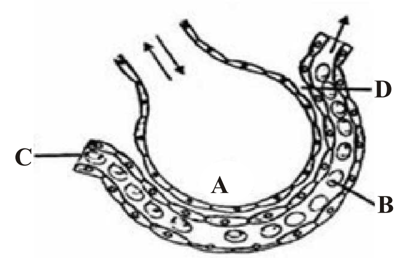
(a) To prevent food from entering into trachea.
(b) To filter and warm the air.
(c) To help in exchange of gases.
(d) To catch dust and bacteria.

3. In the given diagram of human respiratory system which marked label (I, II, III & IV) is the common passageway where the nasal and oral cavities meet?



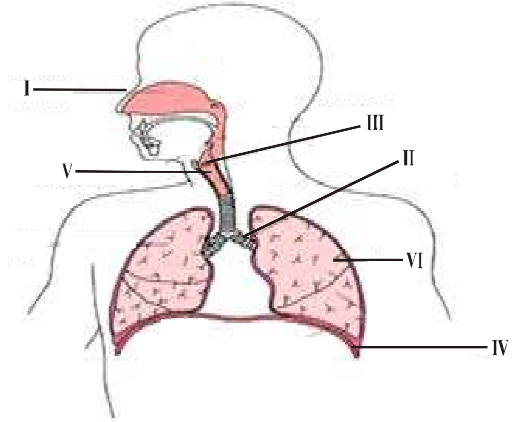
(a) I nasal-cavity (b) II pharynx
(c) III trachea (d) IV lungs

4. In which one of the options given below, the one part A, B, C or D is correctly identified along with its function?



(a) A- Alveolar cavity- It is the main site of exchange of respiratory gases.
(b) B- Red blood cell- It transports mainly carbon dioxide.
(c) C- Arterial capillary- It passes oxygen to tissues.
(d) D- Capillary wall- Here, exchange of O_2 and CO_2 takes place.

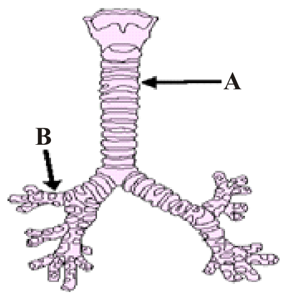
5. In the given diagram of human respiratory system, few parts are marked as I, II, III, IV, V & VI. Choose the correct combination of labelling from the given options.



(a) I- Nose; II- Bronchus; III- Larynx; IV- Diaphragm; V- Trachea; VI- Lung

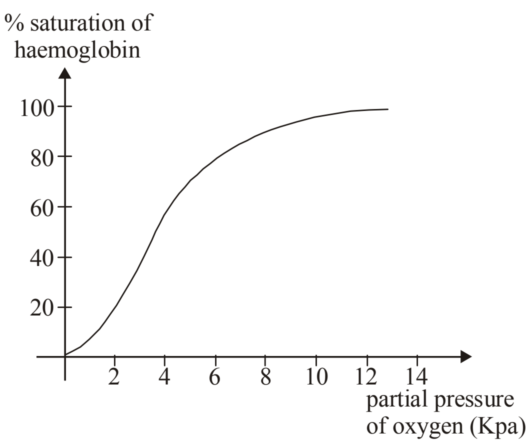
(b) I- Nose; II- Larynx; III- Bronchus; IV- Lung; V- Diaphragm; VI- Trachea
(c) I- Mouth; II- Trachea; III- Larynx; IV-Lung; V- Diaphragm; Vi- Bronchus.
(d) I- Mouth; II- Diaphragm; III- Trachea; IV- Bronchi; V-Larynx; VI- Lung

6. In the given figure, label A represents ____________ while label B represents _________.



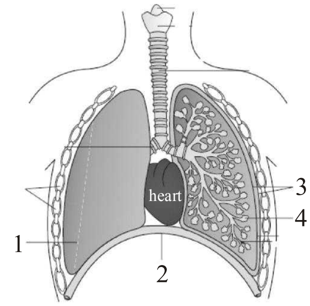
(a) A- Trachea; B- Bronchus
(b) A- Alveolus; B- Bronchiole
(c) A- Bronchiole; B- Trachea
(d) A- Trachea; B- Bronchiole

7. Refer the given figure and answer the question.



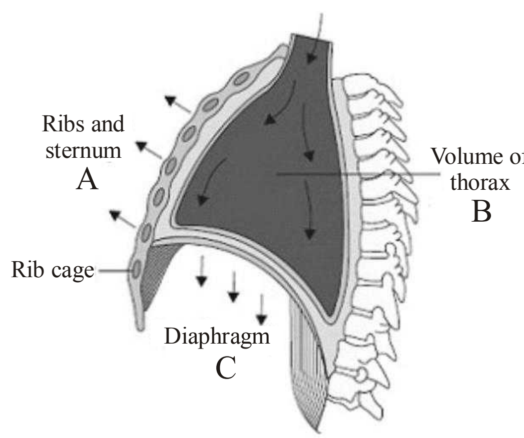
Which of the following statement is correct regarding the above figure?
(a) When percentage saturation of haemoglobin is plotted against the partial pressure of oxygen, a sigmoid curve is obtained.
(b) Binding of oxygen with haemoglobin is primarily related to partial pressure of carbon monoxide.
(c) The given graph illustrates the amount of HbO_2 as similar to Hb at different pO_2.
(d) None of the above.

8. The given figure shows the respiratory system. Identify the correct structure marked as 1, 2, 3 and 4 whose contraction initiated the inspiration which in turn increases the volume of thoracic chamber in the antero-posterior axis.



(a) 1 (b) 2
(c) 3 (d) 4

9. The figure given below shows the mechanism of breathing. Identify the stage (X) of breathing explained & A, B and C marked in the figure.



(a) X – Expiration, A – raised, B – decreased, C – relaxed
(b) X – Inspiration, A – raised, B – decreased, C – relaxed
(c) X – Expiration, A – raised, B – increased, C – contracted
(d) X - Inspiration, A – raised, B – increased, C – contracted

Assertion/ Reason :

DIRECTIONS (Qs. 1-12): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Most fish when out of water, die of suffocation.
Reason : Atmospheric air contains far less oxygen content than the dissolved oxygen in water.

2. **Assertion :** During inspiration, pressure of air falls in the thorax.
Reason : There is a rise in volume of thorax during inspiration.

3. **Assertion :** Vital capacity is higher in athletes than non-athletes.
Reason : Vital capacity is about 3.5-4.5 litres in a normal adult person.

4. **Assertion :** Insects develop a complex system of air tubes called trachea for respiratory purpose.
Reason : Exchange through body surface is not possible in insects.

5. **Assertion :** Forceful expiration occurs through expiratory muscles.
Reason : Expiratory muscles expires quickly.

6. **Assertion :** Coughing and sneezing are necessary.
Reason : Coughing and sneezing are reflex actions

7. **Assertion :** Histamine is involved in allergic and inflammatory reactions.
Reason : Histamine is a vasodilator.

8. **Assertion :** Aerobic animals are not truely aerobic.
Reason : They produce lactic acid anaerobically.

9. **Assertion :** Symptoms of emphysema develops when a person living on plains ascends and stays on a mountain.
Reason : Air pressure and partial pressure of oxygen falls with the rise in altitude.

10. **Assertion :** If there is no air in trachea, it will not collapse.
Reason : Trachea is having the cartilagenous ring.

11. **Assertion :** Inspiration occurs due to muscular relaxation.
Reason : During inspiration, the diaphragm and external intercostal muscle contract simultaneously.

12. **Assertion :** Severe Acute Respiratory Syndrome (SARS) originated in China.
Reason : China is the most populated country of the world.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column - I (Animals)	**Column - II (Mode of respiration)**
(A) Earthworm	I. Pulmonary
(B) Human	II. Branchial
(C) Prawn	III. Tracheal
(D) Insects	IV. Cutaneous

(a) A – I; B – II; C – III; D – IV
(b) A – IV; B – II; C – I; D – III
(c) A – IV; B – I; C – II; D – III
(d) A – III; B – II; C – IV; D – I

2.

Column-I (Disorders)	**Column-II (Symptoms)**
(A) Asthma	I. Inflammation of nasal tract
(B) Bronchitis	II. Spasm of bronchial muscles
(C) Rhinitis	III. Fully blown out alveoli
(D) Emphysema	IV. Inflammation of bronchi
	V. Cough with blood strained sputum

(a) A – IV; B – II; C – V; D – I
(b) A – V; B – III; C – II; D – I
(c) A – III; B – I; C – V; D – IV
(d) A – II; B – IV; C – I; D – III

3.

	Column -I (Respiratory capacities)		Column-II (Respiratory volumes)
(A)	Residual volume	I.	2500 mL
(B)	Vital capacity	II.	3500 mL
(C)	Inspiratory reserve	III.	1200 mL
(D)	Inspiratory capacity	IV.	4500 mL

Which one of the following is the correct matching of two capacities and volume?
(a) A – I; B – II; C – III; D – IV.
(b) A – IV; B – III; C – I; D – II.
(c) A – II; B – III; C – IV; D – I.
(d) A – III; B – IV; C – I; D – II.

4.

	Column - I (Organs)		Column - II (Functions)
(A)	Nose	I.	Stops food from going down into lungs.
(B)	Epiglottis	II.	Produces sound.
(C)	Pharynx	III.	Traps bacteria as well as dust.
(D)	Larynx	IV.	Allows air to pass from nose to oesophagus.

(a) A – II; B – III; C – I; D – IV
(b) A – III; B – I; C – IV; D – II
(c) A – I; B – IV; C – II; D – III
(d) A – IV; B – II; C – III; D – I

2.

	Column I		Column II
(A)	Tidal volume	I.	2500 to 3000 ml
(B)	Inspiratory reserve volume	II.	1000 ml of air
(C)	Expiratory reserve	III.	500 ml of air
(D)	Residual volume	IV.	3400 to 4800 ml of air
E.	Vital capacity	V.	1200 ml of air

(a) A $\rightarrow$ III; B $\rightarrow$ IV; C $\rightarrow$ II; D $\rightarrow$ 1; V $\rightarrow$ V
(b) A $\rightarrow$ III; B $\rightarrow$ I; C $\rightarrow$ II; D $\rightarrow$ 5; V $\rightarrow$ IV
(c) A $\rightarrow$ III; B $\rightarrow$ I; C $\rightarrow$ IV; D $\rightarrow$ 5; V $\rightarrow$ IV
(d) A $\rightarrow$ V; B $\rightarrow$ IV; C $\rightarrow$ II; D $\rightarrow$ 1; V $\rightarrow$ II

Critical Thinking Type Questions :

1. About 70% of CO_2 is transported as
(a) carbonic acid
(b) darboxyhaemoglobin
(c) bicarbonates
(d) carbamino compounds

2. Oxyhaemoglobin dissociates into oxygen and deoxyhaemoglobin at
(a) low O_2 pressure in tissue.
(b) high O_2 pressure in tissue.
(c) equal O_2 pressure inside and outside tissue.
(d) all times irrespective of O_2 pressure.

3. Even when there is no air in it, human trachea does not collapse due to presence of
(a) bony rings
(b) turgid pressure
(c) chitinous rings
(d) cartilaginous rings

4. Dissociation curve shifts to the right when
(a) pH increases.
(b) CO_2 concentration increases.
(c) O_2 concentration decreases.
(d) 2, 3 D-P-G decreases.

5. During inspiration in mammals, the diaphragm becomes
(a) dome shaped (b) raised highly
(c) flat (d) static

6. During oxygen transport, the oxyhaemoglobin at the tissue level liberates oxygen to the cells because in tissue
(a) O_2 concentration is high and CO_2 is low.
(b) O_2 concentration is low and CO_2 is high.
(c) O_2 tension is high and CO_2 tension is low.
(d) O_2 tension is low and CO_2 tension is high.

7. Combining of haemoglobin with O_2 in lungs can be promoted by
(a) decreasing CO_2 concentration in blood.
(b) decreasing O_2 concentration in blood.
(c) increasing CO_2 concentration in blood.
(d) introducting CO_2 into blood.

8. When CO_2 concentration in blood increases, breathing becomes
(a) slow and deep.
(b) faster and deeper.
(c) shallower and slow.
(d) there is no effect on breathing.

9. What would happen if human blood becomes acidic (low pH)?

(a) Oxygen carying capacity of haemoglobin increases.
(b) Oxygen carrying capacity of haemoglobin decreases.
(c) RBCs count increases.
(d) RBCs count decreases.

10. When, under certain conditions, the P_{50} value of haemoglobin rises, the affinity of the pigment of combining with O_2 will

(a) remain same (b) rise
(c) fall (d) first rise and then fall

11. Low oxygen tension in the blood causes

(a) coughing (b) yawning
(c) hiccuping (d) sneezing

12. Arrange the following events in the correct order as they occur during inspiration:

I. Air flows into the lungs.
II. Alveolar volume increases.
III. Thoracic volume increases.
IV. Pleural pressure decreases.
V. Alveolar pressure decreases.

(a) I – II – III – IV – V
(b) III – IV – II – V – I
(c) II – V – I – III – IV
(d) IV – V – II – I – III

18 Body Fluids and Circulation

Fill in the Blanks :

1. Coronary artery disease (CAD) is often referred to as _______ .
2. Hardening of the arteries due to deposition of cholesterol is called _______ .
3. Pulmonary vein, carrying oxygenated blood, opens into _______ .
4. The pacemaker of the human heart is _______ .
5. Contraction of the ventricle in the heart begins by the command from _______ .
6. In mammals the blood from the right ventricle goes to _______ .
7. Fish has _______ and ______ circulatory system.
8. A blockage in aortic valve would directly reduce blood flow to the _______ .
9. _______ plays an important role in blood clotting.

True/ False :

1. Arteries are thick-walled and have narrow lumen as compared to veins.
2. Persons with blood group AB can donate blood to any person with any blood group under ABO system.
3. Blood group AB is universal acceptor.
4. Pulmonary artery carries oxygenated blood to the lungs.
5. Blood from the lungs is returned to heart through 2-veins, one from each lung.
6. A healthy individual has 12 - 16 gms of haemoglobin in every 200ml of blood.
7. RBC as an average life span of 120 days after which they are destroyed in the spleen.
8. Neutrophils and basophils are phagocytic cells which destroy foreign organisms entering the body.
9. A reduction in the number of WBC leads to clotting disorders which will lead to excessive loss of blood from the body.

Conceptual MCQs :

1. Child death may occur in the marriage between
   (a) Rh^+ man and Rh^+ woman
   (b) Rh^+ man and Rh^- woman
   (c) Rh^- man and Rh^- woman
   (d) Rh^- man and Rh^+ woman
2. A person with blood group A requires blood. The blood group which can be given is
   (a) A and B (b) A and AB
   (c) A and O (d) A, B, AB and O
3. Blood group AB has
   (a) no antigen
   (b) no antibody
   (c) neither antigen nor antibody
   (d) both antigen and antibody
4. What is true about leucocytes ?
   (a) Their sudden fall in number is indication of blood cancer
   (b) These are produced in thymus
   (c) These are enucleated
   (d) These can squeeze out through the capillary walls
5. What is correct for blood group 'O'?
   (a) No antigens but both a and b antibodies are present
   (b) A antigen and b antibody
   (c) Antigen and antibody both absent
   (d) A and B antigens and a, b antibodies
6. Which of the following statments is true for lymph?

(a) WBC and serum
(b) all components of blood except RBCs and some proteins
(c) RBCs, WBCs and plasma
(d) RBCs proteins and platelets

7. What is true about RBCs in humans?
(a) They carry about 20–25 per cent of CO_2
(b) They transport 99.5 per cent of O_2
(c) They transport about 80 per cent oxygen only and the rest 20 per cent of it is transported in dissolved state in blood plasma
(d) They do not carry CO_2 at all

8. Antibodies are –
(a) components of blood plasma
(b) RBCs
(c) substances to inactivate antigens
(d) WBC which destroy bacteria

9. A vein differ from an artery in having –
(a) strong muscular walls
(b) narrow lumen
(c) valves to control direction of blood flow opposite to heart
(d) valves to control direction of blood flow towards heart

10. The correct sequence of layers found in the walls of arteries from inside to outward is –
(a) tunica adventitia, tunica interna & tunica media
(b) tunica interna, tunica externa & tunica media
(c) tunica interna, tunica media & tunica externa
(d) tunica media, tunica externa & tunica interna

11. In blood –
(a) WBCs are more than RBCs
(b) RBCs are more than WBCs
(c) RBCs are less than platelets
(d) Platelets are less than WBCs

12. Characteristics of cardiac muscles are that they –
(a) contract quickly and get fatigued
(b) contract quickly and do not get fatigued
(c) contract slowly and get fatigued
(d) contract slowly and do not get fatigued

13. pH of human blood is –
(a) 6.2 (b) 9.4
(c) 7.4 (d) 10

14. Which of the following correctly explains a phase/event in cardiac cycle in a standard electrocardiogram?
(a) QRS complex indicates atrial contraction
(b) QRS complex indicates ventricular contraction
(c) Time between S and T represents atrial systole
(d) P-wave indicates beginning of ventricular contraction.

15. If due to some injury the chordae tendinae of the tricuspid valve of the human heart is partially non - functional, what will be the immediate effect?
(a) The flow of blood into the aorta will be slowed down
(b) The 'pacemaker' will stop working
(c) The blood will tend to flow back into the left atrium
(d) The flow of blood into the pulmonary artery will be reduced

16. 'Bundle of His' is a part of which one of the following organs in humans?
(a) Brain (b) Heart
(c) Kidney (d) Pancreas

17. Which one of the following plasma proteins is involved in the coagulation of blood ?
(a) an albumin (b) serum amylase
(c) a globulin (d) fibrinogen

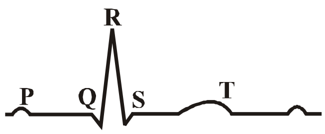
18. Arteries are best defined as the vessels which:
(a) supply oxygenated blood to the different organs
(b) break up into capillaries which reunite to form one visceral organ
(c) break up into capillaries which reunite to form a vein
(d) carry blood from one visceral organ to another visceral organ

19. Which one of the following statements is correct regarding blood pressure ?
(a) 130/90 mmHg is considered high and requires treatment
(b) 100/55 mmHg is considered an ideal blood pressure
(c) 105/50 mm Hg makes one very active
(d) 90/110 mmHg may harm vital organs like brain and kidney

20. Bulk of carbon dioxide (CO_2) released from body tissues into the blood is present as
(a) bicarbonate in blood plasma and RBCs
(b) free CO_2 in blood plasma
(c) 70% carbamino- haemoglobin and 30% as bicarbonate
(d) carbamino-haemoglobin in RBCs

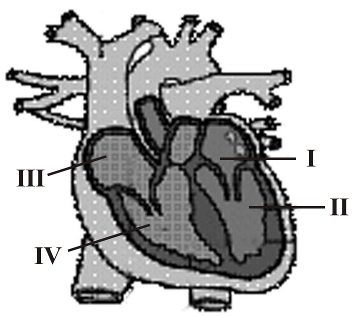
Diagram Based Questions :

1. Given below is the ECG of a normal human. Which one of its components is correctly interpreted?



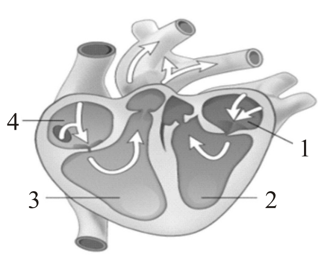
(a) Peak P and Peak R together - Systolic and diastolic blood pressures
(b) Peak P - Initiation of left atrial contraction only
(c) Complex QRS - One complete pulse
(d) Peak T - Initiation of total cardiac contraction

2. The given diagram represents human heart with four chambers labelled as I, II, III & IV?



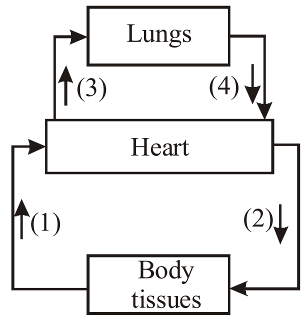
Which labelled structure receives carbon dioxide rich blood from the body?
(a) I (b) II
(c) III (d) IV

3. Refer the given figure of human heart and identify the chamber (marked as 1, 2, 3 & 4) which receives most of the blood returning from the brain.



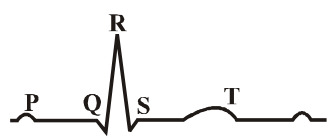
(a) 1 (b) 2
(c) 3 (d) 4

4. The given figure represents the pathway of blood throughout the body.



Identify the correct match of marked number 1, 2, 3 and 4.
(a) 1- Artery
(b) 2- Pulmonary vein
(c) 3- Pulmonary artery
(d) 4- Vein

5. The given figure represents diagrammatic presentation of an ECG. Each peak in the ECG is identified with a letter from P to T that corresponds to a specific electrical activity of the heart.



Which of the following letter shows the incorrect activity of heart?
(a) QRS - Depolarization of the ventricles
(b) R wave - Marks the beginning of the systole.
(c) P- Electrical excitation (or depolarization) of the atria
(d) T wave - Return of the ventricles from excited to normal state (repolarization).

Assertion/ Reason :

DIRECTIONS (Qs. 1-11): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.

(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Closed circulatory system is more effective .than open type.
Reason : The closed circulatory system considerably enhances the speed, precision and efficiency of circulation.
2. **Assertion :** An artificial pacemaker can replace the sinoatrial node of heart.
Reason : This is because, an artificial pacemaker is capable of stimulating the heart electrically to maintain its beats.
3. **Assertion :** Heart of fish contains only deoxygenated blood.
Reason : Oxygenated blood do not return back to the heart in fishes.
4. **Assertion :** The increased permeability of the lymph capillaries is easily altered.
Reason : The increased permeability of the capillary walls leads to oedema or swelling.
5. **Assertion :** Electorcardiogram is record or electrical activity of the heart which shows certain waves called P, Q, R, S and T waves.
Reason : It gives important information concerning the spread of excitation to the different parts of heart and it is of value in the diagnosis of cases of abnormal cardiac rhythm and myocardial damage.
6. **Assertion :** WBCs accumulate at the site of wounds by diapedesis.
Reason : It is the squeezing of leucocytes from the endothelium.
7. **Assertion :** EEG is of immense diagnostic value in the cardiac diseases.
Reason : Defects in cardiac functions can be reflected in changes in the pattern of electrical potentials recorded in the EEG.
8. **Assertion :** Heart valves resemble swing doors in action.
Reason : Valves are present in the heart chamber, at the opening of the heart into large arteries and veins.
9. **Assertion :** Sline water is not given to patients of hypertension.
Reason : Saline water can cause vomiting and may drop blood pressure suddenly causing cardiac arrest.
10. **Assertion :** Blood pressure is arterial blood pressure.
Reason : It is measured by sphygmomanometer.
11. **Assertion :** The muscle fibres of SA node possess the muscle fibres.
Reason : Due to this fact, it can initiate excitory waves at the highest rate

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I (Blood cell)		**Column-II (Description)**
(A)	Erythrocyte	I.	Most abundant white blood cell, and the main phagocytic cell of the blood.
(B)	Eosinophil	II.	Least abundant white blood cell; releases histamine granules.
(C)	Lymphocyte	III.	Resist infections and are associated with allergic reactions.
(D)	Neutrophil	IV.	Blood cell that contains haemoglobin and transports oxygen.
(E)	Basophil	V.	Specialized antibody-producing white blood cells.

(a) A – IV; B – III; C – V; D – I; E – II
(b) A – I; B – II; C – III; D – IV; E – V
(c) A – II; B – III; C – I; D – V; E – IV
(d) A – IV; B – I; C – II; D – III; E – V

2. **Column-I** **(Area of heart)** / **Column-II** **(Receives blood from)**

(A) Right atrium — I. Left atrium
(B) Right ventricle — II. Vena cavae
(C) Left atrium — III. Right atrium
(D) Left ventricle — IV. Pulmonary veins

(a) A- II; B- III; C- IV; D- I
(b) A- I; B- II; C- III; D- IV
(c) A- IV; B- I; C- II; D- III
(d) A- III; B- IV; C- I; D- II

3. **Column - I** / **Column - II**

(A) Cardiac cycle — I. 72 / min
(B) Plasma — II. 120/80 mmHg
(C) Systolic/Diastolic — III. 0.8 seconds
(D) Haemoglobin — IV. 12 -16 gms in every 100 ml of blood
(E) Heart beat — V. 55 % of the blood

	A	B	C	D	E
(a)	I	II	III	IV	V
(b)	III	V	II	IV	I
(c)	III	I	V	II	IV
(d)	V	IV	III	I	II

4. **Column - I** **(Blood vessel)** / **Column - II** **(Function)**

(A) Superior vena cava — I. Carries deoxygenated blood to lungs
(B) Inferior vena cava — II. Carries oxygenated blood to lungs
(C) Pulmonary artery — III. Brings deoxygenated blood from lower parts of the body to the right atrium
(D) Pulmonary vein — IV. Brings oxygenated blood to the left atrium
V. Brings deoxygenated blood from upper parts of the body into the right atrium

(a) A $\rightarrow$ V; B $\rightarrow$ I; C $\rightarrow$ III; D $\rightarrow$ II
(b) A $\rightarrow$ V; B $\rightarrow$ III; C $\rightarrow$ I; D $\rightarrow$ IV
(c) A $\rightarrow$ IV; B $\rightarrow$ V; C $\rightarrow$ III; D $\rightarrow$ I
(d) A $\rightarrow$ V; B $\rightarrow$ I; C $\rightarrow$ II; D $\rightarrow$ III

5. **Column - I** / **Column - II**

(A) Fibrinogen — I. Defence mechanism
(B) Globulins — II. Osmotic balance
(C) Albumins — III. Coagulaton of blood

(a) A $\rightarrow$ III; B $\rightarrow$ I; C $\rightarrow$ II
(b) A $\rightarrow$ I; B $\rightarrow$ III; C $\rightarrow$ II
(c) A $\rightarrow$ III; B $\rightarrow$ II; C $\rightarrow$ I
(d) A $\rightarrow$ II; B $\rightarrow$ I; C $\rightarrow$ III

6. **Column - I** **Types of Lucocytes / WBCs** / **Column - II** **Their % (of total WBC)**

(A) Neutrophils — I. 20 - 25
(B) Basophils — II. 2 - 3
(C) Monocytes — III. 6 - 8
(D) Eosinophils — IV. 0.5 - 1
(E) Lymphocytes — V. 60 - 65

(a) A $\rightarrow$ V; B $\rightarrow$ IV; C $\rightarrow$ III; D $\rightarrow$ I; E $\rightarrow$ II
(b) A $\rightarrow$ I; B $\rightarrow$ II; C $\rightarrow$ III; D $\rightarrow$ V; E $\rightarrow$ IV
(c) A $\rightarrow$ V; B $\rightarrow$ IV; C $\rightarrow$ III; D $\rightarrow$ II; E $\rightarrow$ I
(d) A $\rightarrow$ II; B $\rightarrow$ IV; C $\rightarrow$ I; D $\rightarrow$ III; E $\rightarrow$ I

7. **Column - I** / **Column - II**

(A) Basophils — I. Phagocytes
(B) Neutrophils — II. Secrete histamin, serotonin, heparin and involved in inflammatory response
(C) Monocytes — III. Resist infections and are also involved in allergic reaction
(D) Eosinophils — IV. Immunity
(E) Lymphocytes — V. 60 - 65

(a) A $\rightarrow$ II; B and C $\rightarrow$ I; D $\rightarrow$ III; E $\rightarrow$ IV
(b) A $\rightarrow$ II; B and C $\rightarrow$ III; D $\rightarrow$ I; E $\rightarrow$ IV
(c) A $\rightarrow$ III; B and C $\rightarrow$ I; D $\rightarrow$ II; E $\rightarrow$ IV
(d) A $\rightarrow$ IV; B and C $\rightarrow$ III; D $\rightarrow$ I; E $\rightarrow$ II

Critical Thinking Type Questions :

1. Which is the correct route through which pulse making impulse travels in the heart?
(a) SA node $\rightarrow$ AV node $\rightarrow$ Bundle of His $\rightarrow$ Purkinje fibres

(b) AV node → Bundle of His → SA node → Purkinje fibres → heart muscles
(c) AV node → SA node → Purkinje fibres → Bundle of His → heart muscles
(d) SA node → Purkinje fibres → Bundle of His → AV node → heart muscles

2. If nerves of heart are cut, then heart will
(a) beat rhythmically (b) stop
(c) beat arhythmically (d) shrink

3. Which one of the following will be the cardiac output (in litres per minute) of a heart that has a stroke volume of 0.07 litres and is beating at a rate of 90 per minute?
(a) 63.30 (b) 63.00
(c) 00. 63 (d) 06.30

4. The blood returning to the heart through pulmonary vein has more
(a) RBC (b) haemoglobin
(c) oxygen (d) nutrient

5. First heart sound (LUBB) coincides with which wave of ECG?
(a) R-wave (b) T-wave
(c) P-wave (d) Q-wave

6. What happens when the pacemaker becomes non-functional?
(a) Only the auricles will contract rhythmically.
(b) The cardiac muslces do not contract in a coordinated manner rhythmically.
(c) Only ventricles will contract rhythmically.
(d) Auricles and ventricles contract simultaneously.

7. Maximum amount of oxygen is lost from the blood in the
(a) capillaries surrounding the tissue cells.
(b) arteries of the body.
(c) capillaries surrounding the alveoli.
(d) left auricle of the heart.

8. A drop of each of the following, is placed separately on four slides. Which of them will not coagulate?
(a) Whole blood from pulmonary vein
(b) Blood plasma
(c) Blood serum
(d) Sample from the thoracic duct of lymphatic system

9. If due to some injury, the chordae tendinae of the tricuspid valve of the human heart is partially non-functional, what will be the immediate effect?
(a) The flow of blood into the pulmonary artery will be reduced.
(b) The flow of blood into the aorta will be slowed down.
(c) The 'pacemaker' will stop working.
(d) The blood will tend to flow back into the left atrium.

10. Which of the following set of events can occur simultaneously?
(a) Auricular depolarization, ventricular depolarization, auricular systole.
(b) Ventricular depolarization, auricular systole, ventricular diastole.
(c) Auricular depolarization, ventricular repolarization, auricular diastole.
(d) Auricular depolarizaion, ventricular diastole, auricular systole.

19 EXCRETORY PRODUCTS AND THEIR ELIMINATION

Fill in the Blanks :

1. The projections of renal pelvis are called _______ .
2. Glomerulus and Bowman's capsule constitute _______ .
3. Excretion of nitrogenous waste product in semi-solid form occur in _______ .
4. The ascending loop of Henle is permeable for _______ .
5. Ammonia is the main nitrogenous excretory material in _______ .
6. Colloidal osmotic pressure in blood plasma is mainly due to _______ .
7. The part of the nephron impermeable to water is _______ .
8. In the renal tubules the permeability of the distal convoluted tubule and collecting duct to water is controlled by _______ .
9. The hormone that promotes reabsorption of water from glomerular filtrate is _______ .
10. In comparison to blood plasma, percentage of glucose in glomerular filtrate is _______ .
11. The efferent arteriole emerging from the glomerulus forms a fine capillary network around the renal tubule called the _______ .

True/ False :

1. Maximum number of nephrons in kidney are juxta-medullary type.
2. Malpighian capsules are present in the cortex region.
3. Distal convoluted tubule is incapable of reabsorbing HCO_3^-.
4. During summer when body loses lots of water by evaporation, the release of ADH is suppressed.
5. Counter-current flow of blood in vasa recta helps to retain the reabsorbed sodium in the renal medulla.
6. Urine is concentrated in Henle's loop.
7. Haemodialyser removes urea, uric acid, glucose and proteins.
8. Urine is hypertonic in distal convoluted tubule.

Conceptual MCQs :

1. If Henle's loop were absent from mammalian nephron, which of the following is to be expected?
   (a) The urine will be more dilute
   (b) There will be no urine formation
   (c) There will be hardly any change in the quality and quantity of urine formed
   (d) The urine will be more concentrated
2. A terrestrial animal must be able to
   (a) excrete large amounts of water in urine
   (b) conserve water
   (c) actively pump salts out through the skin
   (d) excrete large amounts of salts in urine
3. A person is undergoing prolonged fasting. His urine will be found to contain abnormal quantities of:
   (a) fats
   (b) amino acids
   (c) glucose
   (d) ketones
4. Which one of the following statements is correct with respect to kidney function regulation ?
   (a) When someone drinks lot of water, ADH release is suppressed.

(b) Exposure to cold temperature blood flow stimulates formation of Angiotensin II.
(c) An increase in glomerular blood flow stimulates formation of Angiotensin II.
(d) During summer when body loses lot of water by evaporation, the release of ADH is suppressed.

5. Nitrogenous waste products are eliminated mainly as
(a) urea in tadpole and ammonia in adult frog
(b) ammonia in tadpole and urea in adult frog
(c) urea in both tadpole and adult frog
(d) urea in tadpole and uric acid in adult frog

6. Patients of diabeties have glucose in urine because –
(a) glucose is not absorbed from GF
(b) glucose is absorbed from GF
(c) glandular cells secreted glucose in GF
(d) concentration of glucose is more in GF as compared to its normal amount

7. Which one of the following body functions is not performed by kidneys ?
(a) Excretion
(b) Osmoregulation
(c) Regulation of blood volume
(d) Destruction of dead blood corpuscles

8. Which secretes renin ?
(a) Stomach
(b) Juxta cortical cell
(c) Juxta glomerular body
(d) Juxta medullary cell

9. The afferent and efferent vessels are –
(a) arterial in nature
(b) venous in nature
(c) one is arterial and the other is venous
(d) none of the above

10. Podocytes are present in –
(a) afferent arteriole
(b) peritubular network
(c) efferent arteriole
(d) Bowman's cup

11. What will happen if the stretch receptors of the urinary bladder wall are totally removed?
(a) Micturition will continue
(b) Urine will continue to collect normally in the bladder
(c) There will be no micturition
(d) Urine will not collect in the bladder

12. Uric acid is the chief nitrogenous component of the excretory products of
(a) earthworm (b) cockroach
(c) frog (d) man

13. Which one of the following is not a part of a renal pelvis?
(a) Peritubular capillaries
(b) Convoluted tubules
(c) Collecting ducts
(d) Loops of Henle

14. Which one of the following correctly explains the function of a specific part of a human nephron ?
(a) Podocytes : create minute spaces (slite pores) for the filtration of blood into the Bowman's capsule
(b) Henle's loop : most reabsorption of the major substances from the glomerular filtrate
(c) Distal convoluted tubule : reabsorption of K^+ ions into the surrounding blood capillaries
(d) Afferent arteriole : carries the blood away from the glomerular towards renal vein.

15. Uricotelic mode of passing out nitrogenous wastes is found in
(a) Reptiles and Bird
(b) Birds and Annelids
(c) Amphibians and Reptiles
(d) Insects and Amphibians

16. A fall in glomerular filtration rate (GFR) activates
(a) adrenal cortex to release aldosterone.
(b) adrenal medulla to release adrenaline.
(c) juxta - glomerular cells to release renin.
(d) posterior pituitary to release vasopressin.

17. In which of the following minimum content of urea is present?
(a) Hepatic portal vein (b) Portal vein
(c) Renal vein (d) Vena cava

18. Duct of Bellini is concerned with
(a) Filtration of urine
(b) Purification of urine
(c) Conduction of urine
(d) All the above

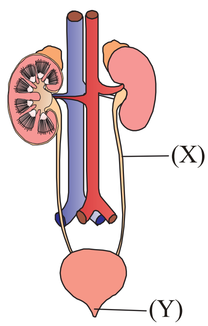
19. Which one is related to urine concentration in mammals ?
(a) Testosterone hormone
(b) Antidiuretic hormone

(c) Oxytocin hormone
(d) All of these

20. A condition of failure of kidney to form urine is called
(a) deamination (b) entropy
(c) anuria (d) None of these

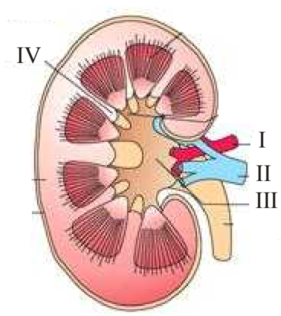
Diagram Based Questions :

1. The label X and Y in the given diagram of human urinary system represents



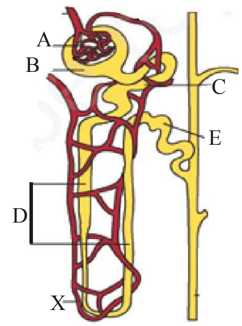
(a) X- Urethra, Y- Ureter
(b) X- Ureter, Y- Urethra
(c) X- Bladder, Y- Urethra
(d) X- Ureter, Y- Bladder

2. The given figure shows the longitudinal section of kidney with few structures labelled as I, II, III & IV identify renal vein in the given figure.



(a) I renal artery (b) II renal vein
(c) III renal pelvis (d) IV renal column

Directions for (Q. 3-5): *Refer the given diagrammatic representation of a nephron of human excretory system and answer the following questions.*

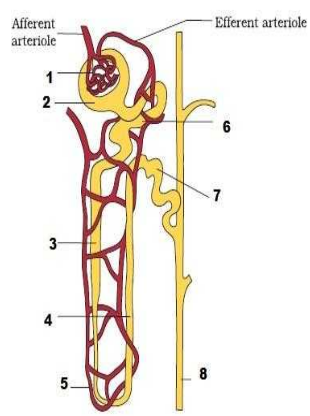


3. The label X represents ___________ that function in _____________.
(a) Vasa recta- Reabsorption of water, minerals and digestive end products.
(b) Henle's loop- Filtration of plasma leaving the blood.
(c) Vasa recta- Filtration of plasma leaving the blood.
(d) Henle's loop- Reabsorption of water, minerals and digestive end products.

4. Which blood component would not usually pass through the membranes from region A to region B?
(a) Mineral salts (b) Red blood cells
(c) Urea (d) Water

5. After the blood enters the kidney, it travels to the ___________.
(a) A (b) B
(c) C (d) D

Directions for (Q. 6 to 7): *Refer the given figure of nephron showing blood vessels and duct and answer the questions.*



6. Cells of which part is lined by simple cuboidal brush border epithelium that increases the surface area for reabsorption? Identify the name also.
(a) 3, Descending limb of loop of Henle
(b) 5, Vasa recta
(c) 6, Proximal convoluted tubule
(d) 7, Collecting duct
7. Which part is capable of reabsorption of HCO3 - and selective secretion of hydrogen and potassium ions and NH_3 to maintain the pH and sodium-potassium balance in blood?
(a) 1 (b) 3
(c) 5 (d) 7

Assertion/ Reason :

DIRECTIONS (Qs. 1-11): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Urinary bladder and ureters are lined by transitional epithelium.
Reason : Ureters carry the urine to urinary bladder where it is stored temporarily.
2. **Assertion :** In vertebrates, the liver is also referred as an accessory excretory organ.
Reason : Liver helps kidneys in the secretion of urine.
3. **Assertion :** Aquatic mammals like whales and seals are said to be ureotelic animals.
Reason : It is because of the fact that their main nitrogenous waste product is urea.
4. **Assertion :** Renal threshold of glucose is said to be 180 mg per 100 ml.
Reason : Glucose starts appearing in the urine when its blood level exceed 180 mg per 100 ml of blood.
5. **Assertion :** If human urine is allowed to stand for some time, it smells strongly of ammonia.
Reason : Main constituent of human urine is ammonia.
6. **Assertion :** Kidneys maintain the osmotic concentration of the blood.
Reason : Kidneys eliminate either hypotonic or hypertonic urine according to the need of the body.
7. **Assertion :** Hemodialysis can save and prolong the life of uremic patients.
Reason : Waste products like urea can be removed from the blood by the process of hemodialysis.
8. **Assertion :** In the descending limb of loop of Henle, the urine is hypertonic, while in ascending limb of loop of Henle, the urine is hypotonic.
Reason : Descending limb is impermeable to Na^+, while ascending limb is impermeable to H_2O.
9. **Assertion :** The glomerular filtrate resembles the protein free plasma in composition and osmotic pressure.
Reason : The glomerular capillary wall and inner membrane of Bowman's capsule are impermeable to large molecules..
10. **Assertion :** During micturition, urine is prevented from flowing back into the ureters.
Reason : Urethral sphincters relax during micturition.
11. **Assertion :** Secreting hypotonic urine is effective in reducing urinary loss of water.
Reason : Hypotonic urine is more concentrated and higher in osmotic pressure than the blood.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I (Function)		Column-II (Parts of excretory systems)
(A)	Ultra filtration	I.	Henle's loop
(B)	Concentration	II.	Ureter of urine
(C)	Transport of	III.	Urinary bladder urine
(D)	Storage of urine	IV.	Malpighian corpuscle
		V.	Proximal convoluted

tubule
(a) A – IV; B – I; C – II; D – III
(b) A – IV; B – III; C – II; D – I
(c) A – V; B – IV; C – I; D – III
(d) A – V; B – IV; C – I; D – II

2.

Column-I (Disorders)	Column-II (Feature)
(A) Uremia	I. Excess of protein in urine
(B) Hematuria	II. Presence of high ketone bodies in urine
(C) Ketonuria	III. Presence of blood cells in urine
(D) Glycosuria	IV. Presence of glucose in urine
(E) Proteinuria	V. Excess of urea in blood

(a) A - V; B -III; C - II; D - IV; E - I
(b) A - IV; B - V; C - III; D - II; E - I
(c) A - V; B -III; C - IV; D - II; E - I
(d) A - III; B -V; C - II; D - I; E - IV

3.

Column-I (Parts of the nephron)	Column-II (Functions)
(A) Proximal convoluted actively in this region.	I. Sodium is reabsorbed tubules
(B) Distal convoluted	II. Sodium and water are tubules reabsorbed under the influence of hormone in this region.
(C) Descending limb	III. Primary site of glucose and amino acid reabsorption.
(D) Ascending limb	IV. Major substance reabsorbed here is water by osmosis.

(a) A – I; B – II; C – III; D – IV
(b) A – IV; B – I; C – II; D – III
(c) A – III; B – IV; C – II; D – I
(d) A – III; B – II; C – IV; D – I

4.

Column I (Types of organ)	Column II (Role in excretion)
(A) Lungs	I. Secretes bile-containing substances like bilirubin, biliverdin, cholesterol, degraded steroid hormones, vitamins and drugs.
(B) Liver	II. Eliminates water and salts in sweat and substances like sterols, hydrocarbons and waxes through sebum.
(C) Skin	III. Remove large amounts of CO_2 (18 litres / day) and also significant quantities of water every day
(D) Kidney	IV. Remove wastes (metabolic by-products) and regulate pH, ion concentration, volume and osmolarity of blood

	A	B	C	D
(a)	I	II	III	IV
(b)	III	I	II	IV
(c)	III	I	IV	II
(d)	II	IV	III	I

5.

Column I	Column II
(A) Fall in GFR	I. Activate the JG cells to release renin
(B) Angiotensin II	II. Increases the glomerular blood pressure and thereby GFR
(C) Renin	III. Carries out the conversion of angioten--sinogen in the liver to angiotensin I.
(D) Aldosterone	IV. Causes reabsorption of Na+ and water from the distal parts of the tubule. This also leads to an increase in blood pressure and GFR.
(E) An excessive loss of fluid from the body	v. Activate osmoreceptors which stimulate the hypothalamus to release ADH from the neurohy-pophysis

	A	**B**	**C**	**D**	**E**
(a)	I	II	III	IV	V
(b)	III	V	II	IV	I
(c)	III	I	V	II	IV
(d)	V	IV	III	I	II

6.

Column I (Excretory organs)	Column II (Animals)
(A) Nephridia	I. *Hydra*
(B) Malpighian tubules	II. Leech
(C) Protonephridia	III. Shark
(D) Kidneys	IV. Round worms
	V. Cockroach

(a) A $\rightarrow$ II; B $\rightarrow$ V; C $\rightarrow$ IV; D $\rightarrow$ III
(b) A $\rightarrow$ IV; B $\rightarrow$ II; C $\rightarrow$ I; D $\rightarrow$ V
(c) A $\rightarrow$ V; B $\rightarrow$ II; C $\rightarrow$ IV; D $\rightarrow$ III
(d) A $\rightarrow$ II; B $\rightarrow$ IV; C $\rightarrow$ V; D $\rightarrow$ I

Critical Thinking Type Questions :

1. Workers in deep mines usually suffer from dehydration because
(a) water is lost due to evaporation.
(b) water is lost due to defecation.
(c) water is lost in the form of urine.
(d) water is lost along with salts in the form of sweat.

2. Which of the following sets of animals produce the same substances as their chief excretory product?
(a) Fish, pigeon and frog
(b) Camel, housefly and snake
(c) Frog, monkey and dog
(d) *Amoeba*, ant and antelope

3. Filtration slits are formed by
(a) endothelial lining of glomerular capillaries.
(b) inner epithelium of Bowman's capsule.
(c) basement membrane.
(d) the participation of all of these.

4. The cells named podocytes occur in
(a) inner wall of Bowman's capsule
(b) outer wall of Bowman's capsule
(c) in the wall of glomerulus
(d) in the wall of Henle's loop

5. Ultrafiltration occurs in a glomerulus when
(a) hydrostatic pressure exceeds osmotic pressure.
(b) osmotic pressure exceeds hydrostatic pressure.
(c) capsular hydrostatic pressure exceeds glomerular hydrostatic pressure.
(d) colloidal osmotic pressure plus capsular pressure remain less than glomerular hydrostatic pressure.

6. Filtration fraction is the ratio of
(a) glomerular filtration rate (GFR) to renal plasma flow (RPF)
(b) glomerular filtrate to urine
(c) haemoglobin to oxyhaemoglobin
(d) O_2 to CO_2

7. In a mammalian kidneys, Bowman's capsules occur in __(i)__ while loops of Henle are situated in __(ii)__.
(a) (i) – cortex, (ii) – medulla
(b) (i) – medulla, (ii) – cortex
(c) (i) – cortex, (ii) – pelvis
(d) (i) – pelvis, (ii) – medulla

8. Urine is hypertonic
(a) in Bowman's capsule.
(b) in PCT.
(c) in the middle of descending & ascending limb of Henle's loop.
(d) at the end of ascending limb of Henle's loop.

9. Diuresis is a condition characterized by
(a) increase in urine volume.
(b) increased glucose excretion.
(c) decrease in urine volume.
(d) decrease in electrolyte balance.

10. In nephron water absorption is maximum in
(a) proximal convoluted tubule (PCT).
(b) ascending limb of Henle.
(c) descending limb of Henle.
(d) distal convoluted tubule (DCT).

20 LOCOMOTION AND MOVEMENT

Fill in the Blanks :

1. Glenoid cavity is found in _______ .
2. The joint in our neck which allows us to rotate our head left to right is _______ .
3. In mammals the lower jaw is made of _______ .
4. Number of floating ribs in human body is _______ .
5. A cup shaped cavity for articulation of femur head is _______ .
6. Red muscle fibres are rich in _______ .
7. Part of the body having a single pair of bones is called _______ .
8. The axon terminals of a nerve cell and the sarcolemma of a skeletal muscle cell join at the _______ .

True/ False :

1. Ciliary movement help in passage of ova through female reproductive tract.
2. The central part of thick filaments, not overlapped by thin filaments is called Z-band.
3. Parietal bone and the temporal bone of the skull are joined by fibrous joint.
4. The 9^{th} and 10^{th} pairs of ribs are called the floating ribs.
5. Glenoid cavity is a depression to which the thigh bone articulates.
6. Accumulation of uric acid crystals in joints causes their inflammation.
7. Acetylcholine is released when the neural signal reaches the motor end plate.
8. Muscle contraction is initiated by the signal sent by CNS *via* a sensory neuron.
9. Anaerobic breakdown of glycogen in the muscles can lead to the accumulation of lactic acid.

Conceptual MCQs :

1. What is sarcomere?
   (a) Part between two H-lines
   (b) Part between two A-lines
   (c) Part between two I-bands
   (d) Part between two Z-lines
2. Long bones function in
   (a) support
   (b) support, erythrocyte and leucocyte synthesis
   (c) support and erythrocyte synthesis
   (d) erythrocyte formation
3. The number of floating ribs in the human body, is
   (a) 6 pairs (b) 5 pairs
   (c) 3 pairs (d) 2 pairs
4. Cartilagenous joints –
   (a) permit slight movements
   (b) are found in symphysis
   (c) are found in the bodies of vertebrae
   (d) all the above
5. In old age stiffness of joints is due to the –
   (a) hardening of bones
   (b) inefficiency of muscles
   (c) decrease in synovial fluid
   (d) enlargement of bones
6. During strenuous exercise, glucose is converted into –
   (a) glycogen (b) pyruvic acid
   (c) starch (d) lactic acid

7. We move our hand while walking for
(a) faster movement
(b) balancing
(c) increasing blood circulation
(d) relieving tension

8. Elbow joint is –
(a) ball and socket joint (b) hinge joint
(c) suture joint (d) gliding joint

9. Hinge joints –
(a) are synovial joints
(b) permit movement in one direction
(c) are found in knee
(d) all the above

10. Immediate source of energy for muscle contraction is
(a) glucose (b) GTP
(c) creatine phosphate (d) ATP

11. Select the correct statement regarding the specific disorder of muscular or skeletal system :
(a) Muscular dystrophy - age related shortening or muscles.
(b) Osteoporosis - decrease in bone mass and higher chance of fractures with advancing age.
(c) Myasthenia gravis - Autoimmune disorder which inhibits sliding of myosin filaments
(d) Gout - inflammation of joints due to extra deposition of calcium.

12. Which one of the following pairs of chemical substances is correctly categorized?
(a) Calcitonin and thymosin - Thyroid hormones
(b) Pepsin and prolactin - Two digestive enzymes secreted in stomach
(c) Troponin and myosin - Complex proteins in striated muscles
(d) Secretin and rhodopsin - Polypeptide hormones

13. The H-zone in the skeletal muscle fibre is due to
(a) The central gap between myosin filaments in the A-band.
(b) The central gap between actin filaments extending through myosin filaments in the A-band
(c) Extension of myosin filaments in the central portion of the A-band.
(d) The absence of myofibrils in the central portion of A-band.

14. Sesamoid bone is derived from-
(a) Cartilage (b) Areolar tissue
(c) Tendon (d) Ligament

15. Myofibrils are made up of
(a) Myosin and actin
(b) Myosin and troponin
(c) Actin and tropomyosin
(d) All the above components

16. Humerus differs from the femur in having:
(a) Sigmoid notch (b) Trochanter
(c) Deltoid ridge (d) None of these

17. Total number of bones in the hindlimb of a man is
(a) 14 (b) 21
(c) 24 (d) 30

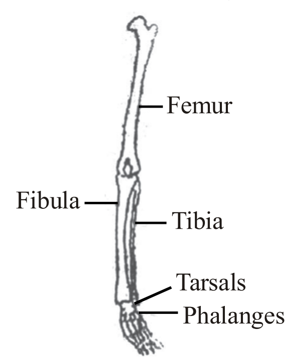
18. The functional unit of contractile system in striated muscle is
(a) cross birdge (b) myofibril
(c) sacromere (d) Z-band

19. The joint between atlas and axis is called
(a) pivot joint (b) hinge joint
(c) saddle joint (d) angular joint

20. Ligament is mainly made up of
(a) reticulin (b) elastin
(c) myosin (d) collagen

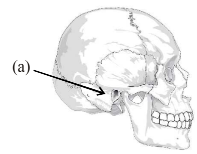
Diagram Based Questions :

1. Given below is a diagram of the bones of the left human hindlimb as seen from the front. It has certain mistakes in labelling. Identify the two bones which are not correctly labelled.



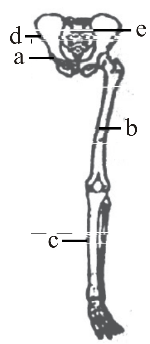
(a) Tibia and Tarsals
(b) Femur and Fibula
(c) Fibula and Phalanges
(d) Tarsals and Femur

2. In the given diagram of skull, what does "a" represent?



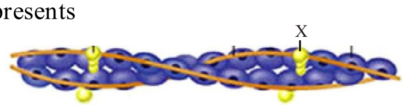
(a) Frontal bone
(b) Temporal bone
(c) Occipital bone
(d) Parietal bone

3. The diagram given below shows the pelvic girdle and lower limb.



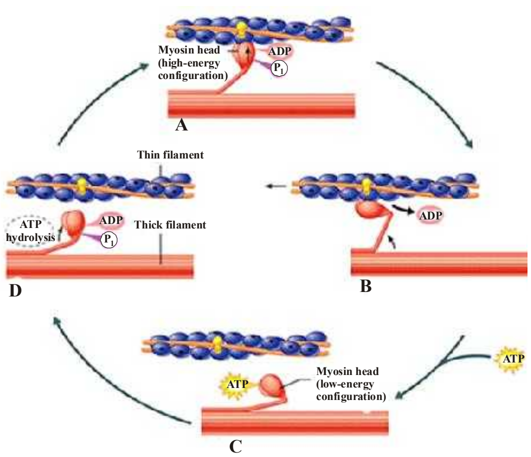
Parts labelled as 'a', 'b', 'c', 'd' and 'e' respectively indicate
(a) Ilium, Femur, Tibia, Pubis and Sacrum
(b) Pubis, Tibia, Femur, Ilium and Sacrum
(c) Ilium, Femur, Tibia, Pubis and Sacrum
(d) Pubis, Femur, Tibia, Ilium and Sacrum

4. The label X in the given figure of an act in filament represents



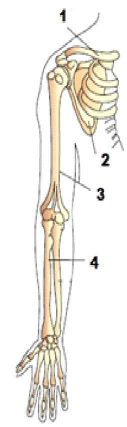
(a) actin (b) myosin
(c) tropomyosin (d) troponin

5. The given figure represents the cross bridge cycle in skeletal muscle. What does the step B in the figure represents?



(a) Attachment of myosin head to actin forming cross bridge.
(b) Release of phosphate. Myosin changes shape to pull actin.
(c) Attachment of new ATP to myosin head. The cross bridge detaches.
(d) Splitting of ATP into ADP and Pi. Myosin cocks into its high energy conformation.

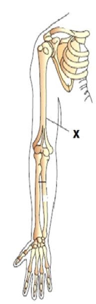
6. The given figure shows right pectoral girdle and upper arm. Few parts are marked as 1, 2, 3 and 4.



Which of the following options shows the correct labelling of marked parts?

	1	2	3	4
(a)	**Clavicle**	**Scapula**	**Humerus**	**Radius**
(b)	Scapula	Clavicle	Radius	Humerus
(c)	Sacrum	Scapula	Ulna	Tibia
(d)	Radius	Clavicle	Scapula	Humerus

7. The given figure shows the structure of pectoral girdle and upper arm. Identify the structure marked as "X" and its feature.



(a) Humerus: Longest bone of upper extremity and is characterized by presence of deltoid tuberosity for the attachment of muscles.
(b) Radius: It is a smaller bone and formed by sesamoid bone.
(c) Ulna: The bone extending from the elbow to the wrist on the side opposite to the thumb in humans.
(d) Femur: Longest and largest bone of body.

Assertion/ Reason :

DIRECTIONS (Qs. 1-9): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** There are similarities between the locomotion of unicellular organisms and multicellular animal.
Reason : Ciliary, flagellar and amoeboid movement occur in unicellular organisms.

2. **Assertion :** Exra oxygen consumption in human body is known as oxygen debt.
Reason : The extra oxygen is required by the body to oxidise the accumulated lactic acid produced during strenous exercise.

3. **Assertion :** Arthritis or inflammation of a joint makes the joint painful.
Reason : Some toxic substances are deposited at the joint.

4. **Assertion :** Biceps and triceps are called antagonistic muscles.
Reason : This is due to the fact that they contract and relax together.

5. **Assertion :** Ball and socket joints are the most mobile joints.
Reason : Synovial fluid is present here.

6. **Assertion :** Triceps is said to be an extensor muscle for elbow joint.
Reason : Triceps relaxes durings extension of forearm at the elbow joint.

7. **Assertion :** Muscle contraction force increases with rise in strength of stimulus.
Reason : This is due to increased contraction of individual muscle fibres with increase in stimulus strength.

8. **Assertion :** The phase of muscle contraction occurs when myosin binds and releases actin.
Reason : Muscle contraction is initiated by a signal sent by the peripheral nervous system via a motor neuron.

9. **Assertion :** Recurrent activation of the muscles will become fatigue.
Reason : Anaerobic breakdown of glycogen in the muscles can lead to the accumulation of lactic acid.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column I (Type of synovial joint)	**Column II (Bone involved)**
(A) Ball and Socket joint	I. Carpal and metacarpal of thumb
(B) Hinge joint	II. Humerus and pectoral girdle
(C) Pivot joint	III. Knee
(D) Saddle joint	IV. Atlas and axis

(a) A – I; B – II; C – III; D – IV
(b) A – II; B – III; C – IV; D – I
(c) A – III; B – I; C – IV; D – II
(d) A – IV; B – III; C – II; D – I

2. | | Column-I | | Column-II |
|---|---|---|---|
| (A) | Carpals | I. | Bones that form the fingers and toes |
| (B) | Tarsals | II. | Bones that form wrist |
| (C) | Phalanges | III. | Bones that form the palms of the hands |
| (D) | Metatarsals | IV. | Bones that form the ankles |

(a) A – II; B – IV; C – I; D – III
(b) A – I; B – II; C – III; D – IV
(c) A – III; B – II; C – IV; D – I
(d) A – IV; B – I; C – III; D – II

3. | | Column-I | | Column-II |
|---|---|---|---|
| (A) | Thoracic | I. | 8 |
| (B) | Wrist bones | II. | 2 pairs |
| (C) | False ribs | III. | 12 |
| (D) | Metatarsal | IV. | 3 pairs |
| (E) | Skull (cranial & facial) | V. | 26 |
| | | VI. | 5 |
| | | VII. | 22 |

	A	B	C	D	E
(a)	I	VI	II	V	III
(b)	III	I	IV	VI	VII
(c)	II	VII	III	V	I
(d)	II	V	VII	I	IV

4. | | Column-I | | Column-II |
|---|---|---|---|
| (A) | Striated appearance of myofibril | I. | Distribution pattern of actin and myosin |
| (B) | Store house of calcium ions | II. | Sarcoplasmic reticulum |
| (C) | Energy released from ATP hydrolysis | III. | Helps myosin head to bind to exposed active sites on actin to form a cross bridge |
| (D) | Globular head of meromyosin | IV. | Active ATPase enzyme and has binding sites for ATP and active sites for actin. |

	A	B	C	D
(a)	I	II	III	IV
(b)	III	I	IV	II
(c)	II	I	III	IV
(d)	III	IV	II	I

5. | | Column I | | Column II (Number of bones) |
|---|---|---|---|
| (A) | Cranium / Brainbox | I. | 29 |
| (B) | Skull (Branial and facial bones) | II. | 8 |
| (C) | Face | III. | 14 |
| (D) | Hind limb | IV. | 12 pairs |
| (E) | Ribs | V. | 30 |

(a) $A \rightarrow I; B \rightarrow II; C \rightarrow III; D \rightarrow V; E \rightarrow IV$
(b) $A \rightarrow II; B \rightarrow I; C \rightarrow III; D \rightarrow V; E \rightarrow IV$
(c) $A \rightarrow I; B \rightarrow II; C \rightarrow III; D \rightarrow IV; E \rightarrow V$
(d) $A \rightarrow V; B \rightarrow IV; C \rightarrow III; D \rightarrow II; A \rightarrow I$

6. | | Column I | | Column II |
|---|---|---|---|
| (A) | False ribs | I. | 1st to 7th pair |
| (B) | True ribs | II. | 11th and 12th pair |
| (C) | Floating ribs | III. | 8th to 10th pair |
| (D) | Sternum | IV. | One |

(a) $A \rightarrow I; B \rightarrow II; C \rightarrow III; D \rightarrow IV$
(b) $A \rightarrow IV; B \rightarrow III; C \rightarrow II; D \rightarrow I$
(c) $A \rightarrow I; B \rightarrow III; C \rightarrow II; D \rightarrow IV$
(d) $A \rightarrow III; B \rightarrow I; C \rightarrow II; D \rightarrow IV$

7. | | Column I | | Column II |
|---|---|---|---|
| (A) | Ribs are attached to the sternum ventrally and to the vertebrae dorsally. | I. | True ribs |
| (B) | Ribs are attached to sternum through coastal cartilage (hyaline) of 7th rib | II. | False ribs |
| (C) | Ribs are not attached to sternum | III. | Floating ribs |

(a) $A \rightarrow I; B \rightarrow II; C \rightarrow III$
(b) $A \rightarrow 1; B \rightarrow III; C \rightarrow II$
(c) $A \rightarrow II; B \rightarrow I; C \rightarrow III$
(d) $A \rightarrow III; B \rightarrow II; C \rightarrow I$

Critical Thinking Type Questions :

1. Which of the following represents the correct order of vertebral regions from superior to inferior?
   I. Sacrum II. Thoracic
   III. Cervical IV. Lumbar
   V. Coccyx
   (a) I – II – III – IV – V (b) II – IV – I – III – V
   (c) IV – I – II – V – I (d) III – II – IV – I – V
2. What is the correct order that a motor nerve impulse travels when triggering a muscle contraction?
   (a) Motor nerve→synaptic cleft→sarcolemma→ sarcoplasmic reticulum→troponin.
   (b) Motor nerve → synaptic cleft → sarcolemma → troponin → sarcoplasmic reticulum.
   (c) Motor nerve → sarcoplasmic reticulum → synaptic cleft → sarcolemma → troponin.
   (d) Motor nerve → sarcolemma → sarcoplasmic reticulum → synaptic cleft → troponin.
3. There are three blanks in the following statement. Mark the correct option having suitable words for filling the blanks.
   The thin filaments of myofibril contain .... 'A'......actin and two filaments of .... 'B'......protein along with .... 'C'......protein for masking binding site for myosin.

	'A'	'B'	'C'
(a)	1F	troponin	tropomyosin
(b)	1F	tropomyosin	troponin
(c)	2F	troponin	tropomyosin
(d)	2F	tropomyosin	troponin

4. In which option the number of bones of two corresponding parts are not the same?
   (a) Thigh and upper arm
   (b) Sole and palm
   (c) Ankle and wrist
   (d) Leg and arm
5. The intercalated discs of________ muscle ________.
   (a) smooth; provide strong mechanical adhesion and rapid electrical communication
   (b) skeletal; are the basis for all voluntary muscle action
   (c) skeletal; make possible both fast twitches and slow twitches
   (d) cardiac; provide strong mechanical adhesion and rapid electrical communication
6. Convexity of one bone articulate with concavity of other bone in
   (a) pivot joint (b) hinge joint
   (c) gliding joint (d) ball and socket joint
7. All or None law is associated with
   (a) skeletal muscle fibre
   (b) neuron
   (c) cardiac muscle fibres
   (d) all of the above
8. Long uninucleate muscles are found in
   (a) diaphragm (b) alimentary canal
   (c) tongue (d) eye
9. Which of the following is not exclusively supplied with involuntary muscles?
   (a) Muscles of iris
   (b) Muscles of the ducts of gland
   (c) Muscles of urethra
   (d) Muscular coats of blood vessel
10. Muscles of alimentary canal are mainly
    (a) striated and myogenic
    (b) striated and neurogenic
    (c) unstriated and neurogenic
    (d) unstriated and myogenic

21 Neural Control and Co-ordination

Fill in the Blanks :

1. The secretion of gastric juice is controlled by _______ .
2. The thinned-out portion of retina where only cones are densely packed is called _______ .
3. At the base of cochlea, the canal that ends at the oval window is _______ .
4. The stereocilia of hair cells of organ of Corti are covered with a thick elastic membrane called _______ .
5. The region of vertebrate's eye where the optic nerve passes out of the retina is called _______ .
6. The amount of light that falls on retina is regulated by _______ .
7. The nerves carrying impulses to CNS are known as _______ .
8. The controlling centre of autonomic nervous system is _______ .
9. Clusters of neuron cell bodies embedded in the white matter of the brain are referred to as _______ .

True/ False :

1. Electrical synapses are more common in our neural system than chemical synapses.
2. Hypothalamus is the major coordination centre for sensory and motor signaling.
3. The tracts of nerve fibres that connect two cerebral hemispheres are called corpora bigemina.
4. The ear ossicle attached to tympanic membrane is malleus.
5. The pressure on ear drum is equalized by Eustachian tube.
6. Somatic nervous system- Conducts impulses from CNS to skeletal muscles.
7. The malleus is attached to the oval window and the stapes is attached to the temporal membrane of the cochlea.
8. The space within cochlea called scala media is filled with endolymph.
9. The vestibular apparatus is composed of two semi-circular canals and the otolith organ consisting of the saccule and utricle.

Conceptual MCQs :

1. Afferent nerve fibres carry impulses from
   (a) effector organs to CNS
   (b) receptors to CNS
   (c) CNS to receptors
   (d) CNS to muscles
2. Iris is part of
   (a) sclerotic
   (b) choroid
   (c) choroid and retina
   (d) sclerotic and choroid
3. Which of the following statements is correct for 'nodes of Ranvier' of nerve?
   (a) Neurilemma is discontinuous
   (b) Myelin sheath is discontinuous
   (c) Both neurilemma and myelin sheath are discontinuous
   (d) Covered by myelin sheath
4. In the resting state of the neural membrane, diffusion due to concentration gradients, if allowed, would drive
   (a) K^+ into the cell
   (b) K^+ and Na^+ out of the cell
   (c) Na^+ into the cell
   (d) Na^+ out of the cell

5. Which part of the brain regulates the body temperature, hunger and water balance ?
(a) Hypothalamus
(b) Infundibulum
(c) Medulla oblongata
(d) Pons veroli

6. Nerve fibres are surrounded by an insulating fatty layer called –
(a) adipose sheath (b) myelin sheath
(c) hyaline sheath (d) peritoneum

7. In a nerve cell potassium concentration is
(a) less on the inside
(b) greater on the outside of membrane
(c) more concentrated inside
(d) equal on both sides of membrane

8. The pathway of reflex arc as :
(a) sense organ, spinal cord, motor neuron, sensory nerve, muscle
(b) sense organ, sensory, neuron, motor neuron spinal cord, muscle
(c) sense organ, motor neuron, spinal cord, sensory neuron, muscle
(d) sense organ, motor neuron, spinal cord, sensory neuron, muscle

9. Energy transformation in nervous system is-
(a) chemical to radiant
(b) chemical to mechanical
(c) chemical to electrical
(d) chemical to osmotic

10. No image formation occurs on blind-spot of retina because–
(a) it is not present on the optical axis of the eye
(b) here cones and rods are absent
(c) on this part only cones are present
(d) the nerve fibres of this region do not contribute in the formation of optic chiasma

11. Alzheimer disease in humans is associated with the deficiency of:
(a) glutamic acid
(b) acetylcholine
(c) gamma aminobutyric acid (GABA)
(d) dopamine

12. The nerve centres which control the body temperature and the urge for eating are contained in:
(a) hypothalamus (b) pons
(c) cerebellum (d) thalamus

13. The purplish red pigment rhodopsin contained in the rods type of photoreceptor cells of the human eye, is a derivative of:
(a) vitamin B_1 (b) vitamin C
(c) vitamin D (d) vitamin A

14. The human hind brain comprises three parts, one of which is :
(a) Spinal cord
(b) Corpus callosum
(c) Cerebellum
(d) Hypothalamus

15. Which part of the human ear plays no role in hearing as such but is otherwise very much required?
(a) Eustachian tube (b) Organ of corti
(c) Vestibular apparatus (d) Ear ossicles

16. The most abundant intracellular cation is :
(a) Ca^{++} (b) H^+
(c) K^+ (d) Na^+

17. Fenestra ovalis is the opening of –
(a) Cranium (b) Tympanum
(c) Tympanic cavity (d) Brain

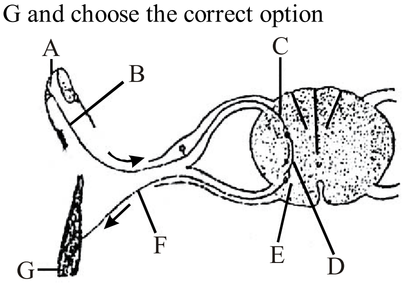
18. Multipolar nerve cells are present in
(a) Cochlea
(b) Dorsal root ganglia of spinal cord
(c) Retina of eye
(d) Brain

19. Which cranial nerve has the highest number of branches?
(a) Facial nerve (b) Trigeminal
(c) Vagus nerve (d) None of these

20. The cavity of diencephalon is known as
(a) I ventricle (b) II ventricle
(c) III ventricle (d) iter

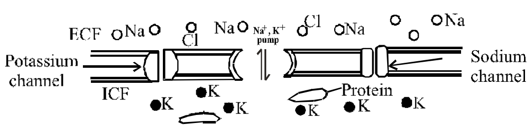
Diagram Based Questions :

1. The following diagram represent the reflex arc. Identify the parts labelled as A, B, C, D, E, F and G and choose the correct option



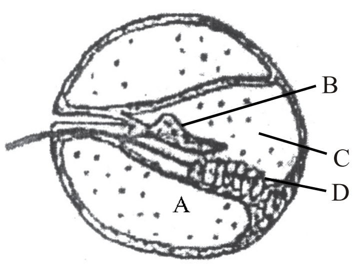
(a) A - sense organ; B - sensory nerve; C - dorsal horn; D - interneuron; E - ventral horn; F - motor nerve ; G - effector
(b) A - sense organ; B - sensory nerve; C - ventral horn; D - interneuron; E - dorsal horn; F - motor nerve; G - effector
(c) A - effector; B - motor nerve; C - dorsal horn; D - interneuron; E - ventral horn; F - sensory nerve; G - effector
(d) A - effector; B - motor nerve; C - ventral horn; D - interneuron; E - dorsal horn; F - sensory nerve; G - sense organ.

2. In the given diagram which stage of conduction of nerve impulse through nerve fibre is observed?



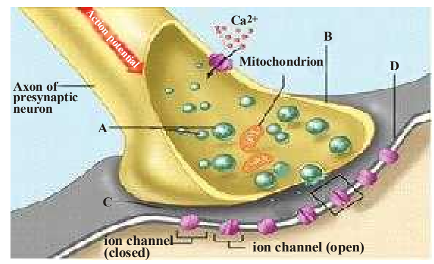
(a) Polarization (b) Resting potential
(c) Repolarization (d) Depolarization

3. Given below is a diagrammatic cross section of a single loop of human cochlea with few part labelled as A, B, C & D.



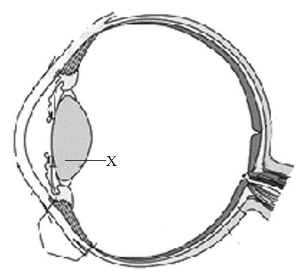
Which one of the following options correctly represents the name of three different parts?
(a) A: Perilymph, B: Tectorial membrane C: Endolymph
(b) B: Tectorial membrane, C:Perilymph, D: Secretory cells
(c) C: Endolymph, D: Sensory hair cells, A: Serum
(d) D: Sensory hair cells, A: Endolymph B: Tectorial membrane

4. The given diagram chows the axon terminal and synapse with few part labelled as A, B, C & D. Choose the correct combination of labelling from the given options.



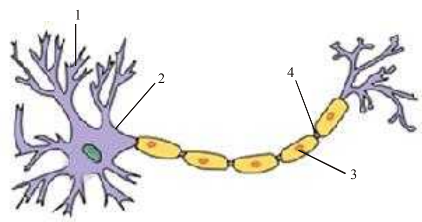
(a) A- Synaptic vesicle, B- Axon terminal, C- Synaptic cleft, D- Postsynaptic membrane
(b) A- Axon terminal, B- Synaptic vesicle, C- Postsynaptic membrane, D- Synaptic cleft.
(c) A- Synaptic vesicle, B- Synaptic cleft, C- Axon terminal, D- Post synaptic membrane
(d) A- Post synaptic membrane, B- Axon terminal, C- Synaptic vesicle, D- Synaptic cleft

5. The given diagram shows different parts of a human eye with one part labeled as X.



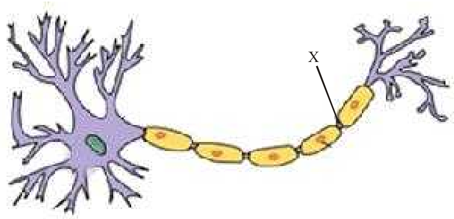
Which of the following statement is correct regarding label X?
(a) It is the opening in lens that permits light into the inner chambers of the eye.
(b) It is the coloured portion of vascular tunic.
(c) It is a biconcave structure that changes shape to bring objects into focus.
(d) It is thick, jelly-like substance in the posterior compartment of the eye.

6. Which of the following options correctly represents the name of 1, 2, 3 and 4 is the given diagram of neuron?



(a) 1- Axon, 2- Dendrites, 3- Node of Ranvier, 4- Myelin sheath
(b) 1- Dendrites, 2- Axon, 3- Node of Ranvier, 4- Myelin sheath
(c) 1- Dendrites, 2- Cell body, 3- Myelin sheath, 4- Node of Ranvier
(d) 1- Axon, 2- Cell body, 3- Dendrites, 4- Node of Ranvier

7. What is the function of label X in the given diagram?



(a) It speeds up the impulse transmission.
(b) It provides electrical insulation.
(c) It conducts impulse towards the nerve cell body.
(d) It is the functional unit of nerve.

Assertion/ Reason :

DIRECTIONS (Qs. 1-10): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Vitamin A deficiency produces night blindness.
Reason : Photosensitive pigment rhodopsin is synthesised from vitamin A.

2. **Assertion :** Tongue is a gustatoreceptor.
Reason : Receptors for gustatory sensations are located in the taste bud.

3. **Assertion :** Circular smooth muscles of iris contract when bright light falls on the eye.
Reason : Pupil gets constricted by the contraction of circular smooth muscles of iris.

4. **Assertion :** The chemical stored in the synaptic vesicles are termed as neurotransmitters.
Reason : Synaptic vesicles release these chemicals in the synaptic cleft.

5. **Assertion :** Nerve conduction is the one way conduction.
Reason : Nerve impulse is transmitted from dendrite terminals to axon terminals.

6. **Assertion :** Cerebrospinal fluid is present throughout the central nervous system.
Reason : CSF has no such function.

7. **Assertion :** The brain stem contains centres for controlling activities.
Reason : Brain stem is very sensitive.

8. **Assertion :** Medulla oblongata causes reflex actions like vomiting, coughing and sneezing.
Reason : It has many nerve cells which control autonomic reflexes.

9. **Assertion :** The imbalance in concentration of Na^+, K^+ and proteins generates resting potential.
Reason : To maintain the unequal distribution of Na^+ & K^+, the neurons use electrical energy.

10. **Assertion :** The auditory ossicles help in hearing.
Reason : Auditory ossicles maintain the balance of air pressure between two sides of the eardrum.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of* which *ONLY ONE is correct.*

1.

	Column-I	Column-II
(A)	Cerebrum	I. Controls the pituitary
(B)	Cerebellum	II. Controls vision and hearing
(C)	Hypothalamus	III. Controls the rate of heart beat
(D)	Medulla oblongata	IV. Maintains body posture

(a) A – II; B – IV; C – I; D – III
(b) A – IV; B – V; C – III; D – I
(c) A – V; B – IV; C – III; D – II
(d) A – V; B – V; C – I; D – II

2.

	Column I (Terms)	Column II (Definition)
(A)	Semi-circular canal	I. Spiral organ of Corti
(B)	Vestibule	II. Fluid found in the scala vestibule and scala tympani
(C)	Cochlea	III. Evaluates rotational motion
(D)	Perilymph	IV. Fluid found within the organ of Corti
(E)	Endolymph	V. Responds to gravity and movements of the head

(a) A – III; B – V; C – I; D – II; E – IV
(b) A – I; B – II; C – III; D – IV; E – V
(c) A – II; B – III; C – IV; D – V; E – I
(d) A – IV; B – I; C – V; D – II; E – III

3.

	Column I	Column II
(A)	Sclera	I. The visible coloured portion of the eye.
(B)	Choroid	II. Its diameter is regulated by the muscle fibres of iris.
(C)	Pupil	III. Composed of a dense connective tissue
(D)	Fovea	IV. Portion of the retina where only the cones are densely packed
(E)	Iris	V. Contains many blood vessels and looks bluish in colour

	A	B	C	D	E
(a)	I	II	III	IV	V
(b)	III	V	II	IV	I
(c)	III	I	V	II	IV
(d)	V	IV	III	I	II

4.

	Column I	Column II
(A)	Cervical nerves	I. 5 pairs
(B)	Thoracic nerves	II. 1 pair
(C)	Lumbar nerves	III. 12 pairs
(D)	Coccygeal nerves	IV. 8 pairs

(a) A $\rightarrow$ I; B $\rightarrow$ IV; C $\rightarrow$ I; D $\rightarrow$ III
(b) A $\rightarrow$ IV; B $\rightarrow$ III; C $\rightarrow$ I; D $\rightarrow$ II
(c) A $\rightarrow$ III; B $\rightarrow$ I; C $\rightarrow$ II; D $\rightarrow$ IV
(d) A $\rightarrow$ IV; B $\rightarrow$ I; C $\rightarrow$ II; D $\rightarrow$ III

5.

	Column I	Column II
(A)	Diencephalon	I. Cerebellum
(B)	Telencephalon	II. Medulla
(C)	Myelencephalon	III. Amygdala
(D)	Metencephalon	IV. Thalamus

(a) A $\rightarrow$ (IV); B $\rightarrow$ (III); C $\rightarrow$ (I); D $\rightarrow$ (II)
(b) A $\rightarrow$ (III); B $\rightarrow$ (IV); C $\rightarrow$ (I); D $\rightarrow$ (II)
(c) A $\rightarrow$ (IV); B $\rightarrow$ (III); C $\rightarrow$ (II); D $\rightarrow$ (I)
(d) A $\rightarrow$ (I); B $\rightarrow$ (II); C $\rightarrow$ (III); D $\rightarrow$ (IV)

6.

	Column I	Column II
(A)	Unipolar neuron	I. In cerebral cortex
(B)	Bipolar neuron	II. In embryonic stage
(C)	Multipolar neuron	III. In retina of eye

(a) A $\rightarrow$ (I); B $\rightarrow$ (II); C $\rightarrow$ (III)
(b) A $\rightarrow$ (I); B $\rightarrow$ (III); C $\rightarrow$ (II)
(c) A $\rightarrow$ (II); B $\rightarrow$ (I); C $\rightarrow$ (III)
(d) A $\rightarrow$ (II); B $\rightarrow$ (III); C $\rightarrow$ (I)

7.

	Column I	Column II
(A)	Pinna	I. Collects vibrations in the air which produces sound
(B)	Ear canal	II. Passage for sound wave from pinna to ear drum
(C)	Tympanic membrane	III. Transfers sound wave to ear ossicles
(D)	Ear Ossicles	IV. Increases the efficiency of transmission of sound waves to the innear ear

(E) Cochlea	V. Has hearing receptors
(F) Eustachian tube	VI. Equalizes the pressure on both sides of ear drum

(a) $A \to (I); B \to (II); C \to (III); D \to (IV); E \to (V); F \to (VI)$
(b) $A \to (I); B \to (VI); C \to (V); D \to (IV); E \to (III); F \to (II)$
(c) $A \to (I); B \to (II); C \to (IV); D \to (III); E \to (V); F \to (VI)$
(d) $A \to (I); B \to (VI); C \to (V); D \to (IV); E \to (III); F \to (II)$

Critical Thinking Type Questions :

1. For sound (good) reflex actions we require intact
(a) spinal cord (b) cerebellum
(c) hypothalamus (d) medulla oblongata

2. Which one of the following is an example of a simple reflex?
(a) Closing of eyes if an object suddenly approaches them.
(b) Climbing stairs in dark.
(c) Watering of mouth at the sight of delicious food.
(d) Tying laces while talking to and looking at another person.

3. In a nerve if sodium pump is blocked, which of the following is most likely to happen ?
(a) Na^+ and K^+ will increases outside the cell.
(b) Na^+ outside the nerve will increase.
(c) Na^+ inside the nerve will increase.
(d) K^+ inside the nerve will increase.

4. A person feels no sensation when he puts his hand over flame. The part of the brain which has damaged is
(a) cerebellum (b) medulla oblongata
(c) diencephalon (d) hypothalamus

5. An axon has four terminal ends connected with dendrites of four different neurons. Its nerve impulse will.
(a) become weak due to distribution into four.
(b) travel in all the four neurons with equal strength.
(c) pass on to one neuron only.
(d) travel to none because the movement of impulse is from dendrite to axon.

6. Sequence of meninges from inner to outside is
(a) Duramater – Arachnoid – Piamater
(b) Duramater – Piamater – Arachnoid
(c) Arachnoid – Duramater - Piamater
(d) Piamater- Arachnoid - Duramater

7. Which of these is an example of conditioned reflex?
(a) Watering of mouth at the taste of food.
(b) Withdrawal of hand on touching a hot plate.
(c) Cycling.
(d) Flowing of tears while peeling and cutting onions.

8. You are watching a horror movie and you notice your heart is beating fast and mouth is dry. It is because of
(a) fight and flight response
(b) sympathetic nervous system
(c) parasympathetic nervous system
(d) both (a) and (b)

9. During the transmission of nerve impulse through a nerve fibre , the potential on the inner side of the plasma membrane has which type of electric charge?
(a) First positive, then negative and again back to positive.
(b) First negative, then positive and again back to negative.
(c) First positive, then negative and continue to be negative.
(d) First negative, then positive and continue to be positive.

10. A person entering an empty room suddenly finds a snake right in front on opening the door. Which one of the following is likely to happen in his neuro-hormonal control system?
(a) Hypothalamus activates the parasympathetic division of brain.
(b) Sympathetic nervous system is activated releasing epinephrine and norepinephrine from adrenal cortex.
(c) Sympathetic nervous system is activated releasing epinephrine and norepinephrine from adrenal medulla.
(d) Neurotransmitters diffuse rapidly across the cleft and transmit a nerve impulse.

22 Chemical Co-ordination and Regulation

Fill in the Blanks :

1. The hormone that supports pregnancy and stimulates mammary glands for the formation of alveoli for storing milk, is secreted from _______.
2. A gorilla like appearance with huge hands and legs is due to abnormal secretion of _______ .
3. Abnormal secretion of thyroxine produces _______ .
4. When amount of ADH decreases in blood, micturition _______ .
5. Diabetes insipidus is caused by hyposecretion of _______ .
6. Thymus in mammals is mainly concerned with _______ .
7. Triple 'F' gland for flight, fright and fight is _______ .
8. Hormone which helps in implantation of embryo in uterus is _______ .
9. Thyroxine acts on every organ of the body, except _____ .

True/ False :

1. Neurohypophysis stores and release hormone by hypothalamus.
2. Norepinephrine is released by Sympathetic fibres.
3. Somatostatin inhibits the release of growth hormone.
4. Calcitonin is released from parathyroid.
5. Organs in the body like gastrointestinal tract, heart, kidney and liver do not produce any hormones.
6. Adenohypophysis is under direct neural regulation of the hypothalamus.
7. Endrocrine glands regulate neural activity and nervous system regulates endocrine glands.
8. Glucagon is secreted by β-cells of Islets of langerhans and stimulates glycogenolysis.

Conceptual MCQs :

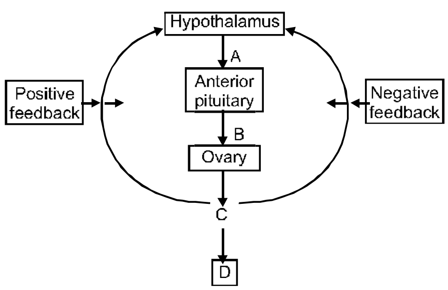
1. ADH or vasopressin is
   (a) enzyme that hydrolyses peptides
   (b) hormone secreted by pituitary that promotes reabsorption of water from glomerular filtrate
   (c) hormone that promotes glycogenolysis
   (d) energy rich compounds connected with muscle contraction.
2. According to the accepted concept of hormone action, if receptor molecules are removed from target organs, then the target organ will
   (a) not respond to the hormone
   (b) continue to respond to hormone without any difference
   (c) continue to respond to the hormone but in the opposite way
   (d) continue to respond to the hormone but will require higher concentration.
3. Parathormone deficiency produces muscle ramps or tetany as a result of
   (a) lowered blood Ca^{2+}
   (b) enhanced blood Na^{+}
   (c) enhanced blood glucose
   (d) enhanced blood Ca^{2+}

4. Insulin differs from growth hormone in that it
   (a) stimulates lipoprotein lipase in vicinity of fat cells
   (b) increases the transport of amino acids across the cell membranes of muscles
   (c) increases mRNA/ribosome acitivity
   (d) stimulates hormone sensitive lipase in fat cells.
5. Progesterone, the component of the oral contraceptive pills, prevents pregnancy by
   (a) preventing the cleavage of the fertilized egg
   (b) preventing the formation of ova
   (c) blocking ovulation
   (d) creating unfavourable chemical environment for the sperms to survive in the female reproductive tract.
6. Acromegaly is caused by
   (a) excess of growth hormone
   (b) excess of thyroxin
   (c) deficiency of thyroxin.
   (d) excess of adrenalin
7. Chemically hormones are
   (a) biogenic amines only
   (b) proteins, steroids and biogenic amines
   (c) proteins only
   (d) steroids only.
8. Which one of the following is not a second messenger in hormone action ?
   (a) Calcium (b) Sodium
   (c) cAMP (d) cGMP
9. Which one of the following statement is correct?
   (a) Endrocrine glands regulate neural activity, and nervous system regulates endocrine glands
   (b) Neither hormones control neural activity nor the neurons control endocrine activity
   (c) Endocrine glands regulate neural activity, but not vice versa.
   (d) Neurons regulate endocrine activity, but not vice versa.
10. Both adrenaline and cortisol are secreted in response to stress. Which of the following statements is true for both of these hormones ?
   (a) They act to increase blood glucose
   (b) They are secreted by the adrenal cortex
   (c) Their secretion is stimulated by adrenocorticotropin
   (d) They are secreted into the blood within seconds of the onset of stress.
11. Glucagon is secreted by –
   (a) β (beta) cells of islets of langerhans
   (b) α (alpha) cells of islets of langerhans
   (c) β cells of pancreas
   (d) Adrenal cortex
12. Leydig cells are meant for –
   (a) formation of sperm
   (b) to produce progesterone
   (c) to produce testosterone
   (d) nutrition of sperm
13. Role of thymus in *Homo sapiens* is chiefly concerned with–
   (a) reproduction
   (b) immunology
   (c) calcium balance
   (d) blood coagulation.
14. Which of the following is not a steroid hormone ?
   (a) Androgen (b) Aldosterone
   (c) Estrogen (d) Relaxin
15. Main similarity between hormone and enzyme is :
   (a) both act at particular pH
   (b) both are proteins
   (c) both are required in small amounts
   (d) both can be used again and again
16. A health disorder that results from the deficiency of thyroxine in adults and characterised by (i) a low metabolic rate, (ii) increase in body weight and (iii) tendency to retain water in tissues is:
   (a) simple goitre
   (b) myxoedema
   (c) cretinism
   (d) hypothyroidism
17. Injury to adrenal cortex is not likely to affect the secretion of which one of the following?
   (a) Aldosterone
   (b) Both Androstenedione and Dehydroepiandrosterone
   (c) Adrenaline
   (d) Cortisol
18. Low Ca^{++} in the body fluid may be the cause of:
   (a) tetany (b) anaemia
   (c) angina pectoris (d) gout
19. The 24 hour (diurnal) rhythm of our body such as the sleep-wake cycle is regulated by the hormone
   (a) calcitonin (b) prolactin
   (c) adrenaline (d) melatonin

20. Which of the following statements is correct in relation to the endocrine system?
(a) Organs in the body like gastrointestinal tract, heart, kidney and liver do not produce any hormones.
(b) Non-nutrient chemicals produced by the body in trace amount that act as intercellular messenger are known as hormones.
(c) Releasing and inhibitory hormones are produced by the pituitary gland .
(d) Adenohypophysis is under direct neural regulation of the hypothalamus.

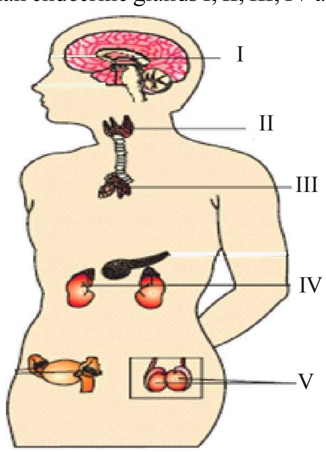
Diagram Based Questions :

1. The given figure shows the hormonal control of female reproductive system in which few steps are marked as A, B, C and D. Identify the correct labelling.



(a) A- GnRH; B - TSH; C - LTH; D - Uterus
(b) A - GnRH; B - FSH/LH; C - Estrogen or progesterone; D - urerus
(c) A - GnRH; B - STH; C - LH; D - Uterus
(d) A - GnRH; B - ACTH; C - LH, D - Uterus

2. The given diagram represents the location of human endocrine glands I, II, III, IV and V.

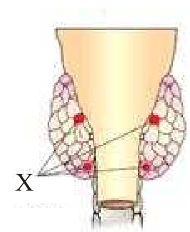


Which of the following gland is correctly matched with their secretions?

	Hormones	Their secretions
A	I	Melatonin
B	II	Thymosin
C	III	Epinephrine
D	IV	Aldosterone
E	V	Testosterone

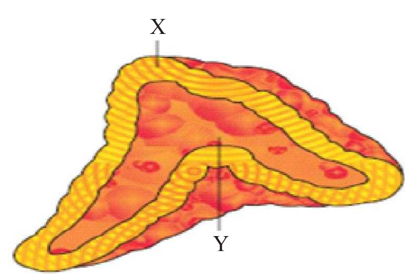
(a) I, II and III only (b) I, IV and V only
(c) II, IV, and V only (d) II, III and V only

3. The hormone released by label "X" in the given figure helps to restore Y. Identify X and Y.



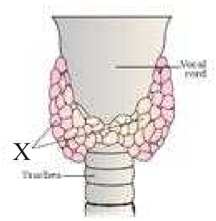
	X	Y
(a)	Thyroxine	Too much calcium in the blood.
(b)	PTH	Lowered levels of calcium in blood.
(c)	Thymosin	Decreased level of blood sugar.
(d)	Adrenaline	Excessive loss of sodium in extracellular fluid.

4. The label X represents ___i_____ and the hormone released by it is _____ii______. Identify (i) and (ii)



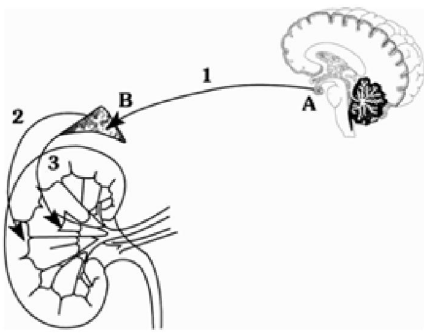
(a) i- Adrenal cortex, ii- Epinephrine
(b) i- Adrenal cortex, ii- Aldosterone
(c) i- Adrenal medulla, ii- Epinephrine
(d) i- Adrenal medulla, ii- Aldosterone

5. Which of the following disease is caused due to over secretion of the structure marked as X?



(a) Gigantism
(b) Diabetes mellitus
(c) Diabetes insipidus
(d) Grave's disease

6. Identify (i) and (ii)



(a) i- Pituitary gland , ii- Adrenal gland
(b) i- Hypothalamus, ii- Pituitary gland
(c) i- Hypothalamus, ii- Adrenal gland
(d) i- Pituitary gland, ii- Hypothalamus

7. Identify the hormone represented by lines 1 and 2?

(a) 1- ACTH, 2- Aldosterone
(b) 1- ACTH, 2- Adrenaline
(c) 1- TSH, 2- Thyroxine
(d) 1- TSH, 2- Aldosterone

Assertion/ Reason :

DIRECTIONS (Qs. 1-9): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Failure of secretion of somatotropin from an early age causes dwarfism in the patient.
Reason : Somatotropin hormone stimulates the body growth and elongation of long bones.

2. **Assertion :** The tadpoles become giant tadpoles when fed on thiourea.
Reason : Thiourea is an antithyroid substance.

3. **Assertion :** Females have less stature than males after puberty.
Reason : This happens because of the presence of hCG in the blood of females.

4. **Assertion :** Aldosterone increases the volume of blood and other extracellular fluids.
Reason : The secretion of aldosterone is stimulated by a fall in the circulating volume of blood.

5. **Assertion :** Steroid hormones easily pass through the plasma - membrane by diffusion.
Reason : Steroids are lipid soluble.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column -I		Column-II
(A)	ADH	I.	Pituitary
(B)	ACTH	II.	ineralocorticoid
(C)	Aldosterone	III.	Diabetes mellitus
(D)	Insulin	IV.	Diabetes insipidus
(E)	Adrenaline	V.	Vasodilator

(a) A – I; B – IV; C – II; D – III; E – V
(b) A – IV; B – II; C – I; D – III; E – V
(c) A – IV; B – I; C – II; D – III; E – V
(d) A – IV; B – I; C – III; D – II; E – V

2.

	Column-I		Column-II
(A)	Hypothalamus	I.	Relaxin
(B)	Anterior pituitary	II.	Estrogen
(C)	Testis	III.	FSH and LH
(D)	Ovary	IV.	Testosterone
		V.	Gonadotropin releasing hormone

(a) A – V; B – III; C – IV; D – II
(b) A – V; B – III; C – II; D – IV
(c) A – I; B – II; C – IV; D – III
(d) A – III; B – V; C – IV; D – II.

3.

	Column-I		Column-II
(A)	FSH	I.	Prepare endometrium for implantation
(B)	LH	II.	Develops female secondary sexual characters
(C)	Progesterone	III.	Contraction of uterine wall
(D)	Estrogen	IV.	Development of corpus luteum
		V.	Maturation of Graafian follicle

(a) A – V; B – IV; C – I; D – II
(b) A – IV; B – V; C – II; D – I
(c) A – IV; B – III; C – II; D – V
(d) A – V; B – I; C – II; D – IV

4.

	Column-I		Column-II
(A)	α-cell	I.	Inhibin
(B)	β-cell	II.	Glucagon
(C)	Leydig cell	III.	Insulin
(D)	Sertoli cells	IV.	Testosterone

(a) A – I; B – III; C – IV; D – II
(b) A – III; B – II; C – IV; D – I
(c) A – I; B – III; C – II; D – IV
(d) A – II; B – III; C – IV; D – I

5.

	Column-I (Hormones)		Column-II (Categories)
(A)	FSH and LH	I.	Glucocorticoids
(B)	Cortisol	II.	Mineralocorticoids
(C)	Androgen	III.	Gonadotropins
(D)	Aldosterone	IV.	Gonadocorticoids

(a) A – III; B – I; C – IV; D – II
(b) A – I; B – II; C – III; D – IV
(c) A – II; B – III; C – IV; D – I
(d) A – IV; B – II; C – I; D – III

6.

	Column I		Column II
(A)	Adrenohypophysis	I.	Epinephrine
(B)	Adrenal medulla	II.	Somatotropin
(C)	Parathyroid gland	III.	Thymosin
(D)	Thymus gland	IV.	Calcitonin

(a) A → III; B → 1; C → IV; D → II
(b) A → I; B → II; C → III; D → IV
(c) A → II; B → I; C → IV; D → III
(d) A → IV; B → III; C → II; D → I

7.

	Column I		List - II
(A)	Somatostain	I.	Pineal gland
(B)	Melatonin	II.	Corpus luteum
(C)	Aldosterone	III.	Placenta
(D)	Progesterone	IV.	Adrenal cortex
(E)	hCG	V.	Islet of Langerhans
		VI.	Adenohy-pophysis

(a) A → V; B → I; C → VI; D → III; E → II
(b) A → I; B → II; C → IV; D → III; E → V
(c) A → II; B → VI; C → IV; D → V; E → III
(d) A → V; B → I; C → IV; D → II; E → III

8.

	Column I		Column II
(A)	Adrenalin	I.	Myxoedema
(B)	Hyperparathyroidism	II.	Accelerates heart beat
(C)	Oxytocin	III.	Salt-water balance
(D)	Hypothyroidism	IV.	Childbirth
(E)	Aldosterone	V.	Deminer-alisation

(a) A → II; B → V; C → IV; D → I; E → III
(b) A → III; B → IV; C → V; D → III; E → II
(c) A → V; B → III; C → II; D → IV; E → I
(d) A → II; B → III; C → IV; D → V; E → I

9.

	Column I	Column II
(A)	Gastrin	I. Acts on gastric gland and stimulates secretion of HCl and pepsinogen
(B)	Secretin	II. Acts on the exocrine part of pancreas and stimulates secretion of water and HCO_3^- ions
(C)	CCK	III. Acts on both pancreas and gall bladder and stimulates the secretion of both pancreatic enzymes and bile juice respectively
(D)	GIP	IV. Inhibits gastric secretion and motility

(a) A → IV; B → III; C → II; D → I
(b) A → II; B → IV; C → III; D → I
(c) A → I; B → II; C → III; D → IV
(d) A → I; B → III; C → II; D → IV

Critical Thinking Type Questions :

1. In hormone action, if receptor molecules are removed from target organ, the target organ will
(a) continue to respond to hormone.
(b) not respond to hormone.
(c) continue to respond but requires higher concentration.
(d) continue to respond but in the opposite way.

2. The number of hormones secreted by anterior pituitary is
(a) 3 (b) 4
(c) 6 (d) 8

3. Which hormone is related to mineral metabolism but is not a peptide / protein in nature ?
(a) PTH (b) ANF
(c) Aldosterone (d) All of the above

4. Pancreatic duct of a healthy dog is blocked. Which of the following function of pancreas will not be affected ?
(a) Maintenance of normal blood sugar level.
(b) Carbohydrate digestion.
(c) Protein digestion.
(d) Neutralization of chyme.

5. A decrease in the level of estrogen and progesterone causes
(a) growth and dilation of myometrium.
(b) growth of endometrium.
(c) constriction of uterine blood vessels leading to sloughing of endometrium or uterine epithelium.
(d) release of ovum from the ovary.

6. Which of the following endocrine glands grows to the maximum size at puberty and then diminishes gradually?
(a) Thymus (b) Pituitary
(c) Thyroid (d) Adrenal

7. Which one is different from the category of other three?
(a) Gastrin (b) Ptyalin
(c) Secretin (d) Glucagon

8. Which of the following disorders are caused by hypersecretion of their concerned hormones ?
(a) gigantism and exophthalmic goitre
(b) tetany and myxoedema
(c) diabetes mellitus and goitre
(d) rickets and diabetes insipidus

9. Hormones produced by anterior lobe of pituitary
(a) control calcium level in blood.
(b) stimulate thyroid and other endocrine glands.
(c) initiate alarm reaction.
(d) regulate water balance in body.

10. Growth hormone of pituitary is more effective in
(a) presence of thyroxine.
(b) absence of thyroxine.
(c) absence of insulin.
(d) presence of adrenaline.

11. Which of the following hormone helps a person who suffers from a marked fall in blood pressure?
(a) Insulin (b) Thyroxine
(c) GH (d) Adrenaline

12. Hormones involved in carbohydrate metabolism are
(a) insulin, glucagon, epinephrine and calcitonin
(b) insulin, glucagon, epinephrine and glucocorticoids
(c) insulin, glucagon, cortisol and melatonin
(d) insulin, glucagon, norepinephrine and melatonin

13. Which of the following hormones are identical?
(a) ACTH and adrenaline
(b) hCG and progesterone
(c) Calcitonin and Oxytocin
(d) Vasopressin and ADH.

14. A man suffering from diabetes mellitus drinks water more frequently as he has to eliminate from blood, the extra
(a) salts (b) sugar
(c) insulin (d) protein

15. Which hormone promotes cell division, protein synthesis and bone growth?
(a) GH (b) ADH
(c) ACTH (d) PTH

16. Injection of glucagon will
(a) cause goitre
(b) cause galactosemia
(c) cause hypoglycemia
(d) increase blood sugar level

17. A person who has protruding eyes, tachycardia and higher body temperature is suffering from
(a) cretinism (b) hyperthyroidism
(c) myxoedema (d) acromegaly

23

Reproduction in Organism

Fill in the Blanks :

1. The period from birth to the natural death of an organism represents ________ .
2. A clone is a group of individuals obtained through _____ .
3. In protists and monerans, asexual reproduction occurs by ______ .
4. Development of an egg without fertilization is called ______.
5. Viviparity is found in ________ .
6. Sexual reproduction can be grouped into _______ distinct states.
7. The term clone is used to describe such organism and ________ similar individual.
8. Many unicellular organisms reproduce by the process of ______ .

True/ False :

1. Bamboo species flower only once in their life time, generally after 50-100 years and produce large number of fruits and die.
2. The reproductive phase is of same duration in all organisms.
3. Stamens are male reproductive part whereas carpels are female reproductive parts.
4. Vegetative propagation by leaves occurs in sweet potato.
5. Water hyacinth is very difficult to get rid off these plants.
6. Conidia are the asexual propagules restricted to kingdom Fungi.
7. Ginger propagates vegetatively with the help of its underground roots.
8. Meiosis never occurs during sexual reproduction.
9. External fertilization is a rule during sexual reproduction.

Conceptual MCQs :

1. In all the methods of asexual reproduction –
   (a) offsprings produced are genetically identical to the parents
   (b) offsprings produced are genetically different from the parents
   (c) offsprings produced may or may not be identical to the parents
   (d) none of the above
2. In sexual reproduction, offsprings resemble the parents –
   (a) structurally but not functionally
   (b) functionally but not structurally
   (c) both structurally and functionally
   (d) neither structurally nor functionally
3. Common method of asexual reproduction is by
   (a) regeneration (b) budding
   (c) archeocytes (d) gemmulation
4. Asexual reproduction takes place in –
   (a) higher animals (b) lower animals
   (c) plants (d) all the above
5. As a result of binary fission number of individuals produced by one fission is –
   (a) two (b) three
   (c) four (d) five
6. Fertilization is internal in
   (a) toads (b) frogs
   (c) dog fish (d) cat fish

7. Which type of reproduction is found in *Hydra* ?
(a) Polyembryony (b) Sexual and asexual
(c) Parthenogenesis (d) Encystment

8. Gemmule formation in sponges is helpful in
(a) parthenogenesis
(b) sexual reproduction
(c) only dissemination
(d) asexual reproduction

9. Which is mode of reproduction in *Amoeba* ?
(a) Binary fission only
(b) Binary fission and multiple fission
(c) Binary fission and conjugation
(d) Multiple fission only

10. Binary fission is found in –
(a) *Amoeba* (b) *Paramecium*
(c) *Planaria* (d) all of these

11. Which are exclusively viviparous ?
(a) Bony fishes
(b) Cartilagenous fishes
(c) Sharks
(d) Whales

12. The polyestrous mammal is –
(a) man (b) rabbit
(c) cat (d) horse

13. Development of an egg without fertilization is called –
(a) gametogenesis (b) metagenesis
(c) oogenesis (d) parthenogenesis

14. What is true in the process of fertilization –
(a) Only one sperm reaches the egg and enters it
(b) The entry of sperm activates the egg for completing meiosis
(c) Two haploid nuclei fuse and immediately divide to produce two nuclei which are again haploid
(d) Only the acrosome of the sperm enters the egg

15. The function of egg cell is/are –
(a) it supplies a haploid set of chromosomes to the future embryo
(b) it provides most of the cytoplasm to the embryo
(c) it supplies food reserves to the embryo
(d) all the above

16. Vegetative propagation in mint occurs by:
(a) offset (b) rhizome
(c) sucker (d) runner

17. Which one of the following is correctly matched
(a) Onion - Bulb
(b) Ginger - Sucker
(c) *Chlamydomonas* - Conidia
(d) Yeast - Zoospores

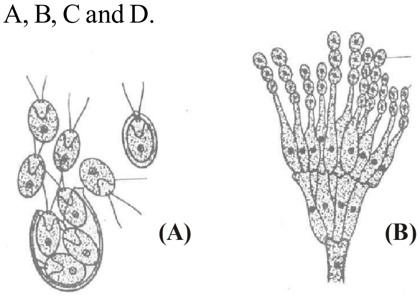
18. Monoecious plant of *Chara* shows occurrence of :
(a) stamen and carpel of the same plant
(b) upper antheridium and lower oogonium on the same plant
(c) upper oogonium and lower antheridium on the same plant
(d) antheridiophore and archegoniophore on the same plant

19. Meiosis takes place in :
(a) Conidia (b) Gemmule
(c) Megaspore (d) Meiocyte

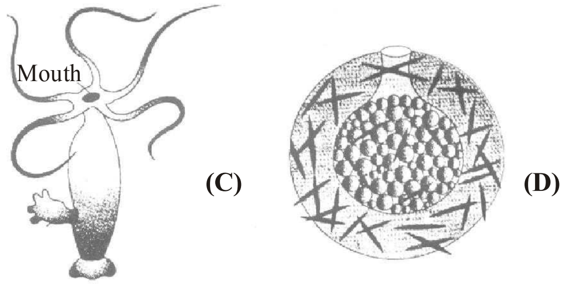
20. Consider the following statements and choose the correct option
(i) the genetic constitution of a plant is unaffected in vegetation propagation
(ii) rhizome in ginger serves as an organ of vegetative reproduction
(iii) totipotency of cells enables us to micropropagate plants
(a) statements (i) and (ii) alone are true
(b) statement (ii) alone is true
(c) statement (iii) alone is true
(d) all the three statements (i), (ii) and (iii) are true

Diagram Based Questions :

1. The given figure shows the members of fungi and simple plants such as algae which undergo asexual reproduction. Identify the correct asexual reproductive structures found in the members A, B, C and D.



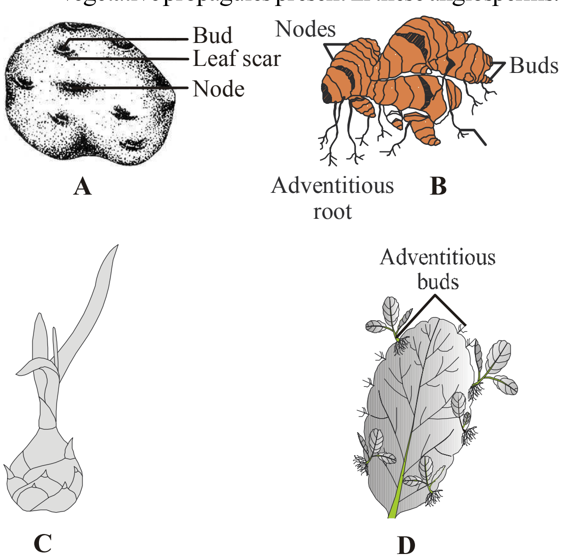
Chlamydomonas *Penicillium*



Hydra Sponge

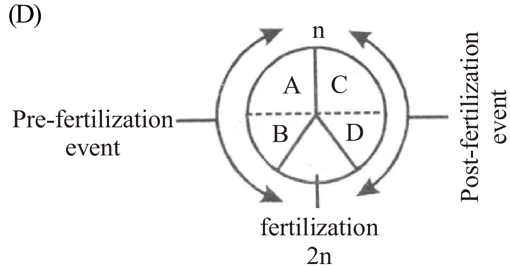
(a) A-Zoogamete, B-Conidia, C-Bud, D-Gemmule
(b) A-Zoospore, B-Conidia, C-Bud, D-Gemmule
(c) A-Zoospore, B-Conidiosporangium, C-Bud, D-Gemmule
(d) A-Aplanospore, B-Conidia, C-Bud, D-Gemmule

2. The given figure shows some examples of angiosperms as A, B, C and D. All these are capable of giving rise to new offsprings with the help of vegetative propagules. Identify the correct unit of vegetative propagules present in these angiosperms.



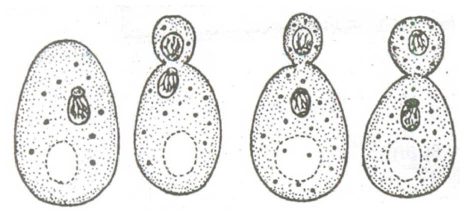
	A	B	C	D
(a)	Tuber	Rhizome	Bulb	Leaf buds
(b)	Offset	Sucker	Stolon	Leaf buds
(c)	Offset	Stolon	Sucker	Leaf buds
(d)	Tuber	Rhizome	Bulbil	Leaf buds

3. The given figure represents the events marked as (A, B, C and D) in the life of general reproduction. Identify the events A, B, C and (D)



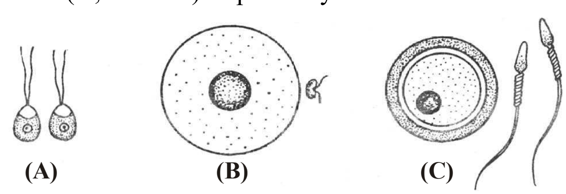
(a) A-Gamete transfer, B-Gametogenesis, D-Zygote formation, E-Embryogenesis
(b) A-Gametogenesis, B-Gamete transfer, D-Zygote formation, E-Embryogenesis
(c) A-Gametogenesis, B-Zygote formation, D-Gamete transfer, E-Embryogenesis
(d) A-Gametogenesis, B-Gamete transfer, D-Embryogenesis, E-Zygote formation.

4. The given figure refers to which type of reproduction in yeast?



(a) Binary fission (b) Budding
(c) Layering (d) Fusion

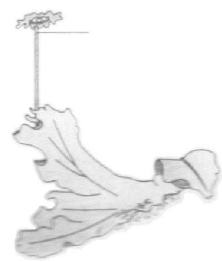
5. The given figures (A, B and C) are types of gametes of different organisms. Identify gametes (A, B and C) respectively.



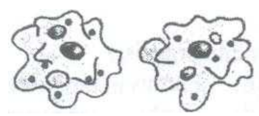
(a) Heterogametes, Isogametes, Homogametes
(b) Isogametes, Homogametes, Heterogametes
(c) Homogametes, Isogametes, Heterogametes
(d) Homo/Isogametes, Heterogametes, Heterogametes

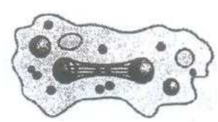
6. Which of the following animal is a dioecious organism ?

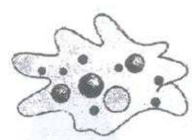
(a)  (b) 

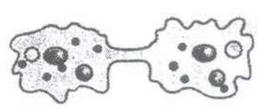
(c)  (d) 

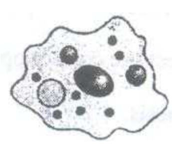
7. The given figures (i to v) represent the process of binary fission in *Amoeba*.

(i) 

(ii) 

(iii) 

(iv) 

(v) 

Arrange the figures in the correct sequence and choose the correct option.

(a) (iv) $\rightarrow$ (iii) $\rightarrow$ (i) $\rightarrow$ (ii) $\rightarrow$ (v)
(b) (iii) $\rightarrow$ (iv) $\rightarrow$ (i) $\rightarrow$ (ii) $\rightarrow$ (v)
(c) (iii) $\rightarrow$ (v) $\rightarrow$ (ii) $\rightarrow$ (iv) $\rightarrow$ (i)
(d) (iv) $\rightarrow$ (iii) $\rightarrow$ (ii) $\rightarrow$ (v) $\rightarrow$ (i)

Assertion/ Reason :

DIRECTIONS (Qs. 1-5): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion**: The genetic constitution of plants is unaffected in vegetative propagation
   Reason: Rhizome in ginger serves as an organ of vegetative reproduction.
2. **Assertion**: Banana fruits are seedless.
   Reason: Most of banana varities are triploid and triploidy is associated with seedlessness.
3. **Assertion**: Basal half of an onion bulb is removed and upper half is sown in the ground. New plant will emerge normally.
   Reason: Bud giving rise to a new plant is present towards base of onion bulb.
4. **Assertion**: Male gametes are non-motile
   Reason: Male gametes are produced in small number.
5. **Assertion**: The entry of sperm activates the egg for completing meiosis.
   Reason: Only the acrosome of the sperm enters the egg.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column-I	Column-II
(A) Animals which give birth to young one	I. *Hydra*
(B) Animal which produces bud	II. *Planaria*
(C) An animal which shows regeneration	III. Viviparous
(D) Provides nutrition to the developing embryo from the mother	IV. Placenta

(a) A – I; B – III; C – II; D – IV
(b) A – III; B – I; C – III; D – IV
(c) A – III; B – I; C – IV; D – II
(d) A – III; B – IV; C – I; D – II

2.

Column-I (Terms)	Column-II (Examples)
(A) Binary fission	I. Algae
(B) Zoospore	II. *Amoeba*
(C) Conidium	III. *Hydra*
(D) Budding	IV. *Penicillium*
E. Gemmules	V. Sponge

(a) A – I; B – IV; C – V; D – III; E – II
(b) A – II; B – I; C – IV; D – III; E – V
(c) A – II; B – IV; C – III; D – V; E – I
(d) A – I; B – IV; C – III; D – II; E – V

3.

Column -I (Name of the organism)	Column- II (Haploid chromosome number in gamete)
(A) *Ophioglossum*	I. 23
(B) Rice	II. 24
(C) Potato	III. 12
(D) Man	IV. 630

(a) A – I; B – II; C – III; D – IV
(b) A – II; B – III; C – IV; D – I
(c) A – III; B – IV; C – II; D – I
(d) A – IV; B – III; C – II; D – I

4.

Column-I (Organism)	Column-II (Approximate life span)
(A) Butterfly	I. 60 years
(B) Crow	II. 140 years
(C) Parrot	III. 15 years
(D) Crocodile	IV. 1 – 2 years

(a) A – IV; B – III; C – I; D – II
(b) A – II; B – III; C – IV; D – I
(c) A – III; B – II; C – I; D – IV
(d) A – IV; B – III; C – II; D – I

5.

Column-I (Name of the organism)	Column-II (Chromosome number in meiocyte) (2*n*)
(A) Housefly	I. 20
(B) Fruit fly	II. 34
(C) Apple	III. 8
(D) Maize	IV. 12

(a) A – II; B – III; C – IV; D – I
(b) A – III; B – IV; C – II; D – I
(c) A – IV; B – III; C – I; D – II
(d) A – IV; B – III; C – II; D – I

6.

Column - I	Column - II
(A) Sponge	I. Tuber
(B) Yeast	II. Offset
(C) Potato	III. Gemmules
(D) Water hyacinth	IV. Budding

(a) A – IV; B – I; C – II; D – III
(b) A – III; B – I; C – IV; D – II
(c) A – III; B – IV; C – I; D – II
(d) A – III; B – IV; C – I; D – II

7.

Column-I	Column-II
(A) Gemmules	I. *Agave*
(B) Leaf-buds	II. *enicillium*
(C) Bulbil	III. Water hyacinth
(D) Offset	IV. Sponges
(E) Conidia	V. *Bryophyllum*

(a) A – IV; B – V; C – I; D – III; E – II
(b) A – IV; B – III; C – II; D – I; E – V
(c) A – III; B – V; C – IV; D – II; E – I
(d) A – IV; B – I; C – V; D – III; E – II

8.

Column-I	Column-II
(A) The pollen transferred from one flower to another	I. Germination
(B) The process in which embryo develops into seedling	II. Pollination
(C) Fertilized egg in humans gets implanted in	III. Menstruation
(D) When egg in humans is not fertilized process occur	IV. Uterus

(a) A – II; B – I; C – IV; D – III
(b) A – I; B – II; C – IV; D – III
(c) A – I; B – II; C – III; D – IV
(d) A – I; B – III; C – II; D – IV

Critical Thinking Type Questions :

1. After culturing the anther of a plant, a few diploid plants were found along with haploid plants. The diploid plants could have arisen from
(a) generative cell of pollen.
(b) cells of anther wall.
(c) vegetative cell of pollen.
(d) exine of pollen wall.

2. Seeds are regarded to be the product of sexual reproduction because they
(a) can be stored for a long period.

(b) give rise to new plants.
(c) are the result of fusion of male gamete with the female gamete.
(d) none of the above

3. If basal half of an onion bulb is removed and upper half is sown in the ground then the new plant will
(a) emerge normally.
(b) not emerge.
(c) be without leaves.
(d) be without flowers.

4. If soil around stem of potato plant is constantly removed from very young stage then only roots remain in the soil then the potato tubers in plant will
(a) be larger (b) be smaller
(c) be formed normally (d) not be formed

5. Offsprings of oviparous animals are at greater risk as compared to offsprings of viviparous animals because
(a) proper embryonic care and protection is lesser.
(b) embryo is not developed.
(c) progenies are with more variation.
(d) progenies are larger.

6. Some organisms are capable of asexual or sexual reproduction. Under favourable conditions, reproduction proceeds asexually. When conditions become more stressful reproduction switches to a sexual mode. Why?
(a) Sexual reproduction is simple and more rapid allowing larger numbers of offspring to be produced.
(b) Sexual reproduction requires two separate individuals, who can mutually provide nutrient support during stress.
(c) Sexual reproduction produces individuals with new combinations of recombined chromosomes increasing diversity.
(d) Asexual reproduction requires more energy.

7. Which is the most common method of reproduction in majority of fungi and bacteria ?
(a) Binary fission
(b) Multiple fission
(c) Budding
(d) Spore formation

8. Select the correct sequence from the following.
(i) Juvenile phase $\rightarrow$ Senescent phase $\rightarrow$ Reproductive phase
(ii) Juvenile phase $\rightarrow$ Reproductive phase $\rightarrow$ Senescent phase
(iii) Reproductive phase $\rightarrow$ Juvenile phase $\rightarrow$ Senescent phase
(iv) Vegetative phase $\rightarrow$ Reproductive phase $\rightarrow$ Senescent phase
(a) (i) and (ii) (b) (i) and (iv)
(c) (iii) and (iv) (d) (ii) and (iv)

9. The primary biological importance of sexual reproduction in an organism is that it
(a) is necessary for the survival of the individual.
(b) causes new mutation to occur in the offsprings.
(c) promotes genetic variability among offsprings.
(d) allows larger number of offsprings to be produced.

10. Plants that have lost their capacity to produce seeds, reproduce by
(a) spores
(b) vegetative propagation
(c) fission
(d) regeneration

11. A feature of reproduction that is common to *Amoeba*, *Spirogyra* and yeast is that
(a) they reproduce asexually.
(b) they are all unicellular.
(c) they reproduce only sexually.
(d) they are all multicellular.

12. Development of zygote depends on
(a) life cycle of the organism
(b) environment it is exposed to
(c) both (a) and (b)
(d) nutrition of organism

13. Sexual reproduction involves
(a) meiosis only.
(b) meiosis and fusion of gametes.
(c) both mitosis and meiosis.
(d) all of the above

14. In which of the following plant, the site of origin of new plants is called node
(a) Potato tuber (b) Onion bulb
(c) Rhizome ginger (d) All of these

15. In a practical test, a student has to identify the organisms in which syngamy does not occur. In those organisms the female gamete undergoes development to form new organisms without fertilization. This phenomenon is called "X". Identify the organisms and the phenomenon "X".
(a) Frog, Parthenogenesis
(b) Lizards, Gametogenesis
(c) Rotifers, Embryogenesis
(d) Honey bee, Parthenogenesis

24 SEXUAL REPRODUCTION IN FLOWERING PLANTS

Fill in the Blanks :

1. Anther is typically _________ .
2. Ovules are attached to a parenchymatous cushion called _________ .
3. The point at which funiculus touches the ovule is ______ .
4. The most common type of ovule is_________ .
5. The device that guides the pollen tube in the cavity of ovary is _________ .
6. Pollen grains can be stored in liquid nitrogen at _________.
7. The seed in which endosperm is used by embryo is called __________ seed.
8. Nucellar polyembryony is reported in species of _______ .

True/ False :

1. During emasculation process, stigma is removed.
2. Emasculated flowers are bagged in order to prevent self-pollination.
3. Pollen grains in some plants remain viable for months.
4. Exine has apertures called germ pores where sporopollenin is present.
5. The PEN (Primary Endosperm Nucleus) develops into endosperm.
6. Tapetum nourishes the developing pollen.
7. Geitonogamy involves the pollen and stigma of flowers of different plants.
8. Somatic embryo is induced usually by an auxin such as 2, 4-D.
9. Milky water of green tender coconut is liquid female gametophyte.

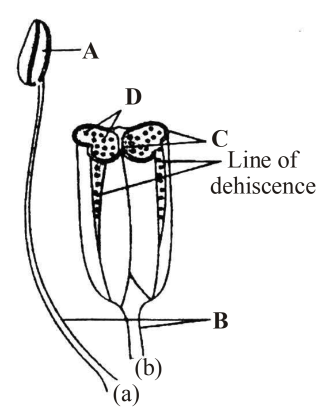
Conceptual MCQs :

1. Which of the following statement is correct ?
   (a) Flower is a modified root
   (b) Flower is a modified shoot
   (c) Flower is a modified leaf
   (d) Flower is a modified inflorescence
2. Which one is female gametophyte –
   (a) embryo (b) embryo sac
   (c) endosperm (d) pistil
3. Which is the most logical sequence with reference to the life cycle of angiosperm ?
   (a) Germination, endosperm formation, seed dispersal, double fertilization
   (b) Cleavage, fertilization, grafting, fruit formation
   (c) Pollination, fertilization, seed formation & germination
   (d) Maturation, mitosis, differentiation
4. The mature male gametophyte in angiosperm is represented by –
   (a) pollen grain
   (b) germinating pollen grain
   (c) embryo sac
   (d) anther
5. Tapetum is –
   (a) parietal in origin usually the inner most layer of anther wall
   (b) modified endothecium of anther wall
   (c) outer most layer of sporogenous tissue modification
   (d) parietal in origin and is the inner most layer of ovule wall
6. Main function of endothecium (in anther) is –
   (a) mechanical (b) nutritive
   (c) dehiscence (d) none of above

7. Development of male gametophyte is –
(a) in vivo (b) in situ
(c) both (d) none of the above
8. A polygonum type of embryo sac is
(a) 7-celled and 8-nucleate
(b) 8-celled and 7-nucleate
(c) 7 -celled and 7-nucleate
(d) 8-celled and 8-nucleate
9. Ovule of an angiosperm is technically equivalent to
(a) a megasporangium
(b) a megagametangium
(c) a micro spore
(d) a mega spore
10. Filiform apparatus are found in
(a) antipodal cell (b) egg cell
(c) secondary nucleus (d) synergids
11. The type of cells under going meiosis in the flowers are
(a) micro spore mother cell & mega spore mother cell
(b) ovule & stamen
(c) tapetal cells
(d) placental cell
12. Self-pollination means –
(a) transfer of pollen from anthers to stigma in the same flowers
(b) transfer of pollen from one flowers to another on the different plant
(c) occurence of male and female sex organ in the same flowers
(d) germination of pollen
13. When pollen grains of a flower are transferred to stigma of another flower on a different plant, the process is called
(a) geitonogamy (b) xenogamy
(c) autogamy (d) homogamy
14. When anther and stigma mature at the same time it is called as
(a) dichogamy (b) allogamy
(c) xenogamy (d) homogamy
15. Chasmogamy refers to the condition where –
(a) flowers remains closed
(b) flowers absent
(c) flowers open
(d) flowers gamopetalous
16. A fruit developed from hypanthodium inflorescence is called
(a) Sorosis (b) Syconus
(c) Caryopsis (d) Hasperidium
17. Cotyledons and testa respectively are edible parts in
(a) walnut and tamarind
(b) french bean and coconut
(c) cashew nut and litchi
(d) groundnut and pomegranate
18. The scutellum observed in a grain of wheat or maize is comparable to which part of the seed in other monocotyledons?
(a) Cotyledon (b) Endosperm
(c) Aleurone layer (d) Plumule
19. Nucellar polyembryony is reported in species of
(a) *Citrus* (b) *Gossypium*
(c) *Triticum* (d) *Brassica*
20. Wind pollinated flowers are
(a) small, brightly coloured, producing large number of pollen grains
(b) small, producing large number of dry pollen grains
(c) large producing abundant nectar and pollen
(d) small, producing nectar and dry pollen

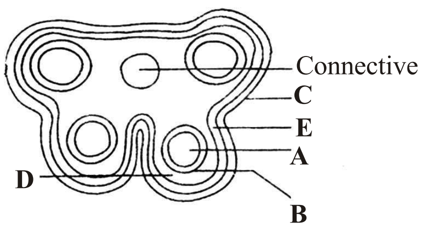
Diagram Based Questions :

1. The given figure shows a typical stamen (a) and three dimensional cut section of an anther. Identify A to D respectively marked in the figures (a & b)



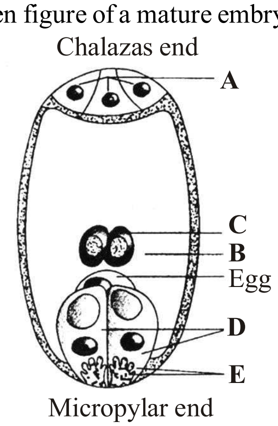
(a) Anther, Petiole, Pollen sac and Megaspore
(b) Anther, Petiole, Megasporangium and Pollen grains
(c) Anther, Pedicel, Megasporangium and Pollen grains
(d) Anther, Filament, Pollen sac and Pollen grains

2. The given diagram refers to a T. S. of anther. Identify A to E respectively



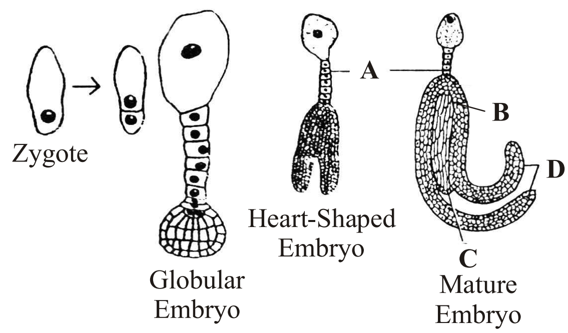
(a) Sporogenous tissue, tapetum, epidermis, middle layer, endothecium
(b) Sporogenous tissue, epidermis, tapetum, middle layer, endothecium
(c) Sporogenous tissue, epidermis, middle layer, tapetum, endothecium
(d) Sporogenous tissue, tapetum, middle layer, epidermis, endothecium

3. Identify A, B, C, D and E structures marked in the given figure of a mature embryo sac.



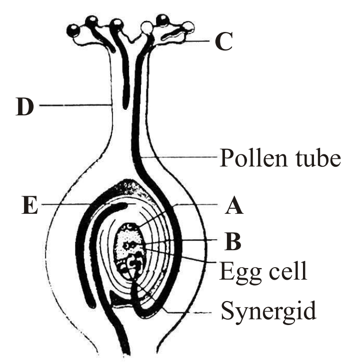
(a)	Antipodal cells	Central cell	Polar nuclei	Synergids	Acrosome
(b)	Antipodal cells	Central cell	Polar nuclei	Synergids	Filiform apparatus
(c)	Synergids	Central cell	Polar nuclei	Antipodal cells	Filiform apparatus
(d)	Synergids	Megaspore mother cell	Polar nuclei	Synergids	Filiform apparatus

4. Diagram given below shows the stages in embryogenesis in a typical dicot plant (*Capsella*). Identify the structures A to D respectively



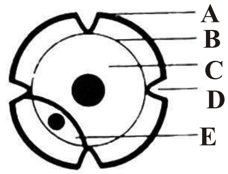
(a) Suspensor, Radicle, Plumule, Cotyledons
(b) Hypophysis, Radicle, Plumule, Cotyledons
(c) Suspensor, Plumule, Radicle, Cotyledons
(d) Suspensor, Radicle, Plumule, Hypocotyls

5. The given figure represent the L.S of a flower showing growth of pollen tube. Few structures are marked as A, B, C, D & E. Identify A, B, C, D and E respectively.



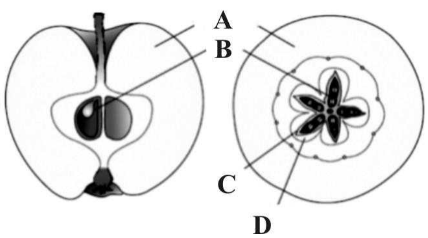
(a) Antipodal cells, Polar nuclei, Stigma, Style, Chalaza
(b) Antipodal cells, Polar nuclei, Style, Stigma, Chalaza
(c) Antipodal cells, Polar nuclei, Stigma, Chalaza, Style
(d) Antipodal cells, Polar nuclei, Chalaza, Stigma, Style

6. In the given figure of pollen grain tetrad, identify the parts marked as A, B, C, D and E.



(a) A - Germ pore, B - Generative cell, C - Intine, D - Exine, E - Vegetative cell
(b) A - Germ pore, B - Generative cell, C - Exine, D - Intine, E - Vegetative cell
(c) A - Intine, B - Exine, C - Germ pore, D - Generative cell, E - Vegetative cell
(d) A - Exine, B - intine, C - Vegetative cell, D - Germ pore, E - Generative cell

7. Identified A, B, C and D in the given figure of false fruit of apple.



(a) A – Mesocarp, B – Endocarp, C – Seed, D – Thalamus
(b) A – Seed, B – Thalamus, C – Mesocarp, D – Endocarp
(c) A – Thalamus, B – Seed, C – Endocarp, D – Mesocarp
(d) A – Mesocarp, B – Endocarp, C – Seed, D – Thalamus

Assertion/ Reason :

DIRECTIONS (Qs. 1-7): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** If pollen mother cells has 42 chromosomes, the pollen has only 21 chromosomes.
Reason : Pollens are formed after meiosis in pollen mother cell.

2. **Assertion:** Endosperm is a nutritive tissue and it is triploid.
Reason: Endosperm is formed by fusion of secondary nucleus to second male gamete. It is used by developing embryo.

3. **Assertion:** The megaspore mother cell divide mitotically to produce four spores.
Reason: Megaspore mother cells are diploid and megaspore is haploid.

4. **Assertion :** Photomodulation of flowering is a phytochrome regulated process.
Reason : Active form of phytochrome (P_{FR}) directly induces floral induction in shoot buds.

5. **Assertion :** Insects visit flower to gather honey.
Reason : Attraction of flowers prevents the insects from damaging other parts of the plant.

6. **Assertion :** Pollen mother cells (PMCs) are the first male gametophytic cells.
Reason : Each PMC gives rise to four pollens.

7. **Assertion :** Chasmogamous flowers require pollinating agents.
Reason : Cleistogamous flowers do not expose their sex organs.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column-I	Column-II
A. Zoophily	I. Pollination by birds
B. Ornithophily	II. Pollination by insects
C. Entomophily	III. Pollination by bats
D. Chiropterophily	IV. Pollination by animals

(a) A – III.; B – II; C – I; D – IV
(b) A – I; B – II; C – III; D – IV
(c) A – IV; B – I; C – II; D – III
(d) A – IV; B – II; C – I; D – III

2.

	Column-I		**Column-II**
A.	Funicle	I.	Mass of cells within ovule with more food
B.	Hilum	II.	Basal part of ovule
C.	Integument	III.	One or 2 protective layers of ovule
D.	Chalaza	IV.	Region where body of ovule fuses with funicle
E.	Nucellus	V.	Stalk of ovule

(a) A – I; B – II; C – III; D – IV; E – V
(b) A – V; B – IV; C – III; D – II; E – I
(c) A – IV; B – II; C – I; D – III; E – V
(d) A – I; B – III; C – V; D – II; E – IV

3.

	Column-I (Items)		**Column-II (Examples)**
A.	Ovary	I.	Groundnut, mustard
B.	Ovule	II.	Guava, orange, mango
C.	Wall of ovary	III.	Pericarp
D.	Fleshy fruits	IV.	Seed
E.	Dry fruits	V.	Fruit

(a) A – V; B – IV; C – III; D – II; E – I
(b) A – I; B – II; C – III; D – IV; E – V
(c) A – I; B – III; C – II; D – IV; E – V
(d) A – V; B – IV; C – I; D – II; E – III

4.

	Column-I		**Column-II**
A.	Parthenocarpy	I.	Inactive state
B.	Polyembryony	II.	Meiosis and syngamy are absent
C.	Apomixis	III.	Extra embryos
D.	Dormancy	IV.	Seedless fruit

(a) A – I; B – II; C – III; D – IV
(b) A – IV; B – III; C – II; D – I
(c) A – IV; B – I; C – II; D – III
(d) A – III; B – II; C – I; D – IV

5.

	Column-I		**Column-II**
A.	Tapetum	I.	Irregular in shape with abundant food reserve
B.	Exine	II.	Acts as nutritive layer
C.	Pollenkit	III.	Thick, rigid protective layer
D.	Vegetative cell	IV.	Involve in the formation of microspores
E.	Sporogenous	V.	Oily and sticky layer, help in tissue pollination.

(a) A – II; B – III; C – V; D – IV; E – I
(b) A – I; B – III; C – II; D – IV; E – V
(c) A – II; B – III; C – I; D – IV; E – V
(d) A – II; B – IV; C – V; D – I; E – III

6.

	Column-I		**Column-II**
A.	Coleorhiza	I.	Grapes
B.	Food storing tissue	II.	Mango
C.	Parthenocarpic fruit	III.	Maize
D.	Single seeded fruit developing from monocarpellary superior ovary	IV.	Radicle
E.	Membranous seed coat	V.	Endosperm

(a) A – III; B – I; C – IV; D – II; E – V
(b) A – IV; B – II; C – V; D – I; E – III
(c) A – V; B – I; C – III; D – IV; E – II
(d) A – IV; B – V; C – I; D – II; E – III

Critical Thinking Type Questions :

1. One of the most resistant known biological material is
(a) lignin (b) hemicellulose
(c) sporopollenin (d) lignocellulose

2. Which of the following is a female gamete in embryo sac ?
(a) Synergid (b) Antipodal cell
(c) Oosphere (d) Central cell

3. The largest cell in a embryo sac is
(a) egg (b) central cell
(c) synergid (d) antipodal cell

4. Which one of the following is not related to other three?
(a) Archaegonium (b) Oogonium
(c) Ovule (d) Antheridium

5. Dicot embryo consists of
   (a) radicle and plumule.
   (b) radicle, plumule, cotyledons and radicle.
   (c) radicle, plumule, cotyledons and tegmen.
   (d) radicle, plumule, cotyledons, tegmen and testa.
6. In a fertilized ovule, n, $2n$ and $3n$ conditions occur respectively in
   (a) antipodal, egg and endosperm.
   (b) egg, nucellus and endosperm.
   (c) endosperm, nucellus and egg.
   (d) antipodals, synergids and integuments.
7. Product of sexual reproduction generally generates
   (a) prolonged dormancy.
   (b) new genetic combination leading to variation.
   (c) large biomass.
   (d) longer viability of seeds.
8. Sequence of development during the formation of embryo sac is
   (a) Archesporium $\rightarrow$ Megaspore $\rightarrow$ Megaspore mother cell $\rightarrow$ Embryo sac.
   (b) Megasporocyte $\rightarrow$ Archesporium $\rightarrow$ Megaspore $\rightarrow$ Embryo sac.
   (c) Megaspore $\rightarrow$ Megaspore mother cell $\rightarrow$ Archesporium $\rightarrow$ Embryo sac.
   (d) Archesporium $\rightarrow$ Megaspore mother cell $\rightarrow$ Megaspore $\rightarrow$ Embryo sac.
9. Which of the following processes is necessary for the complete development of male gametophyte?
   (a) One meiotic cell division and two mitotic cell divisions.
   (b) One meiotic cell division and one mitotic cell division.
   (c) Two meiotic cell divisions and one mitotic cell division.
   (d) Two mitotic cell divisions.
10. Total number of meiotic division required for forming 100 zygotes/100 grains of wheat is
    (a) 100 (b) 75
    (c) 125 (d) 50
11. The endosperm found in angiospermic seed is different from that of gymnosperms in the sense that, in the former
    (a) it is formed before fertilization while in the latter it is formed after fertilization.
    (b) it is formed after fertilization.
    (c) it is cellular while in the latter it is nuclear.
    (d) it is nutritive while in the latter it is protective.
12. Megaspores are produced from the megaspore mother cells after
    (a) meiotic division.
    (b) mitotic division.
    (c) formation of a thick wall.
    (d) differentiation.
13. In angiosperms, syngamy or fertilization refers to
    (a) fusion of a sperm with secondary nucleus.
    (b) fusion of a sperm with oosphere.
    (c) fusion of one sperm with egg and other with secondary nucleus.
    (d) fusion of one of the sperms with a synergid.
14. Unisexuality of flowers prevents
    (a) geitonogamy but not xenogamy.
    (b) autogamy and geitonogamy.
    (c) autogamy but not geitonogamy.
    (d) both geitonogamy and xenogamy.
15. Albuminous seeds store their reserve food mainly in
    (a) perisperm (b) endosperm
    (c) cotyledons (d) hypocotyl
16. Pollination occurs in
    (a) bryophytes and angiosperms.
    (b) pteridophytes and angiosperms.
    (c) angiosperms and gymnosperms.
    (d) angiosperms and fungi.

25 HUMAN REPRODUCTION

Fill in the Blanks :

1. The __________ lead to vas deferens that ascends to the ______ and loops over the __________.
2. A sac shaped like an upside down pear with a thick lining and muscles in the pelvic area where a fertilized egg or zygote comes to grow into a baby is called _______.
3. In the process of spermatogenesis, first maturation division is called _______.
4. Spermatids are transformed into sperm by a process called_______.
5. Semen is a constituent of seminal plasma with _______.
6. Ejaculation of human male contains about 200 – 300 million sperms, of which for normal fertility____% sperms must have normal shape and size and at least ____% must show energetic motility.
7. At the time of implantation, the human embryo is called _______.
8. Fusion of haploid nucleus of sperm and that of ovum lead to the formation of_______.
9. Trophoblast and inner cell mass are the arrangements of blastomeres as outer and inner layers respectively in _______.
10. The placenta is formed from the _______ of the embryo and the _______ of the mother.

True/ False :

1. Each testes has highly coiled 250 compartments called seminiferous tubules.
2. Erection of the penis due to presence of special tissues facilitates insemination.
3. The scrotum keeps the testes warmer, thus helping it to promote the sperm formation.
4. Graafian follicle releases primary oocyte from the ovary by ovulation.
5. At puberty only 60,000 – 80,000 primary follicles are left in each ovary.
6. Myometrium undergoes strong contraction at the time of delivery of baby.
7. Ovarian stroma is divided into two zones: inner cortex and outer medulla.
8. Infundibulum possess finger like projections which help in collection of ovum after the release of secondary oocyte.

Conceptual MCQs :

1. A mature sperm has –
   (a) a pair of flagella
   (b) a nucleus, an acrosome and a centriole
   (c) a nucleus, an acrosome, a pair of centrioles
   (d) a nucleus, an acrosome, a pair of centrioles and a tail
2. Ovulation occurs under the influence of –
   (a) LH (b) FSH
   (c) Estrogen (d) Progesterone
3. Spermatozoa are nourished during their development by –
   (a) setroli cells
   (b) interstitial cells
   (c) connective tissue cells
   (d) none of the above
4. Correct sequence in development is –
   (a) fertilization $\rightarrow$ zygote $\rightarrow$ cleavage $\rightarrow$ morula $\rightarrow$ blastula $\rightarrow$ gastrula
   (b) fertilization $\rightarrow$ zygote $\rightarrow$ blastula $\rightarrow$ morula $\rightarrow$ cleavage $\rightarrow$ gastrula
   (c) fertilization $\rightarrow$ cleavage $\rightarrow$ morula $\rightarrow$ zygote $\rightarrow$ blastula $\rightarrow$ gastrula
   (d) cleavage $\rightarrow$ zygote $\rightarrow$ fertilization $\rightarrow$ morula $\rightarrow$ blastula $\rightarrow$ gastrula

5. Middle piece of mammalian sperm contains –
(a) nucleus (b) vacuole
(c) mitochondria (d) centriole

6. Ovulation or release of ovum occurs on the day of menstrual cycle :
(a) 8-10
(b) 12-14
(c) 4-14
(d) last two day of menstrual cycle

7. At the end of first meiotic division, male germ cell differentiates into:
(a) secondary spermatocyte
(b) primary spermatocyte
(c) spermatogonium
(d) spermatid

8. What is true about cleavage in fertilized egg of human ?
(a) Meroblastic
(b) Starts when egg reaches uterus
(c) Starts in fallopian tubes
(d) It is identical to normal mitosis

9. Which of the following organ is differentiated first during development?
(a) heart (b) skin
(c) brain (d) neural tube

10. At the end of first meiotic division, male sperm differentiates into
(a) secondary spermatocyte
(b) primary spermatocyte
(c) spermatogonium
(d) spermatid

11. In 28 day human ovarian cycle, ovulation occurs on
(a) Day 1 (b) Day 5
(c) Day 14 (d) Day 28

12. The estrous cycle is a characteristic of
(a) human males only
(b) human females only
(c) mammalian males other than primates
(d) mammalian females other than primates

13. After ovulation the collapsed ovarian follicle shrinks and becomes filled with cell to form
(a) corpus luteum (b) corpus albicans
(c) corpus atresia (d) corpus adiposum

14. If mammalian ovum fails to get fertilized, which one of the following is unlikely?
(a) Corpus luteum will disintegrate
(b) Progesterone secretion rapidly declines
(c) Estrogen secretion further decreases
(d) Primary follicle starts developing

15. Which one of the following is the correct matching of the events occurring during menstrual cycle?
(a) Proliferative phase: Rapid regeneration of myometrium and maturation of Graffian follicle.
(b) Development of corpus luteum : Secretory phase and increased secretion of progesterone.
(c) Menstruation: Breakdown of myometrium and ovum not fertilised.
(d) Ovulation: LH and FSH attain peak level and sharp fall in the secretion of progesterone.

16. Seminal plasma in humans is rich in
(a) fructose and calcium but has no enzymes
(b) glucose and certain enzymes but has no calcium
(c) fructose and certain enzymes but poor in calcium
(d) fructose, calcium and certain enzymes

17. The correct sequence of spermatogenetic stages leading to the formation of sperms in a mature human testes is:
(a) spermatogonia - spermatocyte - spermatid - sperms
(b) spermatid - spermatocyte - spermatogonia - sperms
(c) spermatogonia - spermatid - spermatocyte - sperms
(d) spermatocyte - spermatogonia - spermatid - sperms

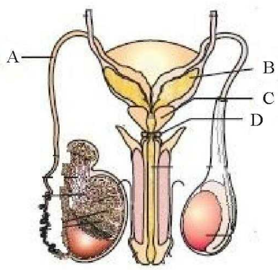
18. *In vitro* fertilisation is a technique that involves transfer of which one of the following into the fallopian tube?
(a) Embryo only, upto 8 cell stage
(b) Either zygote or early embryo upto 8 cell stage
(c) Embryo of 32 cell stage
(d) Zygote only

19. Sertoli cells are found in
(a) ovaries and secrete progesterone
(b) adrenal cortex and secrete adrenaline
(c) seminiferous tubules and provide nutrition to germ cells
(d) pancreas and secrete cholecystokinin

20. The signals for parturition originate from
(a) placenta only
(b) placenta as well as fully developed foetus
(c) oxytocin released from maternal pituitary
(d) fully developed foetus only

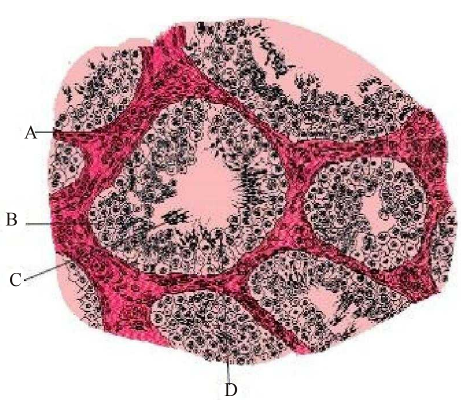
Diagram Based Questions :

1. Given below is a diagrammatic sketch of a portion of human male reproductive system. Select the correct set of the names of the parts marked as A, B, C, and D.



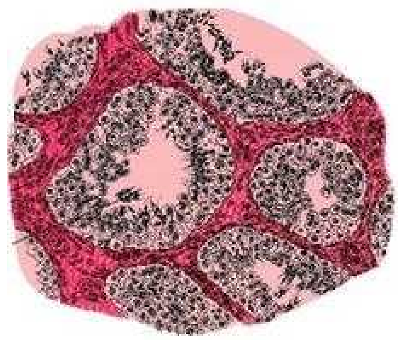
	A	B	C	D
(a)	Ureter	Seminal vesicle	Prostate	Bulbourethral gland
(b)	Ureter	Prostate	Seminal vesicle	Bulbourethral gland
(c)	Vas deferens	Seminal vesicle	Prostate	Bulbourethral gland
(d)	Vas deferens	Seminal vesicle	Bulbourethral gland	Prostate

2. Given below is the diagrammatic sectional view of seminiferous tubule with their parts marked as A, B, C, and D. Select the option which shows the correct identification of the structure with its characteristics.



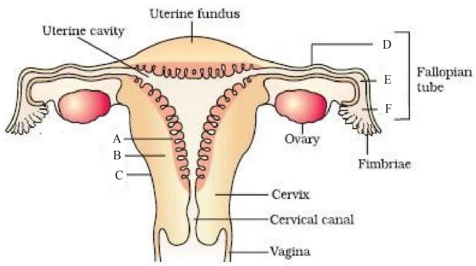
(a) A: Spermatozoa, secretes testicular hormones that control spermatogenesis.
(b) B: Spermatogonium, it is also called male germ cells which undergo meiotic division to from spermatozoa.
(c) C: Interstitial cells, present in the interstitial spaces and store and transport the sperms from the testis to the outside through the urethra.
(d) D: Sertoli cells, it maintains low temperature of the testis.

3. Identify the figure (A) whose sectional view is given below and match with its characteristics (B) and its location (C).



	A	B	C
(a)	Graafian follicle	Involved in the formation of ovum	Ovary
(b)	Seminiferous tubule	Involved in the formation of sperm	Testis
(c)	Ovum surrounded by sperm	Process of fertilization	Graafian follicle
(d)	Mammary gland	Involved in milk secretion	Female reproductive system

4. The given figure shows the diagrammatic sectional view of female reproductive system with few structures marked as A, B, C, D, E and F.



Which of the following options shows the correct labeling of A–F?

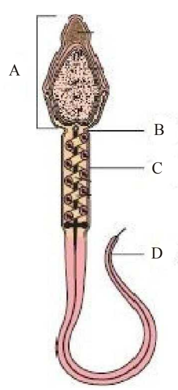
(a) A $\rightarrow$ Myometrium, B$\rightarrow$Isthmus, C$\rightarrow$Endometrium, D $\rightarrow$ Perimetrium, E$\rightarrow$Ampulla, F$\rightarrow$ Infundibulum

(b) A$\rightarrow$Infundibulum, B$\rightarrow$Perimetrium, C$\rightarrow$Endometrium, D$\rightarrow$Myometrium, E$\rightarrow$Ampulla, F$\rightarrow$Isthmus

(c) A$\rightarrow$Endometrium, B$\rightarrow$Myometrium, C$\rightarrow$Perimetrium, D$\rightarrow$Isthmus, E$\rightarrow$Ampulla, F$\rightarrow$Infundibulum

(d) A$\rightarrow$Perimetrium, B$\rightarrow$Endometrium, C$\rightarrow$Isthmus, D$\rightarrow$Infundibulum, E$\rightarrow$Ampulla, F$\rightarrow$Myometrium

5. The figure given below shows the structure of sperm. Identify the correct feature corresponding to the marked structure A, B, C and D.



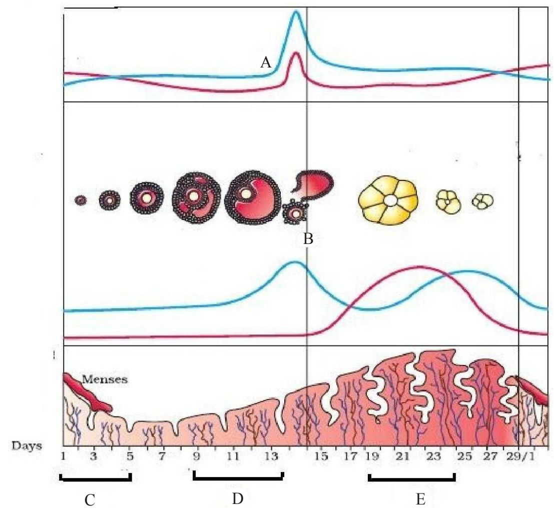
(a) A – Head: Its anterior portion is covered by a structure filled with enzymes that help in the fusion of male and female gametes.

(b) B – Middle piece: It contains a haploid nucleus.

(c) C – Neck: It possesses few ribosomes which produces energy for the process of fertilization.

(d) D – Tail: It releases energy source for swimming of sperm.

6. The figure given below shows the various events occurring during a menstrual cycle with few structures marked as A, B, C and D. Which of the following options shows the correct labeling?



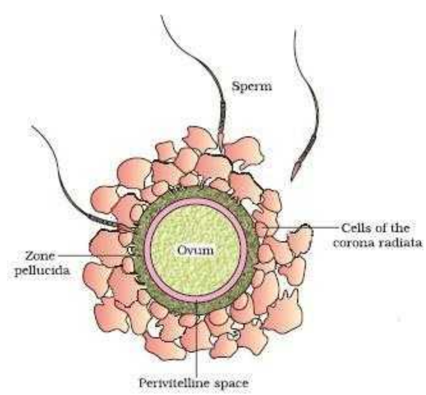
(a) A$\rightarrow$LH, B$\rightarrow$Ovulation, C$\rightarrow$ Menstruation, D$\rightarrow$ Proliferative phase, E$\rightarrow$Luteal phase

(b) A$\rightarrow$FSH, B$\rightarrow$Implantation, C$\rightarrow$Follicular phase, D$\rightarrow$Menstruation phase, E$\rightarrow$Luteal phase

(c) A$\rightarrow$Estrogen, B$\rightarrow$Parturition, C$\rightarrow$Luteal phase, D$\rightarrow$Follicular phase, E$\rightarrow$Follicular phase

(d) A$\rightarrow$Progesterone, B$\rightarrow$ Fertilization, C$\rightarrow$ Menstruation phase, D$\rightarrow$Secretory phase, E$\rightarrow$ Follicular phase

7. Study the given figure and conclude the correct explaination from the options given below:



(a) All the sperm attaches with ovum.
(b) Transport of sperm towards the ovum.
(c) Ovum and surrounded sperms were going to take part in fertilization.
(d) Sperm induces changes in the cells of corona radiata and blocks the entry of other additional sperms.

Assertion/ Reason :

DIRECTIONS (Qs. 1-6): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** During fertilization only head of spermatozoa enters egg.
Reason : If several spermatozoa hit the egg at same time, all can enter the egg.

2. **Assertion :** In morula stage, cells divide without increase in size.
Reason : Zona pellucida remain undivided till cleavage is complete.

3. **Assertion :** In humans, the gamete contributed by the male determines whether the child produced will be male or female.
Reason : Sex in humans is a polygenic trait depending upon a cumulative effect of some genes on X-chromosome and some on Y-chromosome.

4. **Assertion :** Corpus luteum degenerates in the absence of fertilization.
Reason : Progesterone level decreases.

5. **Assertion :** Clitoris is not remnant of penis in females.
Reason : It also have high blood supply and erectile tissue.

6. **Assertion :** Mammalian ova produces hyaluronidase.
Reason : The eggs of mammal are microlecithal and telolecithal.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column I (Structure of Male Reproductive System)	Column II (Features)
(A) Seminiferous tubule	I. Network of seminiferous tubule
(B) Rete testis	II. Secondary sexual characters
(C) Leydig cells	III. Meiosis and sperm formation occurs
(D) Prepuce	IV. Place of implantation
	V. Terminal skin of penis

(a) A – I; B – II; C – III; D – V
(b) A – III; B – I; C – II; D – V
(c) A – III; B – I; C – IV; D – II
(d) A – II; B – IV; C – III; D – V

2.

Column-I (Structures of female reproductive system)	Column-II (Features)
(A) Ampulla	I. It undergoes cyclical changes during menstrual cycle.
(B) Labia majora	II. It helps in collection of ovum after ovulation.
(C) Oviduct	III. Wider part of fallopian tube where fusion of male and female gametes takes place.
(D) Fimbriae	IV. Larger hairy folds which extend down from the mons pubis and surrounds the vaginal opening.
E. Endometrium	V. Also called fallopian tubes, which extend from the periphery of each ovary to the womb.

(a) A – I; B – II; C – III; D – V; E – IV
(b) A – III; B – I; C – II; D – V; E – IV
(c) A – III; B – IV; C – V; D – II; E – I
(d) A – II; B – IV; C – III; D – V; E – I

3.

Column-I	Column-II
(A) Primary oocyte	I. It is formed when oogonia starts division and temporarily arrested at prophase of meiosis I.
(B) Secondary oocyte	II. A large haploid cell which retains bulk of nutrient rich cytoplasm of the primary oocyte.
(C) Primary follicle	III. A large number of these degenerate during the phase from puberty to birth.
(D) Oogonia	IV. Gamete mother cell.
(E) Secondary follicle	V. Surrounded by more layers of granulosa cells and a new theca.
F. Graafian follicle	VI. Rupture to release ovum from the ovary.

(a) A – I; B – II; C – III; D – IV; E – V; F – VI
(b) A – III; B – I; C – IV; D – II; E – V; F – VI
(c) A – VI; B – IV; C – V; D – II; E – I; F – III
(d) A – II; B – IV; C – III; D – V; E – I; F – VI

4.

Column-I (Phases of menstrual cycle)	Column-II (Features)
(A) Menstrual phase	I. Breakdown of endometrial lining of uterus along with its blood vessels which form liquid that comes out of vagina.
(B) Luteal phase	II. A temporary endocrine gland is formed and secretes a hormone which maintains endometrium and implantation of fertilized ovum and other events of pregnancy.
(C) Follicular phase	III. Formation of mature Graafian follicle and regeneration of endometrium of uterus.
(D) Ovulatory phase	IV. Secretion of luteinizing hormone at its maximum level and induces breakdown of mature follicle to release the female gamete

(a) A – IV; B – II; C – III; D – I
(b) A – III; B – I; C – II; D – IV
(c) A – III; B – I; C – IV; D – II
(d) A – I; B – II; C – III; D – IV

5.

Column-I (Features of developing child)	Column-II (Time of there occurrence)
(A) Heart sound	I. By the end of the second month of pregnancy
(B) Foetus develops limbs and digit	II. During the fifth month
(C) Formation of major organ	III. First sign of growing foetus system
(D) First movement of foetus and appearance of hair on head	IV. By the end of 12 weeks
(E) Body covered with hair, eyelid separate, eyelashes are formed	V. By the end of 24 weeks

(a) A – I; B – II; C – III; D – IV; E – V
(b) A – III; B – I; C – IV; D – II; E – V
(c) A – II; B – I; C – III; D – V; E – IV
(d) A – III; B – IV; C – II; D – V; E – I

6.

Column-I (Hormones)	**Column-II (Functions)**
(A) Luteinizing hormone	I. Develop corpus luteum
(B) Progesterone	II. Essential for maintenance of uterine layer (called endometrium)
(C) Estrogen	III. Develops female secondary sexual characters
(D) Follicle stimulating hormone	IV. Maturation of Graafian follicle
(E) Oxytocin	V. Causes uterine contraction.

(a) A – I; B – V; C – III; D – II; E – IV
(b) A – III; B – I; C – II; D – IV; E – V
(c) A – I; B – II; C – III; D – IV; E – V
(d) A – I; B – II; C – III; D – IV; E – V

7.

Column-I	**Column-II**
(A) Fertilization	I. Mitotic division
(B) Implantation	II. Embryo with 8 to 16 blastomeres
(C) Cleavage	III. Ampullary-isthmic junction
(D) Morula	IV. Structure formed by the continuous division of 8 to 16 blastomeres
(E) Blastocysts	V. Embedding of blastocysts in the endometrium

(a) A – I; B – II; C – IV; D – V; E – III
(b) A – III; B – I; C – IV; D – II; E – V
(c) A – III; B – V; C – I; D – IV; E – II
(d) A – III; B – V; C – I; D – II; E – IV

8.

Column-I (Terms)	**Column-II (Definition)**
(A) Parturition	I. Duration between pregnancy (of about 9 month) and birth
(B) Ovulation	II. Attachment of zygote to the endometrium
(C) Gestation	III. Child birth
(D) Implantation	IV. Stoppage of menstruation
(E) Conception	V. Release of egg from Graafian follicle
	VI. Process of milk secretion
	VII. Formation of zygote by fusion of the egg and sperm

(a) A – I; B – II; C – VII; D – V; E – III
(b) A – III; B – I; C – IV; D – II; E – V
(c) A – III; B – V; C – I; D – II; E – VI
(d) A – III; B – V; C – I; D – IV; E – II

Critical Thinking Type Questions :

1. The feature of some structures of male reproductive system is given below. Identify the structure on the basis of the characteristics which surrounds the primary sex organ of male reproductive system.
(a) Its enlarged end is called glans penis.
(b) It travels through the penis and carry semen as well as urine.
(c) It is responsible for maintaining the low temperature by about 2 – 2.5º C from normal body temperature to mature sperm.
(d) Stores sperms prior to ejaculation.

2. Read the following statement and answer the question.
"The urethra originates from a structure (called 'X') and extends through the male external genitalia (called 'Y' which helps in introducing semen into the vagina) to its external opening called urethral meatus."
Identify X and Y.
(a) X - Urinary bladder ; Y - Penis
(b) X - Vas efferentia ; Y - Penis
(c) X - Ejaculatory duct ; Y - Ureter
(d) X - Bulbourethral gland ; Y - Ureter

3. Which of the following is not a uterine function?
(a) Waste removal for the developing embryo.
(b) Nutritional support of the growing embryo.
(c) Place of fusion of male and female gametes.
(d) Mechanical protection of the developing embryo.

4. The glandular tissue of mammary gland is divided into "X" mammary "Y" containing alveoli which secretes milk and store it in the cavity of alveoli. Identify "X" and "Y".

(a) X - 1 – 2 ; Y - Ducts
(b) X - 100 - 200 ; Y - Lobes
(c) X - 50 - 100 ; Y - Ducts
(d) X - 15 - 20 ; Y - Lobes

5. How many ova are released during the middle of the menstrual cycle?
(a) One (b) Two
(c) Three (d) Four

6. Study the given statement and answer the question.
"During 'P' phase of the menstrual cycle, if pregnancy doesn't happen, the 'Q' withers and dies, usually around day 22 in a 28-day cycle. The drop in 'R' levels causes the lining of the uterus to fall away. This is known as 'S'.
Identify P, Q, R and S.
(a) P $\rightarrow$Menstrual, Q$\rightarrow$Graafian follicle, R$\rightarrow$Estrogen , S$\rightarrow$Menarche
(b) P $\rightarrow$Luteal, Q $\rightarrow$Corpus luteum, R $\rightarrow$Progesterone S $\rightarrow$Menstruation
(c) P $\rightarrow$Ovulatory, Q $\rightarrow$Endometrium, R $\rightarrow$Follicle stimulating hormone, S $\rightarrow$Menopause
(d) P $\rightarrow$Follicular, Q $\rightarrow$Secondary oocyte, R $\rightarrow$Luteinizing hormone S $\rightarrow$Menstruation

7. Which of the following hormones attains a peak level in the middle of menstrual cycle?
(a) LH and estrogen
(b) FSH and progesterone
(c) FSH and LH
(d) Estrogen and progesterone

8. Fertilization can only occurs if
(a) sperm reaches to the ampullary – isthmic junction before the ovum.
(b) ovum reaches to the ampullary – isthmic junction before the sperm.
(c) sperms are transported to the uterus and ovum to the fallopian tube simultaneously.
(d) sperm and ovum are transported simultaneously to the ampullary – isthmic junction.

9. The acrosome enables the sperm to
(a) help in motility.
(b) produce energy for activity.
(c) penetrate vitelline membrane of ovum.
(d) fertilize more than one ovum.

10. At the time of fertilization, chromosome number
(a) is halved (b) remains haploid
(c) becomes diploid (d) does not change

11. Foetal ejection reflex in human female is induced by
(a) placenta only
(b) fully developed foetus and placenta
(c) release of oxytocin from pituitary gland
(d) release of full developed corpus luteum

12. After the transformation of spermatids into sperm, their heads become embedded in a cell called "X" and are finally released from the "Y" by the process called "Z". Identify X, Y and Z.

	X	Y	Z
(a)	Spea matogonium	Epididymis	Insemination
(b)	Ley dig	Vas deferens	Parturition
(c)	Sertoli	Seminiferous tubule	Speamiation
(d)	Spea matocyte	Seminiferous tubule	Speamiogenesis

13. Select the option which shows the correct part of a sperm with its corresponding function.
(a) Head: Stimulate Leydig cell to produce androgen hormone.
(b) Neck: Essential for maturation and motility of sperm.
(c) Middle piece: Produces energy from mitochondria for tail movement which facilitate sperm motility.
(d) Tail: Help in fertilization with the help of enzyme present in acrosome.

14. "A" cells starts division and enter in "B" stage of meiotic division and get temporarily "C" at this stage, called "D". Identify A, B, C and D.
(a) A: Oogonia; B: Metaphase I; C: Arrested; D: Primary oocyte.
(b) A: Oogonia; B: Anaphase I; C: Released; D: Secondary oocyte.
(c) A: Oogonia; B: Prophase I; C: Arrested; D: Primary oocyte.
(d) A: Oogonia; B: Telophase I; C: Released; D: Secondary oocyte.

26 Reproductive Health

Fill in the Blanks :

1. Tying up or removing a small part of fallopian duct is called _________.
2. MTPs are considered relatively safe during the ______ weeks of pregnancy.
3. To form embryo in *vitro*, the male gamete is transferred into female gamete directly. Such technique is called_________.
4. The transfer of zygote or early embryo (up to 8 blastomere) into fallopian tube is called _________.
5. The most important component of the oral contraceptive pills is _________.
6. The technique which makes use of amniotic fluid for the detection of prenatal disorder is called as _________.
7. The family planning programme in India were initiated in _________.

True/ False :

1. According to 2001 census our population growth rate was 1.7%.
2. Marriageable age for male and female is respectively 18 and 21 years.
3. Genital herpes and sickle-cell anaemia are both STD.
4. Medical Termination of Pregnancy (MTP) during first trimester is generally safe.
5. Purpose of tubectomy is to prevent egg formation.
6. Genital warts is a sexually transmitted disease caused by herpes virus.
7. In India, there is rapid decline in infant mortality rate and maternal mortality rate.
8. According to the WHO, reproductive health is total well-being in the physical, social, emotional, behavioural aspects of reproduction.

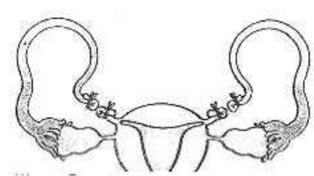
Conceptual MCQs :

1. Copper-T is a device that prevents
   (a) implantation of blastocyst
   (b) ovulation
   (c) fertilization
   (d) egg maturation
2. Which of the following cannot be detected in a developing foetus by amniocentesis?
   (a) Sex of the foetus
   (b) Down syndrome
   (c) Jaundice
   (d) Klinefelter syndrome
3. Consider the statements given below regarding contraception and answer as directed thereafter:
   (i) Medical Termination of Pregnancy (MTP) during first trimester is generally safe
   (ii) Generally chances of conception are nil until mother breast-feeds the infant upto two years
   (iii) Intrauterine devices like copper-T are effective contraceptives
   (iv) Contraception pills may be taken upto one week after coitus to prevent conception
   Which two of the above statements are correct?
   (a) (ii) and (iii) (b) (iii) and (iv)
   (c) (i) and (iii) (d) (i) and (ii)
4. Which one of the following is the most widely accepted method of contraception in India, as at present ?
   (a) Cervical caps
   (b) Tubectomy
   (c) Diaphragms
   (d) IUDs. (Intra uterine devices)
5. Medical Termination of Pregnancy (MTP) is considered safe up to how many weeks of pregnancy?
   (a) Eight weeks (b) Twelve weeks
   (c) Eighteen weeks (d) Six weeks

6. The technique called gamete intrafallopian transfer (GIFT) is recommended for those females:
   (a) who cannot produce an ovum
   (b) who cannot retain the foetus inside uterus.
   (c) whose cervical canal is too narrow to allow passage for the sperms
   (d) who cannot provide suitable environment for fertilisation
7. Legally acceptable term of abortion is –
   (a) MTP (b) MMTP
   (c) MTTP
   (d) None
8. The most important component of the oral contraceptive pills is –
   (a) progesterone
   (b) growth hormone
   (c) thyroxin
   (d) luteinizing hormone
9. Action of vaginal diaphragm is –
   (a) To prevent the ova to come in the uterus
   (b) To prevent the sperm to come in contact with ova
   (c) spermicidal
   (d) anti-implantational
10. Surgical removal or cutting and ligation of the ends of oviduct is known as –
   (a) Tubectomy (b) Oviductomy
   (c) Vasectomy (d) Ovarioctomy
11. Surgical removal of testes is known as –
   (a) Testectomy (b) Gonadectomy
   (c) Castration (d) None
12. Removal of a segment surgically and ligation of cut ends of vas deferens is known as –
   (a) Tubectomy (b) Vasectomy
   (c) Gonadectomy (d) Castration
13. Test tube baby means a baby born when –
   (a) It develops from a non-fertilized egg
   (b) It developed in a test tube
   (c) It is developed through tissue culture method
   (d) The ovum is fertilised externally and thereafter implanted in the uterus
14. The mechanical measure of population control includes –
   (a) Condom only (b) Diaphragm only
   (c) IUD only (d) All of the above
15. Progestasert and LNG-20 are
   (a) Implants
   (b) Copper releasing IUDs
   (c) Non-medicated IUDs
   (d) Hormone releasing IUDs
16. Which of the following is the component of oral pills?
   (a) Progesterone (b) Oxytocin
   (c) Relaxin (d) None of these.
17. One of the legal methods of birth control is :
   (a) by abstaining from coitus from day 10 to 17 of the menstrual cycle
   (b) by having coitus at the time of day break
   (c) by a premature ejaculation during coitus
   (d) abortion by taking an appropriate medicine
18. Which of the following is wrongly matched?
   (a) IUI - semen collected from husband or donor is artificially introduced either into the vagina or into the uterus.
   (b) GIFT - transfer of embryos with more than 8 blastomeres into the Fallopian tube.
   (c) ICSI - sperm directly injected into the ovum.
   (d) ZIFT - transfer of embryos with upto 8 blastomeres into the Fallopian tube.
19. Which of the following is not a sexually transmitted disease?
   (a) Myasthenia gravis
   (b) Trichomoniasis
   (c) Chlamydiasis
   (d) Syphilis
20. Saheli is
   (a) an oral contraceptive for females
   (b) a surgical sterilization method for females
   (c) a diaphragm for females
   (d) a diaphragm used by males

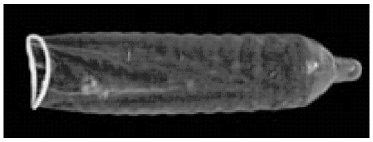
DIAGRAM TYPE QUESTIONS

1. The process done in the given figure



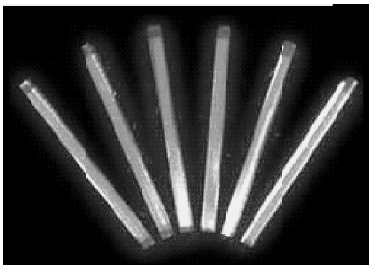
   (a) Prevents egg from reaching the uterus for implantation.
   (b) Avoid insemination
   (c) Inhibits ovulation
   (d) Increases contraceptive efficiency

2. Identify the figure given below.



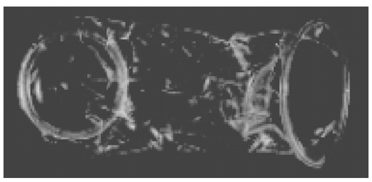
(a) Male condom
(b) Female condom
(c) Norplant
(d) Copper T

3. Which of the following option is correct regarding the diagram given below?



(a) It is a device made of rubber and inserted into the female reproductive tract to cover the cervix during coitus.
(b) It is a device made of thin rubber/ latex sheath and are used to cover penis in the male.
(c) This device is inserted by doctors in the uterus through vagina and increases phagocytosis of sperms within the uterus.
(d) It is a set of 6-small plastic capsules (called implant) which are placed under the skin of a women's upper arm and it prevent pregnancy.

4. Refer the given figure below and answer the question. Which feature is correctly associated with the given figure?



(a) It is a male condom which is used to cover the penis just before the coitus to prevent the entry of ejaculated semen into the female reproductive tract.
(b) It is a female condom which is used to cover the cervix and vagina just before the coitus.
(c) It is a condom which is used to cover penis in male and vagina and cervix in female.
(d) It is one type of IUDs which makes the uterus unsuitable for implantation and cervix hostile to the sperms.

5. The given figure shows one of the elements releasing intrauterine device. Select the option which shows the correct identification of the device and its feature.

(a) CuT; suppress sperm motility and its fertilizing capacity.
(b) Cu7; make uterus unsuitable for the attachment of blastocysts.
(c) Lippes loop; protect the users from contracting AIDS and STDs.
(d) LNG - 20; acts as spermicidal means and decrease the contraceptive efficiency.

Assertion/ Reason :

DIRECTIONS (Qs. 1-5): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion**: IUDs suppresses the process of gametogenesis.
   Reason: It increases the phygocytosis of sperms within the uterus.
2. **Assertion**: Introduction of sex education in schools increased medical asistance.
   Reason: Encouraging myths and misconceptions.
3. **Assertion**: Contraceptive device are introduced into uterus to prevent implantation.
   Reason: These devices acts as a physical barrier for sperm entry.
4. **Assertion :** Cu-T and Cu-7 do not suppresses sperm-motility.
   Reason : Hormones released by them affect sperm motility.
5. **Assertion :** Copper-T is an effective contraceptive device in human females.
   Reason: Copper-T prevents passage of sperms from vagina upwards into Fallopian tubes.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column -1 (Method)	Column -II (Mode of Action)
(A) The contraceptive pill	I. Prevents sperms reaching cervix
(B) Condom	II. Prevents implantation
(C) Vasectomy	III. Prevents ovulation
(D) Copper T	IV. Semen contains no sperms

(a) A – II; B – III; C – I; D – IV
(b) A – III; B – I; C – IV; D – II
(c) A – IV; B – I; C – II; D – III
(d) A – III; B – IV; C – I; D – II

2.

Column-I	Column-II
(A) Non-medicated IUDs	I. Lippes loop
(B) Hormone releasing IUDs	II. Multiload 375
(C) Copper releasing IUDs	III. CuT
	IV. Cu7
	V. LNG - 20
	VI. Progestasert

(a) A – I; B – II; VI; C – III; IV; V
(b) A – I; B – III; VI; C – II; III; IV
(c) A – II; B – III; VI; C – I; III; IV
(d) A – II; B – I; VI; C – III; IV; V

3.

Column-I	Column-II
(A) Hepatitis B	I. Vitamin E
(B) Saheli	II. 7' April, 1948
(C) Normal functioning of reproductive organs	III. CDRI, Lucknow
(D) World Health organisation	IV. Detection of antibody/ antigen
(E) ELISA technique	V. Hepatitis B virus

(a) A – V ; B – III ; C – I; D – II; E – IV
(b) A – V ; B – II ; C – I; D – III; E – IV
(c) A – V ; B – III ; C – IV ; D – II ; E – I
(d) A – V ; B – II ; C – IV ; D – III ; E – I

4.

Column-I	Column-II
(A) Natural methods	I. Coitus interruptus
(B) IUDs	II. LNG - 20
(C) Barrier methods	III. Diaphragms
(D) Surgical methods	IV. Multiload 375
(E) Oral contraceptives	V. Saheli
	VI. Nirodh
	VII. Sterilization
	VIII. Vasectomy
	IX. CuT

(a) A - I; B - II ; IV ; IX; C - III; VI; D - VII ; VIII; E-V
(b) A - I; B - II ; IV; C - III ; VI ; IX; D - VII ; VIII; E-V
(c) A - I; B - II ; IV ; IX; C - III ; IX; D - VII ; VIII; E-V ; VI
(d) A - I; B - IV ; IX; C - II ; III ; VI; D - VII ; VIII; E-V

5.

	Column I		Column II
A.	ICSI	1	Artificially introduction of semen into the vagina or uterus.
B.	IUI	2	Transfer of ovum collected from a donor into the fallopian tube where fertilization occur
C.	IUT	3	Formation of embryo by directly injecting sperm into the ovum
D.	GIFT	4	Transfer of the zygote or early embryo (with upto 8 blastomeres) into a fallopian tube.
E.	ZIFT	5	Transfer of embryo with more than 8 blastomeres into the uterus

	A	B	C	D	E
(a)	5	4	1	3	2
(b)	1	2	3	4	5
(c)	3	5	2	4	1
(d)	3	1	5	2	4

6.

	Column I		Column II
A.	IUDs	1	Prevent conception by blocking entry of sperm through cervix
B.	Condom	2	Inhibits ovulation, implantation and entry of sperm by altering the quality of cervical mucus
C.	Diaphragm	3	Its mode of action is similar to pills
D.	Implants	4	Prevent ejaculated semen into the female genital tract
E.	Pills	5	LNG-20, Progestasert

	A	B	C	D	E
(a)	5	4	1	3	2
(b)	1	2	3	4	5
(c)	3	5	2	4	1
(d)	3	1	5	2	4

Critical Thinking Type Questions :

1. Refer the following statement and answer the question.
"Inability of an individual to inseminate the female or due to very low sperm counts in ejaculates leads to "A". It could be corrected by "B". In "B" the "C" is collected and artificially introduced either into the vagina or into the "D" (IUI - intra-uterine insemination) of the female."
Identify A to D.

	A	B	C	D
a.	STD	Embryo transfer	Urine	Fallopian tube
b.	MTP	GIFT	Ovum	Uterus
c.	Infertility	Artificial technique	Semen	Uterus
d.	Infertility	ZIFT	Sperm	Fallopian tube

2. Which of the following disease is completely curable if detected early and treated properly?
(a) Syphilis (b) Hepatitis B
(c) Genital herpes (d) HIV infection
3. Present increase in India's population has not been due to decline in
(a) decrease in infant mortality rate
(b) decrease number of people reaching reproductive age
(c) decline in death rate
(d) decline in maternal mortality rate
4. The copper ions of IUDs
(a) suppress the motility and fertilization capacity of sperms.
(b) make the uterus unsuitable for implantation.
(c) increase phagocytosis of sperms.
(d) make cervix hostile to sperms.
5. Progestogens in the contraceptive pill
(a) prevents ovulation
(b) inhibits estrogen
(c) checks attachment of zygote endometrium
(d) all of the above
6. Which of the following birth control measures can be
considered as the safest?
(a) The rhythm method
(b) The use of physical barriers
(c) Temination of unwanted pregnancy
(d) Sterilization techniques
7. The success of birth control programmes in controlling population growth is dependent on
(a) use of contraceptives
(b) tubectomy

(c) vasectomy
(d) acceptability of the above by the people

8. Assisted reproductive technologies (ART)
(a) include social awareness programmes to educate people about reproductive health and diseases.
(b) include research organization working on to produce new and more effective contraceptives for birth control.
(c) include a number of special techniques which assist infertile couples to have children.
(d) both (b) and (c)

9. Which of the following abbreviation is related to induce abortion?
(a) IVF (b) IUD
(c) MTP (d) STD

10. Emergency contraceptives are effective if used within
(a) 72 hours of coitus
(b) 72 hours of ovulation
(c) 72 hours of menstruation
(d) 72 hours of implantation

11. Identify the type of most popular contraceptive device whose features are given below.
i. They does not interfere the act of coitus.
ii. These are effective barriers for insemination.
iii. These help in reducing the risk of sexually transmitted diseases.
(a) IUD
(b) Condom
(c) Injectable
(d) Oral contraceptives

12. Study the given reasons on the basis of which pregnancy can be terminated. Identify the correct reasons.
i. To get rid of unwanted pregnancies.
ii. To prevent the fatality or harmfulness to the mother or to foetus or both due to the continuation of pregnancy.
iii. Termination of pregnancy is safe in each and every case.
iv. If the foetus is male.
v. It plays an important role in decreasing the population.
(a) i, ii, only (b) ii, iii only
(c) iii, iv, v only (d) All of these

13. Given below are some examples of sexually transmitted diseases. Identify the one or more which specifically affect the sex organs.
i. AIDS
ii. Syphilis
iii. Gonorrhea
iv. Genital warts
(a) i only (b) i, ii only
(c) ii, iii, iv only (d) All of these.

14. Which of the following infections can also be transmitted by sharing of injection needles, surgical instruments, etc., with infected persons, transfusion of blood, or from an infected mother to the foetus too?
(a) Hepatitis B and HIV
(b) Genital herpes and HIV
(c) Syphilis and Hepatitis B
(d) Chlamydiasis and Trichomoniasis

15. Which of the following assisted reproductive technology has been used for the longest time period?
(a) *In vitro* fertilization
(b) Artificial insemination
(c) Intracytoplasmic sperm injection
(d) Gamete intra fallopian transfer

27 Principles of Inheritance and Variation

Fill in the Blanks :

1. The contrasting pairs of factors in Mendelian crosses are called __________.

2. The monohybrid genotypic ratio 1 : 2 : 1 in F_2 generation indicates __________.

3. The crossing of F_1 to homozygous recessive parent is called __________.

4. ABO blood group system is due to _________.

5. The number of phenotypes in ABO blood groups is __________.

6. The person with Turner's syndrome has _______ and ______.

7. A man has enlarged breasts, sparse hairs on the body and sex chromosomal formula XXY. He then suffers from __________.

8. A character which is expressed in a hybrid is called _______.

True / False :

1. The discrete unit controlling a particular character is called a factor.

2. Alleles do not show any blending and both the characters recover as such in F_2 generation.

3. Genes loosely linked on the same chromosome show similar recombinations as the tightly linked ones.

4. Homozygous sex chromosomes (ZZ) determine female sex in birds.

5. Homozygous sex chromosomes (XX) produce male in *Drosophila.*

6. Cancer cells commonly show chromosomal aberrations.

7. In domesticated fowls, the sex of the progeny depends on the type of sperm that fertilizes the egg.

8. Phenylketonuria is an autosomal recessive gene disorder.

Conceptual MCQs :

1. What contribute to the success of Mendel ?
(a) Qualitative analysis of data
(b) Observation of distinct inherited traits
(c) His knowledge of biology
(d) Consideration of one character at one time

2. Diploid chromosome number in humans is
(a) 46 (b) 44
(c) 48 (d) 42

3. ABO blood group system is due to
(a) multifactor inheritance
(b) incomplete dominance
(c) multiple allelism
(d) epistasis

4. Haemophilia is more common in males because it is a
(a) recessive character carried by Y-chromosome
(b) dominant character carried by Y-chromosome
(c) dominant trait carried by X-chromosome
(d) recessive trait carried by X-chromosome

5. In Down's syndrome of a male child, the sex complement is
(a) XO (b) XY
(c) XX (d) XXY

6. A dihybrid condition is
(a) tt Rr (b) Tt rr
(c) tt rr (d) Tt Rr

7. Mendel's last law is
(a) segregation
(b) dominance
(c) independent assortment
(d) polygenic inheritance

8. The contrasting pairs of factors in Mendelian crosses are called

(a) multiple alleles (b) allelomorphs
(c) alloloci (d) paramorphs

9. Multiple alleles control inheritance of
(a) phenylketonuria (b) colour blindness
(c) sickle cell anaemia (d) blood groups

10. A man of A-blood group marries a women of AB blood group. Which type of progeny would indicate that man is heterozygous A?
(a) AB (b) A
(c) O (d) B

11. An organism with two identical alleles is
(a) dominant (b) hybrid
(c) heterozygous (d) homozygous

12. An allele is dominant if it is expressed in
(a) both homozygous and heterozygous states
(b) second generation
(c) heterozygous combination
(d) homozygous combination

13. In human beings 45 chromosomes/single X/XO abnormality causes
(a) Down's syndrome
(b) Kinefelter's syndrome
(c) Turner's syndrome
(d) Edward's syndrome

14. Sex is determined in human beings
(a) by ovum
(b) at time of fertilization
(c) 40 days after fertilization
(d) seventh to eight week when genitals differentiate in foetus

15. Select the **incorrect** statement from the following:
(a) Galactosemia is an inborn error of metabolism
(b) Small population size results in random genetic drift in a population
(c) Baldness is a sex -limited trait
(d) Linkage is an exception to the principle of independent assortment in heredity

16. Point mutation involves
(a) change in single base pair
(b) duplication
(c) deletion
(d) insertion

17. The genotype of a plant showing the dominant phenotype can be determined by
(a) test cross (b) dihybrid cross
(c) pedigree analysis (d) back cross

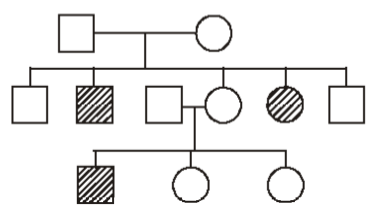
18. Infectious proteins are present in
(a) Gemini viruses
(b) Prions
(c) Viroids
(d) Satellite viruses

19. Which one of the following conditions correctly describes the manner of determining the sex in the given example?
(a) Homozygous sex chromosomes (ZZ) determine female sex in birds.
(b) XO type of sex chromosomes determine male sex in grasshopper
(c) XO condition in human as found in Turner syndrome, determines female sex.
(d) Homozygous sex chromosomes (XX) produce male in *Drosophila.*

20. Mutations can be induced with :
(a) infrared radiations
(b) I AA
(c) ethylene
(d) gamma radiations

Diagram Based Questions :

1. Study the pedigree chart given below and choose its correct representation.

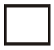


(a) Inheritance of a condition like phenyl-ketonuria as an autosomal recessive trait.
(b) The pedigree chart is wrong as this is not possible.
(c) Inheritance of a recessive sex-linked disease like haemophilia.
(d) Inheritance of a sex-linked inborn error of metabolism like phenylketonuria.

2. Which one of the following symbols and its representation, used in human pedigree analysis is correct?

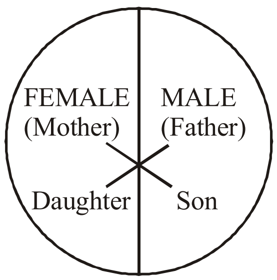
(a)  = mating between relatives

(b)  = unaffected male

(c)  = unaffected female

(d)  = male affected

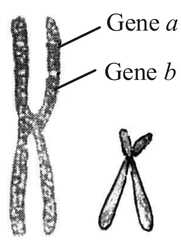
3. The given figure represents the inheritance pattern of a certain type of traits in humans.



Which one of the following conditions could be an example of this pattern?

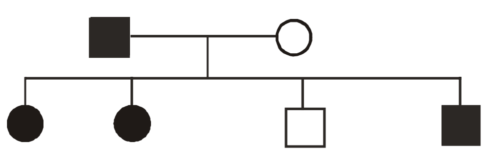
(a) Thalassemia (b) Haemophilia
(c) Phenylketonuria (d) Sickle cell anaemia

4. The given figure is a highly simplified representation of the human sex chromosomes from a karyotype. The gene *a* and *b* could be of



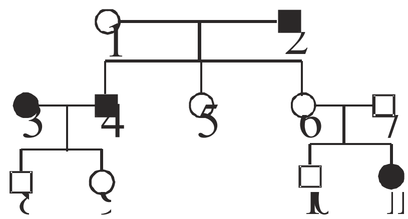
(a) colour blindness and body height.
(b) attached ear lobe and Rhesus blood group.
(c) haemophilia and red-green colour blindness.
(d) phenylketonuria and haemophilia.

5. Study the pedigree chart of a certain family given below and select the correct conclusion which can be drawn for the character.



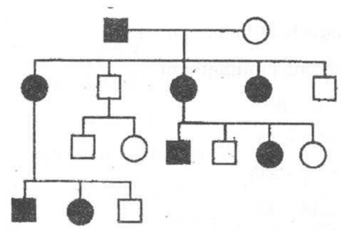
(a) The female parent is heterozygous.
(b) The parents could not have had a normal daughter for this character.
(c) The trait under study could not be colourblindness.
(d) The male parent is homozygous dominant.

6. In Huntington's disease, the unaffected persons are homozygous for normal allele *h*. The following is erroneous because



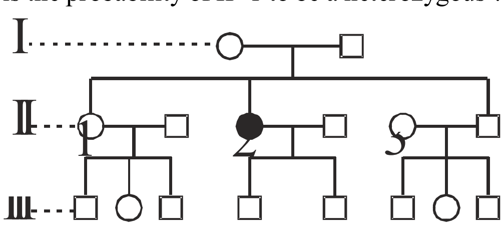
(a) it shows both male and female affected by Huntingtons disease.
(b) either person 6 or 7 should have the disease, if individual 11 shows the disease.
(c) at least one of the 2 children (8, 9) should have the disease
(d) all of the above

7. Identify the type of inheritance shown in the diagram.



(a) dominant X-linked
(b) recessive X-linked
(c) dominant Y-linked
(d) recessive Y-linked

8. Following is a pedigree for albinism (*aa*). What is the probability of II -1 to be a heterozygous ?



(a) $\frac{1}{3}$ (b) $\frac{1}{2}$

(c) $\frac{2}{3}$ (d) $\frac{1}{4}$

Assertion/ Reason :

DIRECTIONS (Qs. 1-8): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** The genetic complement of an organism is called genotype.
Reason : Genotype is the type of hereditary properties of an organism.

2. **Assertion :** Haemophilia is a recessive sex linked disease.
Reason : Haemophilia occurs due to mutation of a structural gene on chromosome 15.

3. **Assertion :** Persons suffering from haemophilia fail to produce blood clotting factor VIII.
Reason : Prothrombin producing platelets in such persons are found in very low concentration.

4. **Assertion :** DNA is associated with proteins.
Reason : DNA binds around histone proteins that form a pool and the entire structure is called a nucleosome.

5. **Assertion :** Cross of F_1 individual with recessive homozygous parent is test cross.
Reason : No recessive individual are obtained in the monohybrid test cross progeny.

6. **Assertion :** In *Mirabilis*, selfing of F_1 pink flower plants produces same phenotypic & genotypic ratio.
Reason : Flower colour gene shows incomplete dominance.

7. **Assertion :** Mendel was successful in his hybridization.
Reason : Garden pea proved ideal experimental material.

8. **Assertion :** In a monohybrid cross, F_1 generation indicate dominant characters.
Reason : Dominance occurs only in heterozygous state.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I		Column-II
A.	ABO blood groups	I.	Dihybrid cross
B.	Law of segregation	II.	Monohybrid cross
C.	Law of Independent assortment	III.	Base pairs substitution
D.	Gene mutation	IV.	Multiple allelism

(a) A – II; B – I; C – IV; D – III
(b) A – IV; B – I; C – II; D – III
(c) A – IV; B – II; C – I; D – III
(d) A – II; B – III; C – IV; D – I

2.

	Column-I		Column-II
A.	Turner syndrome	I.	Trisomy
B.	Linkage	II.	AA + XO
C.	Y-chromosome	III.	Morgan
D.	Down's syndrome	IV.	Testis determining factor

(a) A – II; B – I; C – IV; D – III
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – II; C – I; D – III
(d) A – II; B – III; C – IV; D – I

3.

	Column -I		Column -II
A.	Monoploidy	I.	$2n-1$
B.	Monosomy	II.	$2n+1$
C.	Nullisomy	III.	$2n+2$
D.	Trisomy	IV.	$2n-2$
E.	Tetrasomy	V.	n
		VI.	$3n$

(a) A – V; B – I; C – IV; D – II; E – III
(b) A – V; B – II; C – IV; D – I; E – III
(c) A – VI; B – V; C – III; D – IV; E – II
(d) A – II; B – I; C – III; D – VI; E – V

4.

	Column -I		Column -II
A.	Incomplete dominance	I.	*Drosophila*
B.	Mendelian disorder	II.	*Antirrhinum* sp.
C.	Transforming principle	III.	Griffith
D.	Dihybrid cross	IV.	Haemophilia

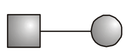
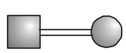
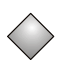
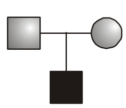
(a) A – I; B – IV; C – III; D – II
(b) A – IV; B – II; C – III; D – I
(c) A – II; B – III; C – IV; D – I
(d) A – II; B – IV; C – III; D – I

5.

	Column -I		Column -II
A.	Alfred Sturtevant	I.	Mapped position of genes
B.	Henking	II.	X-body
C.	Meischer	III.	Nuclein
D.	Morgan	IV.	Dihybrid crosses in *Drosophila*

(a) A – I; B – III; C – IV; D – II
(b) A – I; B – II; C – III; D – IV
(c) A – IV; B – I; C – II; D – III
(d) A – III; B – II; C – V; D – I

6. Match the symbols used in human pedigree analysis (given in column-I) with their name (given in column-II) and choose the correct option.

	Column -I		Column -II
A.		I.	Consanguineous mating
B.		II.	Normal female
C.		III.	Mating
D.		IV.	Affected female
E.		V.	Parents with male child affected with disease
		VI.	Sex unspecified

(a) A – III; B – I; C – II; D – V; E – IV
(b) A – II; B – I; C – VI; D – III; E – IV
(c) A – III; B – IV; C – I; D – V; E – II
(d) A – III; B – I; C – VI; D – V; E – IV

7.

	Column-I		Column-II
A.	Autosomal recessive trait	I.	Down's syndrome
B.	Sex-linked recessive trait	II.	Phenylketonuria
C.	Metabolic error linked to autosomal recessive	III.	Haemophilia
D.	Additional 21[st] chromosome	IV.	Sickle cell anaemia

(a) A – II; B – I; C – IV; D – III
(b) A – IV; B – I; C – II; D – III
(c) A – IV; B – III; C – II; D – I
(d) A – III; B – IV; C – I; D – II

8. Match column-I (Definition) with column-II (Terms) and select the correct option from the codes given below.

	Column-I (Definition)		Column-II (Terms)
A.	A single trait controlled by three or more than three alleles	I.	Pleiotropy
B.	A single trait controlled by three or more than three genes	II.	Multiple alleles
C.	A single gene exhibits multiple phenotypic expression	III.	Polygenic inheritance

(a) A – II; B – III; C – I
(b) A – III; B – II; C – I
(c) A – I; B – II; C – III
(d) A – II; B – I; C – III

Critical Thinking Type Questions

1. Harmful mutations does not get eliminated from gene pool because
(a) they are recessive and carried by homozygous individuals.
(b) they are recessive and carried by heterozygous individuals.
(c) they are formed repeatedly.
(d) they show genetic drift.

2. In a normal couple, half the sons are haemophilic while half the daughters are carriers. The gene responsible for it is located on
(a) X-chromosome of father.
(b) Y-chromosome of father.
(c) one X-chromosome of mother.
(d) both the X-chromosomes of mother.

3. According to the law of independent assortment in a dihybrid cross
(a) there are four genotypes in F_2.
(b) F_2 contains 16 phenotypes.
(c) there is a single individual which is homozygous recessive for both the characters.
(d) it is not possible to forecast the different phenotypes.

4. In case of codominance, the offsprings of F_1 generation have the trait
(a) of either of two parents.
(b) of both the parents.
(c) of none of the parents.
(d) in between the traits of two parents.

5. Regarding ABO blood group, if one parent is homozygous and other is heterozygous, what are the chances that their child will have 'O' blood group?
(a) 25% (b) 50%
(c) 75% (d) Zero

6. Which one of the following correctly represents the nature of blood in the ABO system of blood groups pertaining to the presence of antigens and antibodies?
(a) Blood group A –Antibody A and antigen B
(b) Blood group B–Antigen B and antibody A
(c) Blood group AB–Both antibodies A and B
(d) Blood group O–No antigens and no antibodies

7. In Down's syndrome, karyotyping has shown that the disorder is associated with trisomy of chromosome number 21 usually due to
(a) non-disjunction during egg formation.
(b) non-disjunction during sperm cell formation.
(c) addition of extrachromosome during cleavage of zygote.
(d) non-disjunction during egg cells production and sperm production.

8. In genetics the term test cross means
(a) the crossing of F_1 individual with homozygous recessive.
(b) crossing an F_1 individual with either of the two parents.
(c) crossing F_1 individual with another F_1 individual.
(d) crossing F_1 individual with that of F_2.

9. How would you test a pea plant whether it is a pure or hybrid for tallness ?
(a) Cross the pea plant with another tall pea plant of unknown genotype.
(b) Cross the pea plant with a pure tall pea plant.
(c) Cross the pea plant with a homozygous dwarf pea.
(d) Cross the pea plant with any pea plant.

28 Molecular Basis of Inheritance

Fill in the Blanks :

1. The transcription complex includes _____ and _____.
2. After an mRNA molecule is transcribed from a eukaryotic gene, portions called ____ are removed and the remaining ____ are spliced together to produce an mRNA molecule with a continuous coding sequence.
3. Consider Griffith's experiments on transformation in *Streptococcus pneumoniae*. Now imagine that you are extending these experiments by injecting a mixture of heat-killed strain R bacteria and live strain S bacteria into a mouse. The result will be that the mouse will _______, and you will find live strain _______ bacteria in its blood.
4. The genetic disorder Xeroderma Pigmentosum (XP) is a tragic example of the failure of DNA repair mechanisms. Specifically, XP patients possess a _______ allele that produces a nonfunctional protein whose job it would normally be to repair DNA damage caused by _______.
5. DNA replication is an ______ process and ______ energy.
6. The central dogma of molecular biology states that _____ is transcribed into _____ which is translated into _____.
7. Segments of mRNA removed during splicing are called ______.

True / False :

1. DNA polymerase can synthesize mRNA in the 3' to 5' direction.
2. Satellite DNA occurring as highly repeated short DNA segments.
3. When the small subunit of the ribosome encounters an mRNA the process of translation begins.
4. HGP was coordinated by US Department of Energy and the National Institute of Health.
5. The 23SrRNA acts as a catalyst for the formation of peptide bond in prokaryotes.
6. RNA was the first genetic material to evolve in the living systems.
7. Eukaryotes have split gene arrangement.
8. Less than 2 per cent of the genome codes for protein.
9. Heterochromatin is the most highly condensed form of chromatin.

Conceptual MCQs :

1. DNA replication is
   (a) conservative and discontinuous
   (b) semiconservative and semidiscontinuous
   (c) semiconservative and discontinuous
   (d) conservative
2. The translation termination triplet is
   (a) UAU (b) UAA
   (c) UAC (d) UGC
3. A nucleotide is formed of
   (a) purine, pyrimidine and phosphate
   (b) purine, sugar and phosphate
   (c) nitrogen base, sugar and phosphate
   (d) pyrimidine, sugar and phosphate
4. The process of transfer of genetic information from DNA to RNA/formation of RNA from DNA is
   (a) transversion (b) transcription
   (c) translation (d) translocation

5. The process of translation is
(a) ribosome synthesis
(b) protein synthesis
(c) dNA synthesis
(d) rNA synthesis

6. During DNA replication, the strands separate by
(a) DNA polymerase
(b) topoisomerase
(c) unwindase/Helicase
(d) gyrase

7. Because most of the amino acids are represented by more than one codon, the genetic code is
(a) overlapping (b) wobbling
(c) degenerate (d) generate

8. Who proved that DNA is basic genetic material?
(a) Griffith
(b) Watson
(c) Boveri and Sutton
(d) Hershey and Chase

9. Initiation codon of protein synthesis (in eucaryotes) is
(a) GUA (b) GCA
(c) CCA (d) AUG

10. Protein helping in opening of DNA double helix in form of replication fork is
(a) DNA gyrase
(b) DNA polymerase I
(c) DNA ligase
(d) DNA topoisomerase

11. DNA template sequence of CTGATAGC is transcribed over mRNA as
(a) GUCTUTCG (b) GACUAUCG
(c) GAUTATUG (d) UACTATCU

12. In *Escherichia* coli, lac operon is induced by
(a) lactose (b) promoter gene
(c) β -galactosidase (d) I-gene

13. The wild type *E. coli* cells are growing in normal medium with glucose. They are transferred to a medium containing only lactose as sugar. Which of the following changes takes place?
(a) The lac operon is repressed
(b) All operons are induced
(c) The lac operon is induced
(d) *E.coli* cells stop dividing

14. Okazaki fragments are seen during
(a) transcription (b) translation
(c) replication (d) transduction

15. T.O. Diener discovered a:
(a) free infectious DNA
(b) infectious protein
(c) bacteriophage
(d) free infectious RNA

16. Removal of introns and joining the exons in a defined order in a transcription unit is called:
(a) tailing
(b) transformation
(c) capping
(d) splicing

17. Whose experiments cracked the DNA and discovered unequivocally that a genetic code is a 'triplet'
(a) Hershey and Chase
(b) Morgan and Sturtevant
(c) Beadle and Tantum
(d) Nirenberg and Mathaei

18. Select the two correct statements out of the four (a–d) given below about lac operon.
(i) Glucose or galactose may bind with the repressor and inactivate it
(ii) In the absence of lactose the repressor binds with the operator region
(iii) The z-gene codes for permease
(iv) This was elucidated by Francois Jacob and Jacque Monod

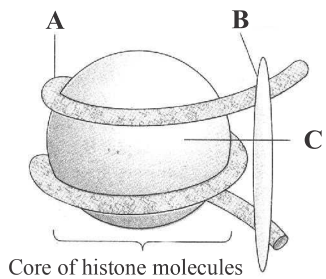
The correct statements are:
(a) (ii) and (iii) (b) (i) and (iii)
(c) (ii) and (iv) (d) (i) and (ii)

19. Satellite DNA is useful tool in:
(a) organ transplantation
(b) sex determination
(c) forensic science
(d) genetic engineering

20. Which one of the following does not follow the central dogma of molecular biology?
(a) Pea (b) *Mucor*
(c) *Chlamydomonas* (d) HIV

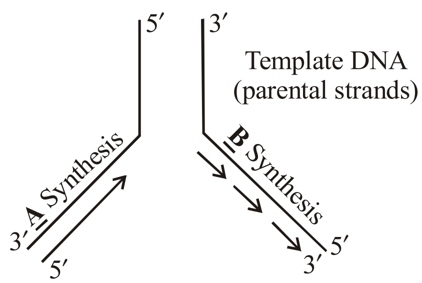
Diagram Based Questions :

1. The given figure shows the structure of nucleosome with their parts labelled as A, B & C. Identify A, B and C.



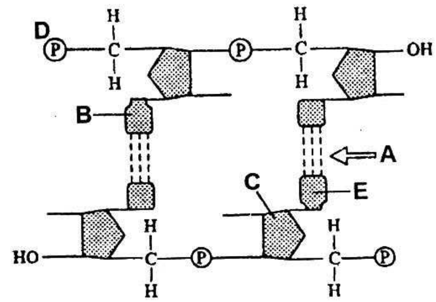
(a) A – DNA; B – H_1 histone; C – Histone octamer
(b) A – H_1 histone; B – DNA; C – Histone octamer
(c) A – Histone octamer; B – RNA; C – H_1 histone
(d) A – RNA; B – H_1 histone; C – Histone octamer

2. Name the types of synthesis A and B occurring in the replication fork of DNA as shown below.



(a) A - Continuous synthesis (synthesis of leading strand); B - Discontinuous synthesis (synthesis of lagging strand).
(b) A - Discontinuous synthesis (synthesis of leading strand); B - Continuous synthesis (synthesis of lagging strand).
(c) A- Continuous synthesis (synthesis of lagging strand); B - Discontinuous synthesis (synthesis of leading strand).
(d) A - Discontinuous synthesis (synthesis of lagging strand); B - Continuous synthesis (synthesis of leading strand).

3. The given figure represents the double stranded poly-nucteotide chain. Some parts are labelled as A, B, C, D and E. Identify the correct labelling of A, B, C, D & E.



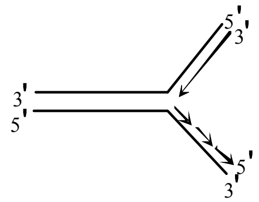
(a) A–Hydrogen bonds, B–Pyrimidine, C–Hexose (deoxyribose) sugar, D–5' end, E–Purine base
(b) A–Hydrogen bonds, B–Purine base, C–Hexose (deoxyribose) sugar, D–5' end, E–Pyrimidine
(c) A–Hydrogen bonds, B–Pyrimidine, |C–Pentose (deoxyribose) sugar, D–5' end, E–Purine base
(d) A–Hydrogen bonds, B–Purine base, C–Pentose (deoxyribose) sugar, D– 5' end, E– Pyrimidine

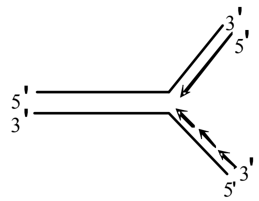
4. The diagram given below shows an important concept (proposed by C) in the genetic implication of DNA. The process occuring in that concept are marked as A and B. Identify A, B and C.

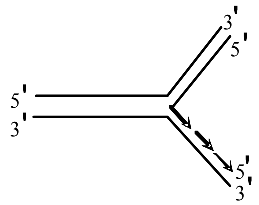
$$\text{DNA} \xrightarrow{A} \text{mRNA} \xrightarrow{B} \text{Protein}$$

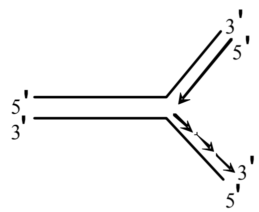
(a) A-Translation, B - Transcription, C-Erwin Chargaff
(b) A-Transcription, B - Translation, C-Francis Crick
(c) A-Translation, B - Extension, C-Rosalind Franklin
(d) A-Transcription, B - Replication, C-James Watson

5. Which one of the following correctly represents the manner of replication of DNA ?

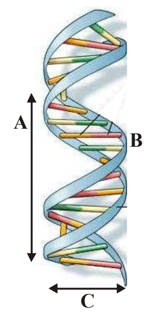
(a) 

(b) 

(c) 

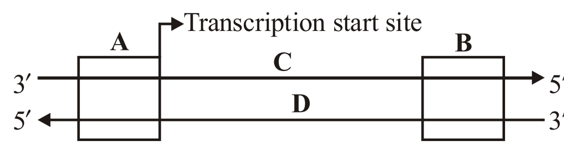
(d) 

6. Given figure represent the DNA double helix model, proposed by Watson and Crick (1953). Select the option that shows correct measurement of A, B and C marked in the figure.



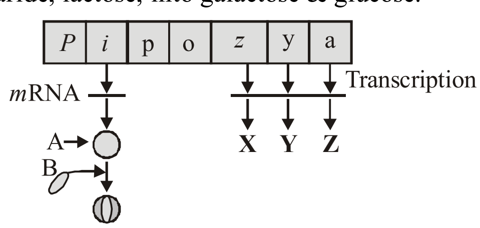
(a) A – 3.4 nm, B – 0.34 nm, C – 2 nm
(b) A – 34 nm, B – 3.4 nm, C – 20 nm
(c) A – 3.4 Å, B – 0.34 Å, C – 20 Å
(d) A – 34 Å, B – 3.4 Å, C – 2 Å

7. Given diagram represents the schematic structure of a transcription unit with some parts labelled as A, B, C and D. Select the option which shows its correct labelling.



	A	B	C	D
(a)	Terminator	Promoter	Template strand	Coding strand
(b)	Promoter	Terminator	Coding strand	Template strand
(c)	Promoter	Terminator	Template strand	Coding strand
(d)	Terminator	Promoter	Coding strand	Template strand

8. The given figure shows *lac* operon model and its functioning. Select the option which correctly labels A, B, X, Y and Z marked in the figure and also identify the label which is primarily responsible for the hydrolysis of the disaccharide, lactose, into galactose & glucose.



	A	B	X	Y	Z	L
(a)	Repressor	Inducer	β-Galacto-sidase	Permease	Trans-acetylase	X
(b)	Repressor	Inducer	Permease	β-Galacto-sidase	Trans-acetylase	Y
(c)	Inducer	Repressor	β-Galacto-sidase	Permease	Trans-acetylase	Z
(d)	Inducer	Repressor	β-Galacto-sidase	Trans-acetylase	Permease	B

Assertion/ Reason :

DIRECTIONS (Qs. 1-9): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion:** Clones are produced by sexual reproduction.
Reason: These are prepared by group of cells descended from many cells or by inbreeding of a heterozygous line.

2. **Assertion:** mRNA attaches to ribosome through its 3' end.
Reason: The mRNA has F-capsular nucleotide and bases of lagging sequence.

3. **Assertion :** Replication and transcription occur in the nucleus but translation in the cytoplasm.
Reason : m-RNA is transferred from the nucleus into the cytoplasm where ribosomes and amino acids are available for protein synthesis.

4. **Assertion :** In recombinant DNA technology human genes are often transferred into bacteria (prokaryotes) or yeast (eukaryote).
Reason : Both bacteria and yeast multiply very fast to form huge population which expresses the desired gene.

5. **Assertion:** An organism with lethal mutation may not even develop beyond the zygote.
Reason: All types of gene mutations are lethal.

6. **Assertion:** Polytene chromosomes have a high amount of DNA.
Reason: Polytene chromosomes are formed by repeated replication.

7. **Assertion :** Replication and transcription occur in the nucleus but translation occurs in the cytoplasm.
Reason : m RNA is transferred from the nucleus into the cytoplasm where ribosomes and amino acids are available for protein synthesis.

8. **Assertion :** In case of incomplete linkage, linked gene show new combination along with parental combination**.**
Reason : In case of incomplete linkage, linked genes are separated by crossing over.

9. **Assertion:** Aneuploidy may be of hypoploidy or hyperploidy type.
Reason: Monosomy lacks one pair of chromo-somes.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column - I	Column - II
(A) Helicase	I. Joining of nucleotides
(B) Gyrase	II. Opening of DNA
(C) Primase	III. Unwinding of DNA
(D) DNA polymerase III	IV. RNA priming

(a) A – II; B – I; C – III; D – IV
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – III; C – I; D – II
(d) A – II; B – III; C – IV; D – I

2.

Column - I	Column - II
A. Splicing	I. *Lac* operon
(B) Okazaki fragments	II. Lagging strands
(C) Jacob and Monad	III. Lactose
(D) Inducer	IV. Removal of intron

(a) A – IV; B – II; C – I; D – III
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – III; C – I; D – II
(d) A – II; B – III; C – I; D – IV

3.

Column - I	Column - II
(A) Operator site	I. Binding site for RNA polymerase
(B) Promoter site	II. Binding site for repressor molecule
(C) Structural gene	III. Codes for enzyme protein
(D) Regulator gene	IV. Codes for repressor molecules

(a) A – II; B – I; C – III; D – IV
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – III; C – I; D – II
(d) A – II; B – III; C – I; D – IV

4.

	Column - I		Column - II
(A)	Termination	I.	Aminoacyl tRNA synthetase
(B)	Translation	II.	Okazaki fragments
(C)	Transcription	III.	GTP dependent release factor
(D)	DNA replication	IV.	RNA polymerase

(a) A – II; B – I; C – III; D – IV
(b) A – III; B – I; C – IV; D – II
(c) A – IV; B – III; C – I; D – II
(d) A – II; B – III; C – I; D – IV

5.

	Column - I		Column - II
(A)	Griffith	I.	Nucleoid
(B)	Hershey and Chase	II.	Active chromatin
(C)	Prokaryotic DNA	III.	Transduction
(D)	Euchromatin	IV.	Transformation

(a) A – II; B – I; C – III; D – IV
(b) A – III; B – I; C – IV; D – II
(c) A – IV; B – III; C – I; D – II
(d) A – II; B – III; C – I; D – IV

6.

Column -I (Codons)		Column -II (Amino acids)	
(A)	UUU	I.	Serine
(B)	GGG	II.	Methionine
(C)	UCU	III.	Phenylalanine
(D)	CCC	IV.	Glycine
(E)	AUG	V.	Proline

(a) A – III; B – IV; C – I; D – V; E – II
(b) A – III; B – I; C – IV; D – V; E – II
(c) A – III; B – IV; C – V; D – I; E – II
(d) A – II; B – IV; C – I; D – V; E – III

7.

Column - I		Column - II	
(A)	β-galactosidase	I.	Joining of DNA fragments
(B)	Permease	II.	Peptide bond formation
(C)	Ligase	III.	Hydrolysis of lactose
(D)	Ribozyme	IV.	Increase permeability of -galactosidase

(a) A – II; B – I; C – IV; D – III
(b) A – III; B – IV; C – I; D – II
(c) A – II; B – IV; C – I; D – III
(d) A – I; B – II; C – IV; D – III

8.

	Column-I		Column-II
(A)	F. Meischer	I.	DNA double helix
(B)	Griffith	II.	Nuclein
(C)	Hershey and Chase	III.	*S. pneumoniae*
(D)	Watson and Crick	IV.	Bacteriophages
(E)	Wilkins and Franklin	V.	X-ray diffraction studies

(a) A – II; B – III; C –IV; D – I; E – V
(b) A – V; B – IV; C –III; D – I; E – II
(c) A – I; B – III; C –IV; D – II; E – V
(d) A – I; B – IV; C –III; D – II; E – V

Critical Thinking Type Questions

1. In tertiary structure of DNA, what is a histone octamer ?
(a) A complex consisting of eight positively charged histone proteins (two of each H_2A, H_2B, H_3 and H_4) that aid in the packaging of DNA.
(b) A complex consisting of eight negatively charged histone proteins (two of each H_2A, H_2B, H_3 and H_4) that aid in the packaging of DNA.
(c) A complex consisting of nine positively charged histone proteins (H_1 and two of each H_2A, H_2B, H_3 and H_4) that aid in the packaging DNA.

(d) A complex consisting of nine negatively charged histone proteins (H_1 and two of each H_2A, H_2B, H_3 and H_4) that aid in the packaging of DNA.

2. Histones are rich in lysine and arginine because
(a) DNA is negatively charged.
(b) DNA is positively charged.
(c) DNA has no charge.
(d) DNA is polar molecule.

3. The most abundant type of RNA in the cell is
(a) *r* RNA (b) *m* RNA
(c) *t* RNA (d) *hn* RNA

4. In terms of DNA and RNA structure, what is a nucleotide ?
(a) A nucleotide is a heterocyclic base.
(b) A nucleotide is a sugar molecule covalently bonded to a heterocyclic base.
(c) A nucleotide is a sugar molecule bonded to phosphate group and a heterocyclic base.
(d) A nucleotide is a heterocyclic base bonded to phosphate group.

5. DNA exists in a double-stranded form whereas RNA is mainly a single stranded molecule. What is the likely reason for DNA being double stranded ?
(a) RNA strands cannot form base pairs.
(b) Double stranded DNA is a more stable structure.
(c) DNA cannot exist in the single stranded form.
(d) It is easier to replicate double stranded DNA than single stranded RNA.

6. *Escherichia coli* fully labelled with ^{15}N is allowed to grow in ^{14}N medium. The two strands of DNA molecule of the first generation bacteria have
(a) different density and do not resemble with their parent DNA.
(b) different density but resemble with their parent DNA.
(c) same density and resemble with their parent DNA.
(d) same density but do not resemble with their parent DNA.

7. Which step of translation does not consume high energy phosphate bond?
(a) Translocation
(b) Peptidyl transferase reaction
(c) Amino acid activation
(d) Aminoacyl tRNA binding to A-site

8. During elongation of polypeptide chain, sigma factor is
(a) functionless.
(b) retained for specific function.
(c) released for re-use.
(d) required during closing of chain.

9. Operon is a
(a) sequence of three nitrogen bases determining a single amino acid.
(b) set of closely placed genes regulating a metabolic pathway in prokaryotes.
(c) segment of DNA specifying a polypeptide.
(d) gene responsible for switching on and switching off other genes.

29 Evolution

Fill in the Blanks :

1. The life appeared about ___________ million yrs. after the formation of earth.
2. _________ proposed the theory of abiogenesis.
3. Our galaxy named, _________ is _________ in shape.
4. According to ___________ the earth is about 4000 yrs. old.
5. The first cellular form of life originated about ___________ million yrs. ago.
6. _________ theory believed that life originated on some other planet, and later got transferred on to earth.
7. Experimental proof for the modern theory of origin of life was given by _________ He used the gases ___________ with water vapours for synthesis of complex organic compounds.
8. Protenoid, the first living molecule, was named ___________ by A. I. Oparin.
9. ___________ and ___________ worked out independently on the origin of life and supported the theory of chemical evolution.

True / False :

1. Adaptative ability has a genetic basis
2. Louis Pasteur belived that life appeared only from pre-existing life.
3. The thorns in *Bougainvillea* and tendrils in cucurbits represent divergent evolution.
4. The similarity in the eyes of *Octopus* and monkeys is the result of convergent evolution.
5. The white-winged moths were completely wiped out after industrialization.
6. The skull of modern human resembles more closely to baby chimpanzee than to adult chimpanzee.
7. Earth was formed about 4.6 million years ago.
8. Changes in allelic frequency in a population will lead to Hardy-Weinberg equilibrium.

Conceptual MCQs :

1. Evolution is
   (a) progressive development of a race
   (b) history and development of a race alongwith variations
   (c) history of a race
   (d) development of a race
2. Which was absent in the atmosphere at the time of origin of life ?
   (a) NH_3 (b) H_2
   (c) O_2 (d) CH_4
3. Evolutionary convergence is development of
   (a) common set of characters in group of different ancestry
   (b) dissimilar characters in closely related groups
   (c) common set of characters in closely related groups
   (d) random mating
4. Theory of natural selection dwells on
   (a) role of environment in evolution
   (b) natural selection acting on favourable variations
   (c) changes in gene complex resulting in heritable variations
   (d) none of these
5. Genetic drift is change of
   (a) gene frequency in same generation
   (b) appearance of recessive genes

(c) gene frequency from one generation to next
(d) none of the above

6. Which one is irrelevant to evolution of man?
(a) Perfection of hand for tool making
(b) Change of diet from hard nuts/roots to soft food
(c) Increased ability to communicate or develop community behaviour
(d) Loss of tail

7. Homologous organs are
(a) wings of insects and Bat
(b) gills of Fish and lungs of Rabbit
(c) pectoral fins of Fish and fore limbs of Horse
(d) wings of Grosshopper and Crow

8. The presence of gill slits, in the embryos of all vertebrates, supports the theory of
(a) biogenesis (b) recapitulation
(c) metamorphosis (d) organic evolution

9. The homologous organs are those that show similarity in
(a) size (b) origin
(c) function (d) appearance

10. Genetic drift operates only in
(a) smaller populations
(b) larger populations
(c) mendelian populations
(d) island populations

11. Which of the following are homologous organs?
(a) Wings of birds and locust
(b) Wings of birds (sparrow) and pectoral fins of fish
(c) Wings of bat and butterfly
(d) Legs of frog and cockroach

12. Which one of the following sequences was proposed by Darwin and Wallace for organic evolution ?
(a) Variations, natural selection, overproduction, constancy of population size
(b) Overproduction, variations, constancy of population size, natural selection
(c) Variations, constancy of population size, overproduction, natural selection
(d) Overproduction, constancy of population size, variations, natural selection

13. Convergent evolution is illustrated by
(a) dogfish and whale
(b) rat and dog
(c) bacterium and protozoan
(d) starfish and cuttle fish

14. Among the human ancestors the brain size was more that 1000 cc in
(a) *Homo erectus*
(b) *Ramapithecus*
(c) *Homo habilis*
(d) *Homo neanderthalensis*

15. *Peripatus* is a connecting link between:
(a) Mollusca and Echinodermata
(b) Annelida and Arthropoda
(c) Coelenterata and Porifera
(d) Ctenophora and Platyhelminthes

16. Darwin's finches are a good example of:
(a) Industrial melanism
(b) Connecting link
(c) Adaptive radiation
(d) Convergent evolution

17. What was the most significant trend in the evolution of modern man (*Homo sapiens*) from his ancestors?
(a) Shortening of jaws
(b) Binocular vision
(c) Increasing cranial capacity
(d) Upright posture

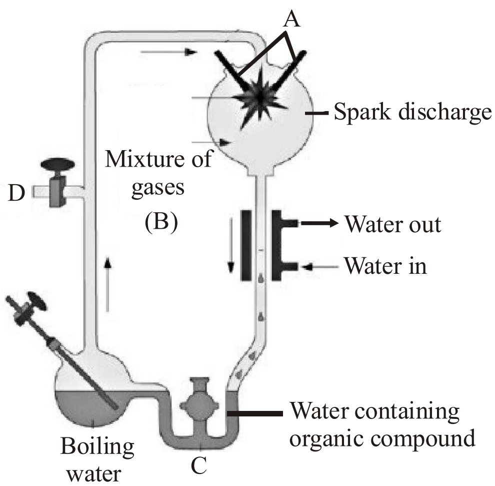
18. The extinct human who lived 1,00,000 to 40,000 years ago, in Europe, Asia and parts of Africa, With short stature, heavy eyebrows, retreating fore heads, large jaws with heavy teeth, stocky bodies, a lumbering gait and stooped posture was
(a) *Homo habilis*
(b) Neanderthal human
(c) Cro-magnan humans
(d) *Ramapithecus*

19. The idea of mutations was brought forth by
(a) Gregor Mendel, who worked on *Pisum sativum.*
(b) Hugo de Vries, who worked on evening *Primrose*.
(c) Hardy Weinberg, who worked on allele frequencies in a population.
(d) Charles Darwin, who observed a wide variety of organisms during sea voyage.

20. Which of the following cannot be explained by Lamarckism?
(a) Absence of lips in snakes
(b) Long neck of giraffe
(c) Degeneration of visual apparatus in cave dwellers
(d) Dull progeny of noble laureate

Diagram Based Questions :

1. The given diagram represents Miller's experiment. Choose the correct combination of labelling A, B , C, D and E.



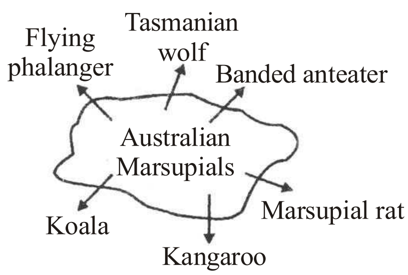
(a) A–Electrodes, B– $NH_3 + H_2 + H_2O + CH_4$, C– liquid water in trap, D–vacuum pump

(b) A– Electrodes, B–$NH_4 + H_2 + CO_2 + CH_3$, C– liquid water in trap, D – Vacuum pump

(c) A– Electrodes, B–NH_3 + H_2O, C–liquid water in trap, D – Tap

(d) A– Electrodes, B–$NH_3 + H_2 + H_2O + CH_4$, C – liquid water in trap, D– Vacuum pump

2. The given diagram of marsupials of Australia provides an example of



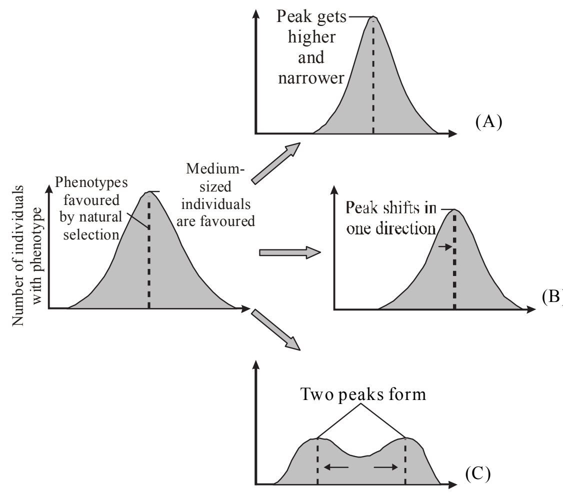
(a) convergent evolution

(b) parallel evolution

(c) recapitulation

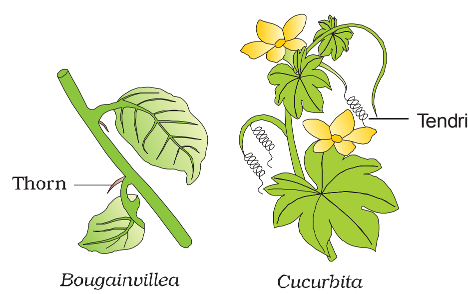
(d) divergent evolution

3. Following is the diagrammatic representation of the operation of natural selection of different traits. Which of the following options correctly identifies all the three graphs A, B and C



	A	B	C
(a)	Directional	Stabilizing	Disruptive
(b)	Stabilizing	Directional	Disruptive
(c)	Disruptive	Stabilizing	Directional
(d)	Directional	Disruptive	Stabilizing

4. The given figure shows an example of



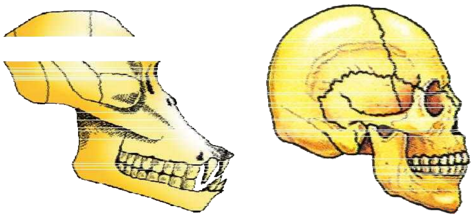
(a) homologous organs

(b) convergent evolution

(c) divergent evolution

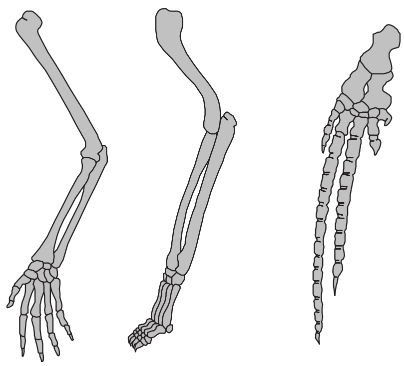
(d) both (a) and (c)

5. The diagram given below shows the skull of two different mammals. Which of the following accurately describes the differences between these skulls?



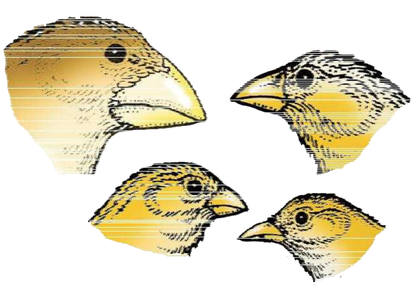
(a) Skull A has more teeth than skull B.
(b) Skull A has more brain capacity than skull B.
(c) Skull A is of a human and skull B is of an ape.
(d) Skull A is of an ape and skull B is of human.

6. The given bones in the forelimbs of three mammals figure shows.



For these mammals, the number, position, and shape of the bones must likely indicates that they may have
(a) developed in a common environment.
(b) developed from the same earlier species.
(c) identical genetic makeup.
(d) identical methods of obtaining food.

7. The diagram below shows four species of birds that evolved from an ancestral species that had a small pointed beak. Today, all four species inhabit the same island.



Which statement best explains the variation in the beaks of these four species?
(a) Over time, an abundance of seeds for food led to increased similarities between the species.
(b) Over time, an abundance of seeds for food led to increased differences between the species.
(c) Competition of limited food resources led to selection for similar traits.
(d) Competition for limited food resources led to selection for different traits.

Assertion/ Reason :

DIRECTIONS (Qs. 1-10): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion:** We have lost all the direct evidence of origin of life.

Reason: The persons responsible for protecting evidences were not skilled.

2. **Assertion :** *Ginkgo biloba* is a living fossil.

Reason : Organism which have persisted and remain unchanged for the past several million years while their relatives disappeared.

3. **Assertion :** Among the primates, chimpanzee is the closest relative of the present day humans.

Reason : The banding pattern in the autosome numbers 3 and 6 of man and chimpanzee is remarkably similar.

4. **Assertion :** From evolutionary point of view, human gestation period is believed to be shortening.

   Reason : One major evolutionary trend in humans has been the larger head undergoing relatively faster growth rate in the foetal stage.

5. **Assertion :** Natural selection is the outcome of differences in survival and reproduction among individuals that show variation in one or more traits.

   Reason : Adaptive forms of a given trait tend to become more common; less adaptive ones become less common or disappear.

6. **Assertion :** Coacervates are believed to be the precursors of life.

   Reason : Coacervates were self-duplicating aggregates of proteins surrounded by lipid molecules.

7. **Assertion :** The earliest organisms that appeared on the earth were non-green and presumably anaerobes.

   Reason : The first autotrophic organisms were the chemoautotrophs that never released oxygen.

8. **Assertion :** Human ancestors never used their tails and so the tail expressing gene has disappeared in them.

   Reason : Lamarck's theory of evolution is popularly called theory of continuity of germ plasm.

9. **Assertion :** Comparative biochemistry provides a strong evidence in favour of common ancestory of living beings.

   Reason : Genetic code is universal.

10. **Assertion :** Darwin's finches show a variety of beaks suited for eating large seeds, flying insects and cactus seeds.

    Reason : Ancestral seed-eating stock of Darwin's finches radiated out from South American mainland to different geographical areas of the Galapagos Islands, where they found competitor-free new habitats.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column - I		**Column - II**
(A)	Mutation	I.	Change in population's allele frequencies due to chance alone.
(B)	Gene flow	II.	Differences in survival and reproduction among variant individuals.
(C)	Natural selection	III.	Immigration, emigration change allele frequencies.
(D)	Genetic drift	IV.	Source of new alleles.

(a) A – I; B – II; C – III; D – IV
(b) A – IV; B – II; C – III; D – I
(c) A – III; B – I; C – IV; D – II
(d) A – IV; B – III; C – II; D – I

2.

	Column-I		**Column-II**
(A)	Human embryos have gill	I.	Chemical evolution
(B)	Oparin and Haldane	II.	Stimulation experiment
(C)	Miller and Urey	III.	Wings of bird and butterfly
(D)	Analogous organs	IV.	Ontogeny repeats phylogeny

(a) A – III; B – IV; C – II; D – I
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – I; C – II; D – III
(d) A – IV; B – I; C – III; D – II

3.

	Column-I (Name of the Scientist)		Column-II (Contributions)
(A)	Charles Darwin	I.	Mutation theory
(B)	Lamarck	II.	Germ plasm theory
(C)	Hugo de Vries	III.	Philosophie Zoologique
(D)	Ernst Haeckel	IV.	The Origin of species
(E)	August Weismann	V.	Biogenetic law
		VI.	Essay on population

(a) A – IV; B – III; C – I; D – V; E – II
(b) A – IV; B – III; C – V; D – I; E – VI
(c) A – IV; B – VI; C – V; D – III; E – I
(d) A – II; B – III; C – I; D – V; E – II

4.

	Column-I		Column-II
(A)	Mesozoic	I.	First amphibians
(B)	Devonian	II.	Proliferation of reptiles
(C)	Palaeocene	III.	Raise of modern mammals
(D)	Permian	IV.	Radiation of primitive mammals
		V.	160 million years

(a) A – V; B – IV; C – III; D – II
(b) A – V; B – I; C – IV; D – II
(c) A – V; B – I; C – II; D – III
(d) A – V; B – I; C – IV; D – III

5.

	Column-I		Column-II
(A)	Saltation	I.	Darwin
(B)	Formation of life was preceded	II.	Louis Pasteur
(C)	Reproductive fitness	III.	de Vries
(D)	Life comes from pre-existing life	IV.	Oparin and haldane

(a) A – III; B – IV; C – I; D – II
(b) A – IV; B – III; C – II; D – I
(c) A – II; B – III; C – I; D – IV
(d) A – I; B – IV; C – III; D – II

6.

	Column-I		Column-II
(A)	Wallace	I.	Essay on population
(B)	Malthus	II.	Biston
(C)	Hardy-weinberg law	III.	$p^2 + q^2 + 2pq = 1$
(D)	Industrial melanism	IV.	Co-proposer of Natural selection

(a) A – III; B – IV; C – II; D – I
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – I; C – II; D – III
(d) A – IV; B – I; C – III; D – II

Critical Thinking Type Questions

1. Which one of the following describes correctly the homologous structures?
(a) Organs that have no function now, but had an important function in ancestors.
(b) Organs appearing only in embryonic stage and disappearing later in the adult.
(c) Organs with anatomical similarities, but performing different functions.
(d) Organs with anatomical dissimilarities, but performing same function.

2. Select the correct order of geological time scale of earth.
(a) Palaeozoic $\rightarrow$ Archaeozoic $\rightarrow$ Coenozoic
(b) Archaeozoic $\rightarrow$ Palaeozoic $\rightarrow$ Proterozoic
(c) Palaeozoic $\rightarrow$ Mesozoic $\rightarrow$ Coenozoic
(d) Mesozoic $\rightarrow$ Archaeozoic $\rightarrow$ Proterozoic

3. The first organisms were
(a) chemoautotrophs
(b) chemoheterotrophs
(c) autotrophs
(d) eukaryotes

4. Diversity in the type of beaks of finches adapted to different feeding habits on the Galapagos Islands, as observed by Darwin, provides evidence for
(a) intraspecific variations
(b) intraspecific competition
(c) interspecific competition
(d) origin of Species by natural selection

5. According to Oparin, which one of the following was not present in the primitive atmosphere of the earth?
(a) Methane (b) Oxygen
(c) Hydrogen (d) Water vapour

6. Evolution of different species in a given area starting from a point and spreading to other geographical areas is known as.
(a) adaptive radiation
(b) natural selection
(c) migration
(d) divergent evolution

7. The eye of octopus and eye of cat show different patterns of structure, yet they perform similar function. This is an example of
(a) Homologous organs that have evolved due to divergent evolution.
(b) Analogous organs that have evolved due to convergent evolution.
(c) Analogous organs that have evolved due to divergent evolution.
(d) Homologous organs that have evolved due to convergent evolution.

8. Fossil remains of *Archaeopteryx* indicates that
(a) it was a flying reptile from Triassic.
(b) it was a flying reptile from Permian.
(c) reptiles gave rise to birds during Permian.
(d) reptiles gave rise to birds during Jurassic.

9. *Archaeopteryx* is known as missing connecting link because it is a fossil and shows the characters of
(a) fishes and amphibians.
(b) birds and reptiles.
(c) reptiles and mammals.
(d) chordates and nonchordates.

10. The shape of the heals of Darwins finches, industrial melanism, or the changes in horse teeth are all examples of
(a) artificial selection.
(b) natural selection.
(c) convergent evolution.
(d) homologous structures.

11. Stabilizing selection favours
(a) both extreme forms of a tract.
(b) intermediate forms of a tract.
(c) environmental differences.
(d) one extreme form over the other extreme form and over intermediates forms of a tract.

30 HEALTH AND DISEASE

Fill in the Blanks :

1. ________ is the causative agent of mad cow disease.
2. Hepatitis- B is ________ generation vaccine.
3. Prions were discovered by ________
4. ________ vaccine prevents from TB.
5. ________ is used for testing typhoid fever
6. Mantoux test is for ________
7. Pregnancy test detects the presence of ________ hormone in urine
8. Kuru is commonly known as ________

True / False :

1. Injecting microbes during immunization induces passive immunity.
2. Cell-mediated immune response is responsible for graft rejection.
3. Colostrum during initial days of lactation provides active immunity to infant.
4. Heroin, commonly called smack, is obtained by acetylation of morphine.
5. Cocaine is obtained from the latex of *Papaver somniferum*.
6. Marijuana interferes with the transmission of dopamine.
7. Morphine is an effective sedative and pain killer.
8. *Hashish* causes after thought perceptions and hallucinations.
9. Benign tumours show the property of metastasis.

Conceptual MCQs :

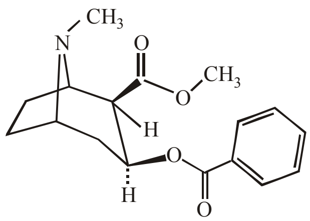
1. AIDS is caused by HIV that principally infects
   (a) all lymphocytes (b) activator B cells
   (c) cytotoxic T cells (d) T_4 lymphocytes
2. ELISA is used to detect viruses, where
   (a) DNA-probes are required
   (b) southern bloting is done
   (c) alkaline phosphatase is the key reagent
   (d) catalase is the key reagent
3. Common cold is not cured by antibiotics because it is
   (a) caused by a virus.
   (b) caused by a Gram-positive bacterium.
   (c) caused by a Gram-negative bacterium.
   (d) not an infectious disease.
4. Select the correct statement with respect to diseases and immunisation?
   (a) If due to some reason B-and T-lymphocytes are damaged, the body will not produce antibodies against a pathogen.
   (b) Injection of dead / inactivated pathogens causes passive immunity.
   (c) Certain protozoans have been used to mass produce hepatitis B vaccine.
   (d) Injection of snake antivenom against snake bite is an example of active immunisation.
5. Which one of the following acts as a physiological barrier to the entry of micro-organisms in human body ?
   (a) Epithelium of urogenital tract
   (b) Tears
   (c) Monocytes
   (d) Skin
6. Which one of the following is categorised as a parasite in true sense ?
   (a) The female *Anopheles* bites and sucks blood from humans.
   (b) Human foetus developing inside the uterus draws nourishment from the mother.
   (c) Head louse living on the human scalp as well as laying eggs on human hair.
   (d) The cuckoo (koel) lays its eggs in crow's nest.

7. At which stage of HIV infection does one usually show symptoms of AIDS?
   (a) When the infecting retrovirus enters host cells.
   (b) When viral DNA is produced by reverse trancriptase.
   (c) When HIV replicates rapidly in helper T-lymphocytes and damages large number of these.
   (d) Within 15 day of sexual contact with an infected person.
8. Where will you look for the sporozoites of the malarial parasite?
   (a) Saliva of infected female *Anopheles* mosquito.
   (b) Red blood corpuscles of humans suffering from malaria.
   (c) Spleen of infected humans.
   (d) Salivary glands of freshly moulted female *Anopheles* mosquito.
9. Widal test is used for the diagnosis of
   (a) malaria (b) pneumonia
   (c) tuberculosis (d) typhoid
10. Which of the following is a pair of viral diseases?
    (a) Common cold, AIDS
    (b) Dysentery, common cold
    (c) Typhoid, tuberculosis
    (d) Ringworm, AIDS
11. Which one of the following statements is **correct**?
    (a) Benign tumours show the property of metastasis.
    (b) Heroin accelerates body functions.
    (c) Malignant tumours may exhibit metastasis.
    (d) Patients who have undergone surgery are given cannabinoids to relieve pain.
12. Select the correct statement from the ones given below?
    (a) Barbiturates when given to criminals make them tell the truth.
    (b) Morphine is often given to persons who have undergone surgery as a pain killer.
    (c) Chewing tobacco lowers blood pressure and heart rate.
    (d) Cocaine is given to patients after surgery as it stimulates recovery.
13. Which one of the following depresses brain activity and produced feelings of calmness, relaxation and drowsiness?
    (a) Morphine (b) Valium
    (c) Amphetamines (d) Hashish
14. A person likely to develop tetanus is immunised by administering
    (a) preformed antibodies
    (b) wide spectrum antibiotics
    (c) weakened germs
    (d) dead germs
15. The letter T in T -lymphocyte refers to
    (a) Thalamus (b) Tonsil
    (c) Thymus (d) Thyroid
16. Use of anti-histamines and steroids give a quick relief from
    (a) nausea (b) cough
    (c) headache (d) allergy
17. The pathogen *Microsporum* responsible for ringworm disease in humans belongs to the same kingdom of organisms as that of
    (a) *Taenia*, a tapeworm
    (b) *Wuchereria*, a filarial worm
    (c) *Rhizopus*, a mould
    (d) *Ascaris*, a round worm
18. Motile zygote of Plasmodium occurs in :
    (a) Gut of female Anopheles
    (b) Salivary glands of Anopheles
    (c) Human RBCs
    (d) Human liver
19. Common cold differs from pneumonia in, that :
    (a) Pneumonia is a communicable disease whereas the common cold is a nutritional deficiency disease.
    (b) Pneumonia can be prevented by a live attenuated bacterial vaccine whereas the common cold has no effective vaccine.
    (c) Pneumonia is caused by a virus while the common cold is caused by the bacterium *Haemophilus influenzae*.
    (d) Pneumonia pathogen infects alveoli whereas the common cold affects nose and respiratory passage but not the lungs.
20. Cirrhosis of liver is caused by the chronic intake of
    (a) Opium (b) Alcohol
    (c) Tobacco (Chewing) (d) Cocaine

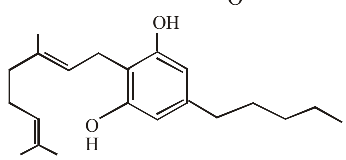
Diagram Based Questions :

1. Identify the molecules (a) and (b) given below and select the right option giving their source and use.

(a)

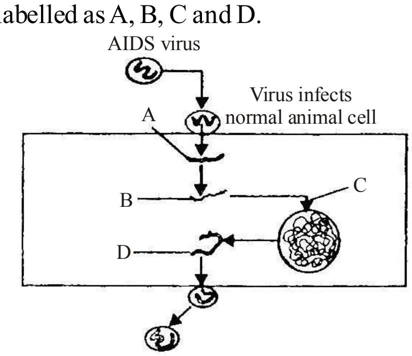


(b)



	Molecule	Source	Use
(a)	(a) Cocaine	*Erythroxylum coca*	Accelerates the transport of dopamine
(b)	(b) Heroin	*Cannabis sativa*	Depressant and slows down body functions
(c)	(b) Cannabinoid	*Atropa belladonna*	Produces hallucinations
(d)	(a) Morphine	*Papaver somniferum*	Sedative and pain killer

2. Refer the given figure showing the mode of action of AIDS virus and identify the sequences labelled as A, B, C and D.



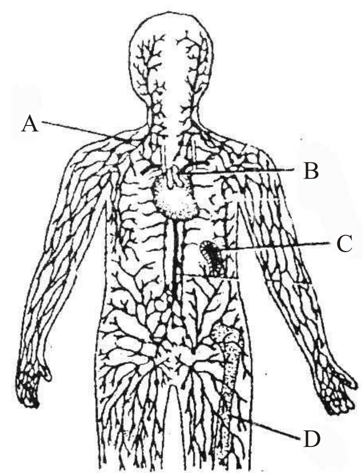
(a) A - Viral DNA introduced into cell; B - Viral DNA; C - Viral DNA incorporates into host RNA; D - New viral RNA produced

(b) A - Viral RNA introduced into cell; B - Viral RNA; C - Viral DNA incorporates into host DNA; D - New viral DNA produced

(c) A - Viral RNA introduced into cell; B - Viral DNA; C - Viral DNA incorporates into host DNA; D - New viral RNA produced

(d) A - Viral DNA introduced into cell; B - Viral RNA; C - Viral RNA incorporates into host DNA; D - New viral DNA produced

3. Given figure shows the human lymphatic system with some part marked as A, B, C and D identify the correct part



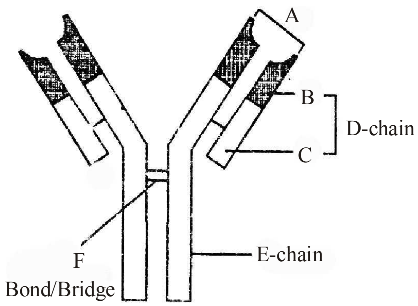
(a) A - lymph nodes (primary lymphoid organ), B - thymus (primary lymphoid organ), C - spleen (secondary lymphoid organ), D - bone marrow (secondary lymphoid organ)

(b) A - lymph nodes (primary lymphoid organ), B - thymus (secondary lymphoid organ), C - spleen (primary lymphoid organ), D - bone marrow (primary lymphoid organ)

(c) A - lymph nodes (secondary lymphoid organ), B - thymus (primary lymphoid organ), C-spleen (secondary lymphoid organ), D - bone marrow (primary. lymphoid organ)

(d) A- lymph nodes (primary lymphoid organ), B - thymus (secondary lymphoid organ), C - spleen (secondary lymphoid organ), D - bone marrow (secondary lymphoid organ)

4. The diagram given below shows an antibody molecule with their parts labelled as A, B, C, D, E & F. Identify the part marked as A, B, C, D, E and F.



(a) A-Antigen binding site; B-Variable region (of L-Chain); C - Constant region (of L-Chain); D - Light polypeptide chain (L-Chain); E-Heavy polypeptide chain (H-Chain); F - Disulfide bond.
(b) A - Antigen binding site; B-Constant region (of L-Chain); C - Variable region (of L-Chain); D - Light polypeptide chain (L-Chain); E-Heavy polypeptide chain (H-Chain); F - Disulfide bond.
(c) A-Antigen binding site; B-Variable region (of L-Chain); C - Constant region (of L-Chain); D - Heavy polypeptide chain (L-Chain); E - Light polypeptide chain (H-Chain); F - Hydrogen bond
(d) A-Antigen binding site; B-Variable region (of L-Chain); C - Constant region (of L-Chain); D - Light polypeptide chain (L-Chain); E - Heavy polypeptide chain (H-Chain); F - Hydrogen bond

Assertion/ Reason :

DIRECTIONS (Qs. 1-13): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion:** There is no chance of malaria to a man on the bite of male *Anopheles* mosquito.
Reason: It carries a non-virulant strain of *Plasmodium*.

2. **Assertion :** Rabies is an infection of mammals, it involves central nervous system which may result in paralysis and finally death.
Reason : This is caused by neurotropic bacteria in saliva of rabies animal.

3. **Assertion :** Cancer cells are virtually immortal until the body in which they reside dies.
Reason : Cancer is caused by damage to genes regulating the cell division cycle.

4. **Assertion :** Antigen can be easily recognized because it has antigenic determinants.
Reason : The recognition ability is innate.

5. **Assertion :** *Escherichia coli, Shigella sp.* and *Salmonella sp.* are all responsible for diarrhoeal diseases.
Reason : Dehydration is common to all types of diarrhoeal diseases and adequate supply of fluids and electrolytes should be ensured.

6. **Assertion:** Epstein– Barr virus is an oncovirus.
Reason: It stimulates the growth of cancer.

7. **Assertion:** HIV infected person are prone to oppurtunistic diseases.
Reason: Immune system weakens during HIV infection.

8. **Assertion :** Mast cells in the human body release excessive amounts of inflammatory chemicals which cause allergic reactions.
Reason : Allergens in the environment on reaching human body stimulate mast cells in certain individuals.

9. **Assertion :** Interferons are a type of antibodies produced by body cells infected by bacteria.
Reason : Interferons stimulate inflammation at the site of injury.

10. **Assertion :** Organ transplantation patients are given immunosuppressive drugs.
Reason : Transplanted tissue has antigens which stimulate the specific immune response of the recipient.

11. **Assertion :** The antibodies separted from serum are homogenous.
Reason : Monoclonal antibodies are homogenous immunological reagents.

12. **Assertion :** Cocaine has a potent stimulating action on central nervous system, producing a sense of euphoria and increased energy.
Reason : It interferes with the transport of the neuro-transmitter acetylcholine.

13. **Assertion :** Active immunity is slow and takes time to give its full effective response.
Reason : Injecting the microbes intentionally during immunization or infectious organisms

gaining access into body during natural infection induces active immunity.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I (components of body defence)		Column-II (Description)
A.	Active natural immunity	I.	Injection of gamma globulins
B.	First line of defence	II.	Complement proteins and interferons
C.	Passive natural immunity	III.	Direct contact with the pathogens that have entered inside
D.	Second line of defence	IV.	Surface barriers
		V.	Antibodies transferred through the placenta

(a) A – IV; B – III; C – V; D – II
(b) A – III; B – IV; C – II; D – V
(c) A – III; B – IV; C – V; D – II
(d) A – V; B – III; C – II; D – I

2.

	Column I (Drugs)		Column II (features)
A.	LSD	I.	Euphorian effect
B.	Disulfiram	II.	Parasympatholytic
C.	Cocaine	III.	*Cannabis*
D.	Scopolamine	IV.	Ergot alkaloid
E.	Hashish	V.	Antabuse

(a) A – IV; B – V; C – I; D – II; E – III
(b) A – IV; B – I; C – V; D – II; E – III
(c) A – IV; B – V; C – II; D – I; E – III
(d) A – V; B – IV; C – I; D – II; E – III

3.

	Column-I (Diseases)		Column-II (Pathopen/prevention/ treatment)
A.	Amoebiasis	I.	*Lassa virus*
B.	Diphtheria	II.	Use only sterilized food and water
C.	Cholera	III.	DPT vaccine
D.	Rabies	IV.	Use oral rehydration therapy

(a) A – II; B – III;C – IV; D – I
(b) A – I; B – II; C – III; D – IV
(c) A – II; B – IV; C – I; D – III
(d) A – II; B – I; C – III; D – IV

4.

	Disease	Causative organisms	Mode of Infection
(a)	Elephantiasis	*Wuchereria bancrofti*	With infected water and food
(b)	Malaria	*Plasmodium vivax*	Bite of male *Anopheles* mosquito
(c)	Typhoid	*Salmonella typhi*	With inspired air
(d)	Pneumonia	*Streptococcus pneumoniae*	Droplet infection

5.

	Column I		Column II
A.	Appearance of dry, scaly lesions on various parts of the body such as skin nails and scalp.	I.	*Entamoeba histolytica*
B.	Chronic inflammation of the lymphatic vessel of lower limbs.	II.	*Ascaris lumbricoides*
C.	Fever, chills, cough, headache and in severe cases the lips and finger nails may turn gray to bluish in colour	III.	*Haemophilus influenzae*
D.	Constipation, abdominal pain and cramps, stool with excess mucous and blood clots.	IV.	*Wuchereria bancrofti*
E.	Internal bleeding, muscular pain, fever, anaemia and blockage of intestinal passage.	V.	*Microsporum*

	A	B	C	D	E
(a)	I	II	III	IV	V
(b)	III	V	II	IV	I
(c)	III	I	V	II	IV
(d)	V	IV	III	I	II

Critical Thinking Type Questions

1. Which of the following pair of diseases is caused by virus?
(a) Typhoid and tetanus

(b) AIDS and syphilis
(c) Rabies and mumps
(d) Cholera and tuberculosis

2. A certain patient is suspected to be suffering from acquired immuno deficiency syndrome. Which diagnostic technique will you recommend for its detection?
(a) WIDAL (b) ELISA
(c) MRI (d) Ultrasound

3. Which of the following disease is caused by the member of retro-virus group?
(a) Cancer (b) AIDS
(c) Dengue (d) Common cold

4. A person suffering from a disease caused by *Plasmodium* experiences recurring chill and fever at the time when
(a) The sporozoites released from RBCs are being rapidly killed and broken down inside speen.
(b) The trophozoites reach maximum growth and give out certain toxins.
(c) The parasite after its rapid multiplication inside RBCs ruptures them, releasing the stage to enter fresh RBCs.
(d) The microgametocytes and megagametocytes are being destroyed by the WBCs.

5. Hormone produced against allergic reaction is
(a) epinephrine
(b) nor-epinephrine
(c) glucocorticoid
(d) mineralocorticocoid

6. Vaccines produced through genetic engineering are considered safe because they
(a) are active form of antigens.
(b) are the least active forms.
(c) contain antibodies for coat proteins only.
(d) contain antibodies against whole antigen.

7. If you keep the sanitary system around yourself sound then the disease which will not most probably break out is :
(a) cholera (b) malaria
(c) beri-beri (d) scurvy

8. In polio, the legs get paralyzed and atrophied due to :
(a) obstruction of muscles.
(b) death of some muscles.
(c) degeneration of bones.
(d) shrinkage of muscles.

9. Which of these may cause hypothermia in humans ?
(a) Smoking
(b) LSD
(c) Dopamine
(d) Alcohol consumption

10. The main reason, why antibodies could not solve all the problems of bacteria mediated diseases, is the
(a) Development of mutant strains resistant to antibodies.
(b) Inactivation of antibodies by bacterial enzymes.
(c) Decreased efficiency of the immune system.
(d) Insensitivity of the individual following prolonged exposure to antibiotics.

11. Which part of the brain is not affected by alcohol?
(a) Cerebrum (b) Cerebellum
(c) Medulla oblongata (d) Pons varolii

12. Smoking addiction is harmful because it produces polycyclic aromatic hydrocarbons which causes
(a) reduction in oxygen transport.
(b) retardation of growth of foetus.
(c) increase in blood sugar level.
(d) cancer.

13. In alcoholics, liver gets damaged as it
(a) secretes more bile.
(b) stores excess of glycogen.
(c) accumulates excess of fats.
(d) all of the above.

14. There is a patient having a disease in which a semi–solid material oozes out and forms a tough membrane over it in air passage. The disease is called
(a) diphtheria (b) pertussis
(c) tetanus (d) TB

15. Saline is given to a person suffering with cholera because
(a) it causes lysis of bacterial cell wall.
(b) cholera results in severe diarrhoea leading to loss of salts.
(c) both (a) & (b)
(d) saline helps to produce antitoxins.

16. A person is injected with globulin against hepatitis. This is
(a) naturally acquired active immunity.
(b) naturally acquired passive immnity.
(c) artificially acquired active immunity.
(d) artificially acquired passive immunity.

31 Strategies for Enhancement in Food Production

Fill in the Blanks :

1. When breeding is between animals of the same breed it is called ______________, while crosses between different breeds are called ______________.
2. A branch of science that deals with the maintenance of hives of honeybees for the production of honey is called ______.
3. 33 percent of India's GDP (Gross Domestic Product) comes from ______________ and employs ______________ percent of the population.
4. The entire collection (of plants/ seeds) having all the diverse alleles for all genes in a given crop is called _________. collection.
5. In *Abelmoschus esculentus* (bhindi), resistance genes are transferred from a wild species against yellow mosaic virus and resulted in a new variety of *A. Esculentus* called _____
6. A plant cell has potential to develop into full plant. This property of the plant cell is called ________ .
7. The scientific process by which crop plants are enriched with certain desirable nutrients is called ________ .
8. The technique of obtaining large number of plantlets by tissue culture method is called _______ .
9. Protoplast of two different species are fused in _______ .

True/ False :

1. By inbreeding, purelines cannot be evolved.
2. Continued inbreeding, especially close inbreeding reduces fertility and productivity.
3. Haploid culture technique was developed by Guha and Maheshwari.
4. Mutation is a sudden heritable change in a character of an organism.
5. The germplasm, stored in the gene bank are actively utilized by breeders to develop novel varieties.
6. In 2000, maize hybrids that had twice the amounts of the amino acids, lysine and proline, compared to existing maize hybrids were developed.
7. Single cell *Spirulina* can produce large quantities of food rich in protein, minerals, vitamins, etc.
8. Common button mushrooms are a very rich source of vitamin C.
9. *Pusa Sawani,* a variety of Okra is resistant to aphids.
10. Agriculture accounts for approximately 33% of India's GDP and employs nearly 62% of the population.

Conceptual MCQs :

1. Which one of the following is an exotic Indian fish ?
   (a) *Catla catla*
   (b) *Heteropneustes fossilis*
   (c) *Cyprinus carpio*
   (d) *Labeo rohita*
2. The silkworm's silk is the product of
   (a) cuticle of the larva
   (b) cuticle of the adult
   (c) salivary gland of the larva
   (d) salivary gland of the adult
3. Which one of the following is a viral disease of poultry ?
   (a) Coryza
   (b) New castle disease
   (c) Pasteurellosis
   (d) Salmonellosis.

4. Breeding of crops with high levels of minerals, vitamins and proteins is called
(a) somatic hybridisation
(b) biofortification
(c) biomagnification
(d) micropropagation

5. Three crops that contribute maximum to global food grain production are
(a) wheat, rice and maize
(b) wheat, rice and barley
(c) wheat, maize and sorghum
(d) rice, maize and sorghum

6. Jaya and Ratna developed for green revolution in India are the varieties of
(a) maize (b) rice
(c) wheat (d) bajra

7. Himgiri developed by hybridization and selection for disease resistance against rust pathogens is a variety of
(a) chilli (b) maize
(c) sugarcane (d) wheat

8. India's wheat yield revolution in the 1960s was possible primarily due to
(a) hybrid seeds
(b) increased chlorophyll content
(c) mutations resulting in plant height reduction
(d) quantitative trait mutations

9. The technique of obtaining large number of plantlets by tissue culture method is called
(a) plantlet culture
(b) organ culture
(c) micropropagation
(d) macropropagation

10. Inter generic crosses are rarely successful through usual breeding techniques. Which of the following may be used to achieve success in this regard?
(a) Embryo culture
(b) Hybridoma technology
(c) Somatic hybridization
(d) None of the above

11. The quickest method of plant breeding is
(a) introduction (b) selection
(c) hybridization (d) mutation breeding

12. Heterosis is also called
(a) mutation (b) hybrid vigour
(c) variation (d) hybrid sterility

13. Which of the following is **not** used as a biopesticide ?
(a) *Trichoderma harzianum*
(b) Nuclear Polyhedrosis Virus (NPV)
(c) *Xanthomonas campestris*
(d) *Bacillus thuringiensis*

14. Consider the following four statements (A-D) and select the option which includes all the correct ones only.
(1) Single cell Spirulina can produce large quantities of food rich in protein, minerals, vitamins etc.
(2) Body weight-wise the micro-organism Methylophilus methylotrophus may be able to produce several times more proteins than the cows per day.
(3) Common button mushrooms are a very rich source of vitamin C.
(4) A rice variety has been developed which is very rich in calcium.

Options :
(a) Statements (3), (4)
(b) Statements (1), (3) and (4)
(c) Statements (2), (3) and (4)
(d) Statements (1), (2)

15. The process of RNA interference has been used in the development of plants resistant to
(a) nematodes (b) fungi
(c) viruses (d) insects

16. Green revolution in India occurred during
(a) 1960.s (b) 1970.s
(c) 1980.s (d) 1950.s

17. In plant breeding programmes, the entire collection (of plants/seeds) having all the diverse alleles for all genes in a given crop is called :
(a) cross-hybridisation among the selected parents.
(b) evaluation and selection of parents.
(c) germplasm collection
(d) selection of superior recombinants.

18. The scientific process by which crop plants are enriched with certain desirable nutrients is called

(a) crop protection
(b) breeding
(c) bio-fortification
(d) bio-remediation

19. Desired improved varieties of economically useful crops are raised by
(a) migration
(b) biofertilizer
(c) hybridization
(d) natural selection

20. The process in which mature differentiated cells reverse to meristematic activity to form callus is called
(a) dedifferentiation
(b) differentiation
(c) redifferentiation
(d) None of the above

Assertion/ Reason :

DIRECTIONS (Qs. 1-5): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion**: Interbreeding is the mating of more closely related individuals within the same breed for 4-6 generations
Reason: Interbreeding increases homozygosity to develop a pure line animal.

2. **Assertion**: Animal husbandry is the industrial practice of breeding and raising livestock.
Reason: Dairy form management deals with processes which improve the quality and quantity of milk production

3. **Assertion**: Inbreeding is carried out in animal husbandry
Reason: It increases homozygosity to develop a pure line animal

4. **Assertion**: Plant cells are totipotent.
Reason: A graft of a plant can generate a whole new individual out of just a small branch cutting.

5. **Assertion**: Hisardale is a new breed of sheep developed in America by method of cross-breeding.
Reason: In this method, supermales of one breed are mated with superior females of another breed.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column -I		Column -II
(A)	Pisciculture	I.	Micropropagation
(B)	Apiculture	II.	Crop production
(C)	Tissue culture	III.	Rearing of fishes
(D)	Green revolution	IV.	Fish-production
E.	Blue revolution	V.	Bee-keeping

(a) A – III; B – V; C – IV; D-I; E – II
(b) A – III; B – V; C – I; D – II; E – IV
(c) A – V; B – III; C – I; D – II; E – IV
(d) A – III; B – V; C – II; D – I; E – IV

2.

	Column-I	Column-II
(A)	Many people have deficiencies as they cannot buy fruits & vegetables	I. Single cell proteins
(B)	Crops with higher vitamins, proteins and fats	II. Micropropagation
(C)	Growing microbes as the alternative source of proteins	III. Somaclones
(D)	Capacity to generate plant from a single cell or explant	IV. Hidden hunger

(E)	Production of thousand plants through tissue culture	V.	Bio-fortification
(F)	Genetically identical plants	VI.	Totipotency

(a) A – IV; B – V; C – VI; D – I; E – II; F – III
(b) A – IV; B – V; C – VI; D – I; E – III; F – II
(c) A – IV; B – V; C – I; D – VI; E – II; F – III
(d) A – VI; B – V; C – I; D – IV; E – II; F – III

3.

	Column -I		Column -II
(A)	Semi Dwarf Wheat	I.	Sonalika
(B)	Semi Dwarf Rice	II.	Kalyan sona
		III.	IR-8
		IV.	Jaya
		V.	Taichung Native-1
		VI.	Ratna

(a) A – I, III, V; B – II, IV, VI
(b) A – III, IV, V, VI; B – I, II
(c) A – I, II, IV; B – III, V, VI
(d) A – I, II; B – III, IV, V, VI

4.

	Column-1 (Crop)		Column-II (Resistance to diseases)
(A)	Wheat	I.	Tobacco mosaic virus and leaf curl
(B)	*Brassica*	II.	Bacterial blight
(C)	Cowpea	III.	Leaf and stripe rust
(D)	Cauliflower	IV.	White rust
(E)	Chilli	V.	Black rot and curl blight black rot

(a) A – IV; B – III; C – II; D – I; E – V
(b) A – III; B – IV; C – II; D – V; E – I
(c) A – IV; B – III; C – V; D – I; E – II
(d) A – III; B – IV; C – I; D – V; E – II

Critical Thinking Type Questions :

1. Select the correct chronological order of the events occuring during callus culture
(a) Callus $\rightarrow$ Cell division $\rightarrow$ Explant $\rightarrow$ Addition of cytokinin $\rightarrow$ Cells acquire meristematic property.
(b) Explant $\rightarrow$ Callus $\rightarrow$ Cell division $\rightarrow$ Addition of cytokinin $\rightarrow$ Cells acquire meristematic property.
(c) Explant $\rightarrow$ Cell division $\rightarrow$ Callus $\rightarrow$ Addition of cytokinin $\rightarrow$ Cells acquire meristematic property.
(d) Callus $\rightarrow$ Explant $\rightarrow$ Cell division $\rightarrow$ Addition of cytokinin $\rightarrow$ Cells acquire meristematic property.

2. Which one of the following combination would a sugarcane farmer look for in the sugarcane crop ?
(a) Thick stem, long internodes, high sugar content and disease resistant.
(b) Thick stem, high sugar content and profuse flowering.
(c) Thick stem, short internodes, high sugar content, disease resistant.
(d) Thick stem, low sugar content, disease resistant.

3. The biggest compulsion of plant breeding is
(a) infrastructure.
(b) trained manpower.
(c) transfer of genes from unrelated sources.
(d) availability of desirable gene in the crop and its wild relatives.

4. High milk yielding varieties of cows are obtained by
(a) super ovulation
(b) artificial insemination
(c) use of surrogate mothers
(d) all of the above

5. Crop improvement is possible through
(a) judicious combination of selection, introduction and hybridization.
(b) selection
(c) scientific improvement of cultivated plants.
(d) introduction.

6. In order to obtain virus-free plants through tissue culture the best method is
(a) meristem culture
(b) protoplast culture
(c) embryo rescue
(d) anther culture

7. Which of the following is the process of choosing parent organisms for the characteristic that is wanted in their offspring?
(a) Active selection
(b) Reproductive selection
(c) Selective breeding
(d) None of the above

8. Which of the following is the consequence of plant diseases?
   (a) Reduced yield and lower quality of produce.
   (b) Reduced yield, lower quality of produce and increased cost of production.
   (c) Reduced yield, lower quality of produce and poisonous produce.
   (d) Reduced yield, lower quality of produce, increased cost of production and poisonous produce.
9. Sharbati sonora variety of wheat was obtained by
   (a) X-ray treatment.
   (b) crossing with wild varieties of wheat.
   (c) hybridization between wild grasses.
   (d) irradiation of sonora 64 with gamma rays.
10. Plants derived sexually from the same plant are _______ while those derived from somatic tissue from the same plant are ______________.
   (a) identical, different
   (b) different, also different
   (c) different, identical
   (d) identical, also identical
11. Which of the following pair of hormones are required for a callus to differentiate ?
   (a) Auxin and cytokinin
   (b) Auxin and ethylene
   (c) Auxin and abscisic acid
   (d) Cytokinin and gibberellin
12. In crop improvement programme, haploids are important because they
   (a) require one half of nutrients.
   (b) are helpful in study of meiosis.
   (c) grow better under adverse conditions.
   (d) form perfect homozygous.
13. Which of the following techniques used in animal biotechnology are required for the rapid multiplication and production of animals with a desirable genotype ?
   (a) Protoplast fusion and embryo transfer.
   (b) Hybrid selection and embryo transfer.
   (c) *In vitro* fertilization and embryo transfer.
   (d) All of the above
14. The way in which biotechnology is contributed to sustainable agriculture is
   (a) biofertilizer
   (b) single cell protein (SCP)
   (c) disease and insect resistant varieties
   (d) all of the above
15. An improved variety of transgenic basmati rice
   (a) does not require chemical fertilizers and growth hormones.
   (b) gives high yield and is rich in vitamin A.
   (c) is completely resistant to all insect pests and diseases of paddy.
   (d) gives high yield but has no characteristic aroma.
16. In tissue culture medium, the embryoids formed from pollen grains is due to
   (a) cellular totipotency
   (b) organogenesis
   (c) double fertilization
   (d) test-tube culture
17. Plants can be disease resistant by
   (a) breeding with their wild relatives.
   (b) colchicine treatment.
   (c) hormone treatment.
   (d) heat treatment.
18. The greatest threat to genetic diversity in agricultural crops is
   (a) extensive use of insecticides and pesticides.
   (b) extensive mixed cropping.
   (c) introduction of high yielding varieties.
   (d) extensive use of fertilizers.
19. Which of the following is not used for crop improvement?
   (a) Inbreeding
   (b) Introduction
   (c) Hybridization
   (d) Mutations
20. Somaclonal variation appears in
   (a) organisms produced through somatic hybridization.
   (b) plants growing in highly polluted conditions.
   (c) apomictic plants.
   (d) tissue culture raised plants.

32 Microbes in Human Welfare

Fill in the Blanks :

1. The large vessels for growing microbes on an industrial scale are called _________ .
2. The chemical substances produced by some microbes which can kill or retard the growth of other microbes are called _________ .
3. The symbiotic association between fungi and roots of higher plants is called __________ .
4. The solids which settle after primary treatment of sewage are called ___________ .
5. Methane content of biogas is _________ .
6. The amount of oxygen required by microbes in the decomposition of organic matter is called _________ .
7. Sewage treatment process in which part of decomposer bacteria is recycled into starting of the process is called __________ .
8. Physical removal of large and small from the sewage through filtration and sedimentation is called _______.
9. Secondary sewage treatment is mainly a _______.

True/ False :

1. Mycorrhizae are tolerant of salinity and absorption of phosphorous
2. Organic farming utillizes genetically modified crops like Bt cotton.
3. The greater the BOD of waste water, more is its polluting potential.
4. First antibiotic was discovered by Alexander Flemming.
5. Each antibiotic is effective only against one particular kind of germ.
6. *Methanobacterium* is an aerobic bacterium found in rumen of cattle.
7. Biogas (commonly called gobar gas) is pure methane.
8. Activated sludge sediment in settlement tanks of sewage treatment plants is rich source of aerobic bacteria.

Conceptual MCQs :

1. Conversion of sugar into alcohol during fermentation is due to the direct action of
   (a) temperature
   (b) micro-organisms
   (c) zymase
   (d) concentration of sugar solution
2. Which one of the following is not true about antibiotics?
   (a) First antibiotic was discovered by Alexander Flemming.
   (b) The term 'antibiotic' was coined by S. Waksman in 1942.
   (c) Some persons can be allergic to a particular antibiotic.
   (d) Each antibiotic is effective only against one particular kind of germ.
3. Yogurt and buttermilk are produced with the use of
   (a) *Saccharomyces* (b) *Penicillium*
   (c) *Lactobacillus* (d) *Aspergillus*
4. Which one of the following is used in the manufacture of alcohol ?
   (a) Bacteria (b) Water molds
   (c) Yeasts (d) Slime molds
5. Biogas consists of –
   (a) Carbon monoxide, methane and hydrogen.
   (b) Carbon dioxide, methane and hydrogen.
   (c) Carbon monoxide, ethane and hydrogen.
   (d) Carbon dioxide, ethane and hydrogen.
6. What are the advantage of gobar gas over

conventual utilization?
(a) More efficient source of energy
(b) Used as good fertilizer
(c) Reduces the chances of spreading of pathogens
(d) All of the above

7. Sewage purification is done by
(a) microbes (b) fertilizers
(c) antibiotics (d) antiseptics

8. A free living nitrogen-fixing cyanobacterium which can also form symbiotic association with the water fern *Azolla* is
(a) *Anabaena* (b) *Tolypothrix*
(c) *Chlorella* (d) *Nostoc*

9. A common biocontrol agent for the control of plant diseases is
(a) Baculovirus
(b) *Bacillus thuringiensis*
(c) *Glomus*
(d) *Trichoderma*

10. The common nitrogen fixer in paddy fields is
(a) *Rhizobium* (b) *Azospirillum*
(c) *Oscillatoria* (d) *Frankia*

11. Which one of the following is not used in organic farming?
(a) *Glomus* (b) Earthworm
(c) *Oscillatoria* (d) Snail

12. An organism used as a biofertilizer for raising soyabean crops is
(a) *Azotobacter* (b) *Azospirillum*
(c) *Rhizobium* (d) *Nostoc*

13. Which one of the following help in absorption of phosphorus from soil by plants?
(a) *Glomus* (b) *Rhizobium*
(c) *Frankia* (d) *Anabaena*

14. Which one of the following is a wrong matching of a microbe and its industrial product, while the remaining three are correct?
(a) Yeast - statins
(b) *Acetobacter aceti* - acetic acid
(c) *Clostridium butylicum* - lactic acid
(d) *Aspergillus niger* - citric acid

15. *Monascus purpureus* is a yeast used commercially in the production of :
(a) ethanol
(b) streptokinase for removing clots from the blood vessels.
(c) citric acid
(d) blood cholesterol lowering statins

16. A patient brought to a hospital with myocardial infarction is normally immediately given :
(a) Penicillin (b) Streptokinase
(c) Cyclosporin-A (d) Statins

17. Yeast is used in the production of
(a) Citric acid and lactic acid
(b) Lipase and pectinase
(c) Bread and beer
(d) Cheese and butter

18. Which one of the following is an example of carrying out biological control of pests/diseases using microbes ?
(a) *Trichoderma* sp. against certain plant pathogens
(b) Nucleopolyhedrovirus against white rust in *Brassica*
(c) *Bt* - cotton to increase cotton yield
(d) Lady bird beetle against aphids in mustard

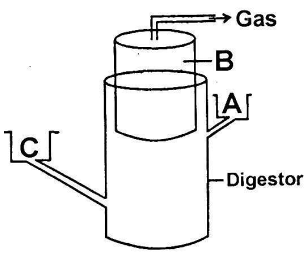
19. The domestic sewage in large cities
(a) has a high BOD as it contains both aerobic and anaerobic bacteria.
(b) is processed by aerobic and then anaerobic bacteria in the secondary treatment in Sewage Treatment Plants (STPs).
(c) when treated in STPs does not really require the aeration step as the sewage contains adequate oxygen.
(d) has very high amounts of suspended solids and dissolved salts.

20. During sewage treatment, biogases are produced which include :
(a) methane, oxygen, hydrogen sulphide
(b) hydrogen sulphide, methane, sulphur dioxide
(c) hydrogen sulphide, nitrogen, methane
(d) methane, hydrogen sulphide, carbon dioxide

21. A good producer of citric acid is :
(a) *Pseudomonas* (b) *Clostridium*
(c) *Saccharomyces* (d) *Aspergillus*

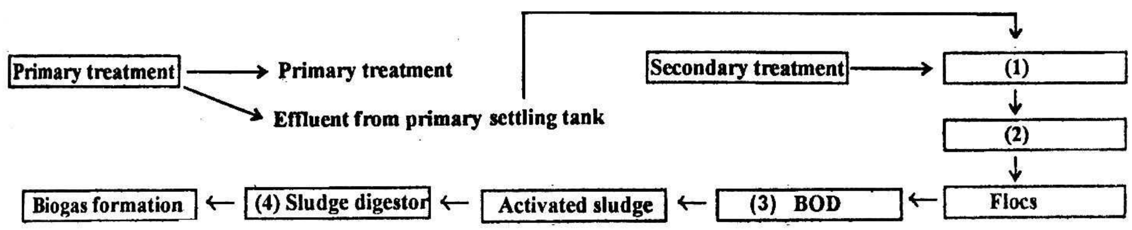
Diagram Based Questions :

1. The diagram below shows a typical biogas plant. With few structure labelled as A, B and C. Identify A, B and C.



(a) A – Sludge, B – Methane, Oxygen, C – Dung, water
(b) A – Sludge, B – Methane, Carbon dioxide, C– Dung, water
(c) A – Sludge, B – Ethylin, Carbon dioxide, C – Dung, water
(d) A – Sludge, B – Methane, Carbon dioxide, C – Sewage

2. The given figure shows the sewage treatment with few steps are marked as 1, 2, 3, and 4. In which of the following options, correct word for all the four numbers (1,2,3 and 4) are indicated-



(a) 1 – Large aeration tanks, 2 – Chemically agitation, 3 – High, 4 – Anaerobic
(b) 1 – Large aeration tanks, 2 – Mechanically agitation, 3 – Low, 4 – Anaerobic
(c) 1 – Large aeration tanks, 2 – Chemically agitation, 3 –Low, 4 – Aerobic
(d) 1 – Large aeration tanks, 2 – Mechanically agitation, 3 – High, 4 – Anaerobic

Assertion/ Reason :

DIRECTIONS (Qs. 1-7): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** A person who has received a cut and is bleeding needs to be given anti-tetanus treatment.
Reason : Anti-tetanus injection provides immunity by producing antibodies for tetanus.

2. **Assertion :** Dope test is used to estimate the level of blood alcohol by analyzing the breath of persons drinking alcohol.
Reason : A drunken person usually feels tense and less talkative.

3. **Assertion :** In plant tissue culture, somatic embryos can be induced from any plant cell.
Reason : Any viable plant cell can differentiate into somatic embryos.

4. **Assertion :** *Cannabis sativa* is a powerful anti-depressant.
Reason : Hashish and Marijuana are derived from it.

5. **Assertion :** Insect resistant transgenic cotton has been produced by inserting Bt gene.
Reason : The Bt gene is derived from a bacterium.

6. **Assertion:** Interferons are effective against viruses.
Reason : Proteins which can be synthesized only by genetic engineering are effective against viruses.

7. **Assertion :** In case of vegetatively propagated crops, pure-line selection is not required.
Reason : Hybrid vigour is mostly used in vegetatively propagated plants.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I		**Column-II**
(A)	*Aspergillus niger*	I.	Ethanol
(B)	*Clostridium*	II.	Statins
			butydicum
(C)	*Saccharomyces*	III.	Citric acid
			cerevisiae
(D)	*Trichoderma polysporum*	IV.	Butyric acid
(E)	*Monascus purpureus*	V.	Cyclosporin A

(a) A – IV; B – III; C – II; D – I; E – V
(b) A – V; B – IV; C – I; D – II; E – III
(c) A – III; B – IV; C – I; D – V; E – II
(d) A – III; B – IV; C – V; D – I; E – II

2.

	Column-I		**Column-II**
(A)	Lady bird	I.	
Methanobacterium			
(B)	Mycorrhiza	II.	*Trichoderma*
(C)	Biological control	III.	Aphids
(D)	Biogas	IV.	*Glomus*

(a) A – II; B – IV; C – III; D – I
(b) A – III; B – IV; C – II; D – I
(c) A – IV; B – I; C – II; D – III
(d) A – III; B – II; C – I; D – IV

3.

	Column-I		**Column-II**
(A)	*Escherichia coli*	I.	'*nif*' gene
(B)	*Rhizobium meliloti*	II.	Digests hydrocarbons of crude oil
(C)	*Bacillus thuringiensis*	III.	Human insulin production
(D)	*Pseudomonas putida*	IV.	Biocontrol of fungal disease
		V.	Biodegradable insecticide

(a) A – III; B – I; C – V; D – II
(b) A – III; B – I; C – V; D – IV
(c) A – I; B – II; C – III; D – IV
(d) A – II; B – I; C – III; D – IV

4.

	Column-I		**Column-II**
(A)	Cyanobacteria	I.	Biopesticides
(B)	*Mycorrhiza*	II.	Solubilization of phosphate
(C)	*Bacillus thuringiensis*	III.	Cry protein
(D)	Single cell protein	IV.	Rhizobia

(a) A and II (b) C and III
(c) C and IV (d) A and III

5.

Type of Microbe	Scientific Name	Commercial Product
Bacterium	A	Clot buster enzyme
B	*Aspergillus niger*	Citric acid
Fungus	*Trichoderma polysporum*	C
Bacterium	D	Butyric acid

(a) A – *Streptococcus*, B – Fungus, C – Cyclosporin-A, D – *Clostridium butylicum*
(b) A – *Clostridium butylicum*, B – *Streptococcus*, C – Fungus, D – Cyclosporin-A
(c) A – Cyclosporin-A, B - *Clostridium butylicum* C – *Streptococcus*, D – Fungus
(d) A – Fungus, B – Cyclosporin-A, C – *Clostridium butylicum*, D - *Streptococcus*

6.

	Column-I		**Column-II**
(A)	Statins	I.	Yeast
(B)	Ethanol	II.	Blood-cholesterol lowering agent
(C)	Dung	III.	Insect-resistant plant
(D)	Bt-cotton	IV.	Biogas

(a) A – II; B – I; C – IV; D – III
(b) A – III; B – IV; C – I; D – II
(c) A – I; B – II; C – III; D – IV
(d) A – IV; B – II; C – I; D – III

Critical Thinking Type Questions :

1. Which of the following is the pair of biofertilizers?
(a) *Azolla* and blue green algae
(b) *Nostoc* and legume
(c) *Rhizobium* and grasses
(d) *Salmonella* and *E. coli*

2. Microbes are diverse group which include
I. Bacteria II. Mosses
III. Protozoans IV. Fungi
(a) I, III, IV (b) I, IV
(c) I, II (d) III, IV

3. Microbes are present in
I. soil II. air
III. water IV. thermal springs
(a) I, III, IV (b) I, II, III, IV
(c) I, II (d) III, IV

4. The following bacteria help in nitrogen fixation from atmosphere.
I. *Azotobacter* II. *Rhizobium*
III. *Azospirillum* IV. *Lactobacillus*
Identify the correct bacteria.
(a) I, III, IV (b) I, II, III, IV
(c) II, III, IV (d) I, II, III

5. Which of the following is used as biofertilizer ?
I. Cyanobacteria
II. Yeast
III. Symbiotic bacteria
IV. Free living bacteria
(a) I, II, III (b) I, II, IV
(c) I, III, IV (d) II, III, IV

6. Some industrial products are given below which are synthesized from microbes.
I. Antibiotics
II. Fermented beverages
III. Enzymes and chemicals
IV. Bioactive molecules
Choose the correct option.
(a) I, III, IV (b) I, II, III, IV
(c) I, III (d) I, II, III

7. Methanogens grow anaerobically on cellulosic material and produces which of the following gases ?
I. Methane II. Oxygen
III. Carbon dioxide IV. Hydrogen
(a) I, III, IV (b) I, II, III, IV
(c) II, III, IV (d) I, II

8. Cheese and yogurt are products of
(a) pasteurisation (b) fermentation
(c) dehydration (d) distillation

9. Which of the following is common to *Azospirillum*, *Azotobacter*, *Anabaena*, *Nostoc* and *Oscillatoria*?
(a) Prokaryotes
(b) Nitrogen-fixers
(c) Both (a) and (b)
(d) Eukaryotes

10. *Lactobacillus* mediated change of milk to curd occurs due to
(a) coagulation and partial digestion of milk fats.
(b) coagulation and partial digestion of milk proteins.
(c) coagulation of milk proteins and complete digestion of milk fats.
(d) coagulation of milk fats and complete digestion of proteins.

11. Crystals of Bt-toxin produced by some bacteria do not kill the bacteria themselves because
(a) bacteria are resistant to the toxin.
(b) toxin is inactive.
(c) toxin is immature.
(d) bacteria enclose toxins in a special sec.

12. Choose the correct sequence of microbes involved in biogas production.
(a) Fragmentative microbes, decomposers, methanogens.
(b) Decomposers, methanogens, putrefying microbes.
(c) Putrefying microbes, methanogens, saprophytic microbes.
(d) Decomposers, fermentative microbes, methanogens.

13. Which one of the micro-organism is used for production of citric acid in industries?
(a) *Lactobacillus bulgaricus*
(b) *Penicillium citrinum*
(c) *Aspergillus niger*
(d) *Rhizopus nigricans*

14. A genetically engineered micro-organism used successfully in bioremediation of oil spills is a species of
(a) *Pseudomonas*
(b) *Trichoderma*
(c) *Xanthomonas*
(d) *Bacillus*

15. *Bacillus thuringiensis* (*Bt*) strains have been used as
(a) biofertilizers
(b) biometallurgical techniques
(c) biomineralization processes
(d) bioinsecticidal plants

33 Biotechnology : Principles and Processes

Fill in the Blanks :

1. The enzyme used for joining two DNA fragments is called _______ .
2. Agarose extracted from sea weeds is used in _______ .
3. During heat shock to the bacterium, the temperature used for giving thermal shock is _______ .
4. _______ is a procedure through which a piece of DNA is introduced in a host bacterium.
5. For transformation, micro-particles coated with DNA to be bombarded with gene gun are made up of _______ .
6. A device in which substances are treated to stimulate transformation by living cells is called __________.
   (a) assimilator (b) digester
   (c) bioreactor (d) agitator
7. The first restriction endonuclease reported was _______ .
8. The polymerase enzyme used in PCR is _______ .
9. The first step in the PCR is _______ .

True/False :

1. Multiple copies of gene can be synthesized in PCR.
2. When cut by same restriction enzyme, the resultant DNA fragments do not have the same kind of sticky-ends.
3. Restriction enzymes cut DNA at specific sequence called *recognition sites.*
4. '*Ori*' is a sequence responsible for controlling the copy number of the linked DNA in cloning vector.
5. Selectable marker selectively permitting the growth of the non-transformants.
6. The ligation of alien DNA is carried out at a restriction site present in one of the two antibiotic resistance genes.
7. T-DNA transform normal plant cell into a tumor.
8. Retroviruses in animals have the ability to transform normal cell into cancerous cells.
9. T plasmids of *Agrobacterium tumefaciens* is modified into cloning vector which is more pathogenic to plants.

Conceptual MCQs :

1. A genetic clone is
   (a) a plant produced by asexual means.
   (b) hybrid produced by sexual means.
   (c) homozygous plant produced by sexual means.
   (d) heterozygous plant produced by sexual means.
2. PCR (Polymerase Chain Reaction) method is useful for
   (a) amplification of DNA for forming billions of copies of itself .
   (b) monoclonal antibody production.
   (c) hybridoma production.
   (d) All of the above
3. *Agrobacterium tumefaciens* is used in genetic engineering for
   (a) DNA-mapping
   (b) DNA-modification
   (c) vector
   (d) DNA finger printing
4. A genetically engineered bacteria used for clearing oil spills is

(a) *Escherischia coli*
(b) *Bacillus subtilis*
(c) *Agrobacterium tumifaciens*
(d) *Pseudomonas putida*

5. Genetic engineering is
(a) study of extra nuclear gene.
(b) manipulation of genes by artificial method.
(c) manipulation of RNA.
(d) manipulation of enzymes.

6. Which of the following enzymes cut the DNA molecule at specific nucleotide sequence ?
(a) Restriction endonuclease
(b) DNA - ligase
(c) RNA - polymerase
(d) Exonuclease

7. Which structure involved in genetic engineering?
(a) Plastid (b) Plasmid
(c) Codon (d) None of these

8. Genetic engineering aims at
(a) destroying wild gene
(b) preserving defective gene
(c) curing human disease by introducing new gene (Haemophilia)
(d) all the above

9. Which of the following technique is used for the separation of DNA fragments ?
(a) Gel electrophoresis
(b) Chromatography
(c) Transformation
(d) Transduction

10. Which of the following is a cloning vector ?
(a) Bacteriophage (b) Plasmid
(c) Cosmid (d) All of these.

11. Which of the following is a tool of recombinant DNA technology ?
(a) Cloning vectors
(b) Ligase enzymes
(c) Restriction enzymes
(d) All of the above

12. Which of these is not correctly matched ?
(a) Gene gun—bioplastics
(b) Plasmids—extrachromosomal DNA
(c) DNA ligase—Biological scissors
(d) Bacteriophages—viruses.

13. Which of the following is molecular scissors?
(a) EcoRI (b) Hind III
(c) Bam H II (d) All of these

14. The prerequisite for biotechnological production of antibiotic is
(a) To isolate antibiotic gene
(b) To search an antibiotic producing micro-organism
(c) To join antibiotic gene with *E.coil* plasmid
(d) all of these

15. Restriction enzyme EcoRI always cleaves the nitrogen sequence in DNA
(a) AAGCTT (b) GGATCC
(c) GAATTC (d) TGGCCA

16. Which one of the following is used as vector for cloning genes into higher organisms?
(a) Baculovirus
(b) *Salmonella typhimurium*
(c) *Rhizopus nigricans*
(d) Retrovirus

17. Restriction endonucleases are enzymes which
(a) make cuts at specific positions within the DNA molecule
(b) recognize a specific nucleotide sequence for binding of DNA ligase
(c) restrict the action of the enzyme DNA polymerase
(d) remove nucleotides from the ends of the DNA molecule

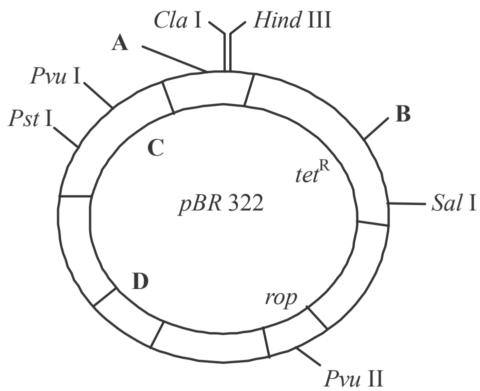
18. There is a restriction endonuclease called *EcoRI*. What does .co. part in it stand for ?
(a) colon (b) coelom
(c) coenzyme (d) *coli*

19. PCR and Restriction Fragment Length Polymorphism are the methods for :
(a) Study of enzymes
(b) Genetic transformation
(c) DNA sequencing
(d) Genetic Fingerprinting

20. For transformation, micro-particles coated with DNA to be bombarded with gene gun are made up of :
(a) Silver or Platinum
(b) Platinum or Zinc
(c) Silicon or Platinum
(d) Gold or Tungsten

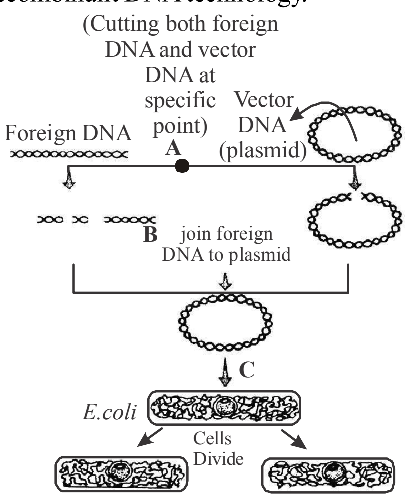
Diagram Based Questions :

1. The given figure shows the *E.Coli* cloning vector P^{BR322} showing restriction sites. Some parts are labelled as A, B, C & D. Choose the option showing the correct labelling.



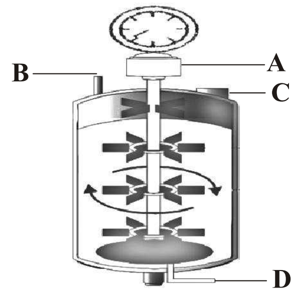
	A	B	C	D
(a)	*Hind* I	*EcoR* I	*amp*^{R}	*ori*
(b)	*Hind* I	*BamH*I	*kan*^{R}	*amp*^{R}
(c)	*BamH*I	*Pst* I	*ori*	*amp*^{R}
(d)	*EcoR* I	*BamH*I	*amp*^{R}	*ori*

2. Which one of the following option is correct for A, B and C marked in the given diagram of recombinant DNA technology.



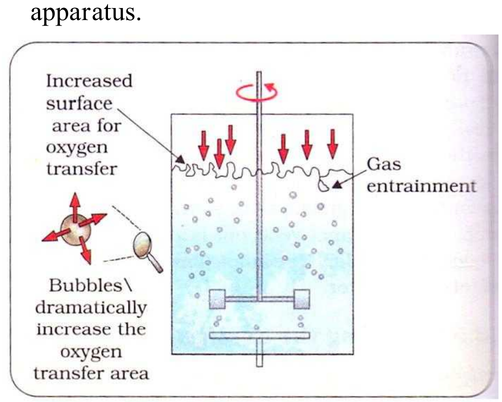
(a) A-Exonuclease; B-Ligases; C-Transformation
(b) A-Endonuclease; B-gyrase; C-Transformation
(c) A-Exonuclease; B-Hydrolase; C-Transduction
(d) A-Restriction endonuclease; B-Ligases; C-Transformation

3. The given figure shows a simple stirred tank bioreactor with their parts labelled as A, B, C and D. Identify A, B, C and D.



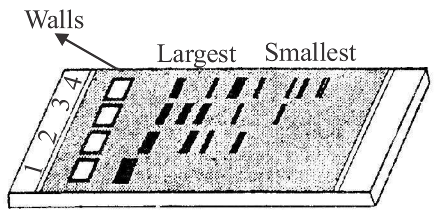
(a) A - Motor, B-pH control, C-Foam braker, D - Sterile air
(b) A - pH control, B- Motor, C-Foam braker, D-Sterile air
(c) A - pH control, B- Sterile air, C-Motor, D-Foam braker
(d) A- Motor, B-Sterile air, C-pH control, D-Foam braker

4. Identify the correct match for the given apparatus.



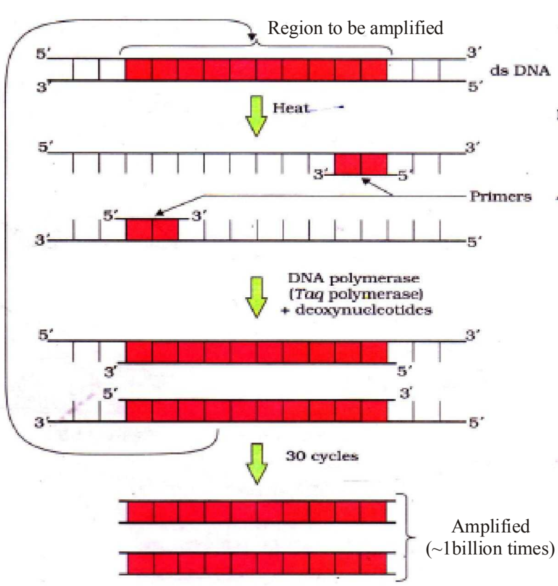
	Apparatus	Function
(a)	Gene gun	Vectorless direct gene transfer
(b)	Column chromatography	Separation of chlorophyll pigments
(c)	Sparged stirred tank bioreactor	Carry out fermentation process
(d)	Respirometer	Finding out rate of respiration

5. Identify the correct match of the technique with their role shown in the given figure.



(a) Electrophoresis – Differential migration of DNA fragments
(b) Column chromatography – Separation of chlorophyll pigments
(c) Gene cloning – Technique of obtaining identical copies of a particular DNA or a gene segment
(d) Microinjection – Technique of introducing foreign genes into a host cell

6. The figure given below shows three steps (A, B, C) of Polymerase Chain Reaction (PCR). Select the option giving correct identification together with what it represents?



(a) B - Denaturation at a temperature of about 98°C separating the two DNA strands.
(b) A - Denaturation at a temperature of about 50°C.
(c) C - Extension in the presence of heat stable DNA polymerase.
(d) A - Annealing with two sets of primers.

Assertion/ Reason :

DIRECTIONS (Qs. 1-5): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion**: The uptake of DNA during transformation is an active, energy requiring process.
Reason: Transformation occurs in only those bacteria. Which possess the enzymatic machinery involved in the active uptake and recombination.

2. **Assertion :** In recombinant DNA technology, human genes are often transferred into bacteria (prokaryotes) or yeast (eukaryote).
Reason : Both bacteria and yeast multiply very fast to form huge population, which express the desired gene.

3. **Assertion :** Restriction enzymes cut the strand of DNA to produce sticky ends.
Reason : Stickiness of the ends facilitates the action of the enzyme DNA polymerase.

4. **Assertion :** Insect resistant transgenic cotton has been produced by inserting Bt gene.
Reason : The Bt gene is derived from a bacterium.

5. **Assertion :** "DNA finger printing" has become a powerful tool to establish paternity and identity of criminals in rape and assault cases.
Reason : Trace evidences such as hairs, saliva and dried semen are adequate for DNA analysis.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column - I		**Column - II**
(A)	Plasmid	I.	Selectable marker
(B)	*amp*	II.	Extrachromosomal DNA
(C)	*Ti*-plasmid	III.	Enzyme
(D)	Chitinase	IV.	*Agrobacterium tumefaciens*

(a) A – IV; B – I; C – II; D – III
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – I; C – III; D – II
(d) A – I; B – IV; C – II; D – III

2.

	Column - I		**Column - II**
(A)	Recombinant DNA technology	I.	Vector
(B)	Cloning vehicles	II.	Sealing enzyme
(C)	Macromolecular separation	III.	Electrophoresis
(D)	DNA ligase	IV.	Genetic engineering

(a) A – IV; B – I; C – II; D – III
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – I; C – III; D – II
(d) A – I; B – IV; C – II; D – III

3.

	Column - I		**Column - II**
(A)	*EcoR* I	I.	*Bacilius amyloliquefaciens*
(B)	*Bam H*I	II.	*Haemophilus influenza*
(C)	*Hind* III	III.	*Escherichia coli*
(D)	pBR 322	IV.	Artificial plasmid

(a) A – III; B – I; C – II; D – IV
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – I; C – III; D – II
(d) A – I; B – IV; C – II; D – III

4.

	Column - I		**Column - II**
(A)	Restriction enzyme	I.	Jumping gene
(B)	Transposons	II.	Cloning vehicle
(C)	Bacteriophage	III.	*Hind* III
(D)	Palindromes	IV.	MALAYALAM

(a) A – III; B – I; C – II; D – IV
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – I; C – III; D – II
(d) A – I; B – IV; C – II; D – III

5.

	Column - I		**Column - II**
(A)	Competent	I.	*Thermus aquaticus*
(B)	*Taq* DNA polymerase	II.	Antibiotic
(C)	Ampicillin	III.	Micro-injection
(D)	Ethidium bromide	IV.	DNA staining

(a) A – III; B – I; C – II; D – IV
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – I; C – III; D – II
(d) A – I; B – IV; C – II; D – III

6.

	Column - I		**Column - II**
(A)	PCR	I.	Large scale culture
(B)	Bioreactor	II.	To induce alien DNA in host cell
(C)	Gene gun	III.	Restriction endonuclease
(D)	*EcoR* I	IV.	Amplification of gene

(a) A – IV; B – I; C – II; D – III
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – I; C – III; D – II
(d) A – I; B – IV; C – II; D – III

7.

	Column - I		**Column - II**
(A)	Primers	I.	PCR
(B)	Separation and purification of products	II.	C_2H_5OH
(C)	Precipitation of DNA	III.	Uptake of foreign DNA by bacterium
(D)	Transformation	IV.	Down stream processing

(a) A – IV; B – I; C – II; D – III
(b) A – II; B – I; C – IV; D – III
(c) A – IV; B – I; C – III; D – II
(d) A – I; B – IV; C – II; D – III

Critical Thinking Type Questions :

1. Why the same basic techniques can be used to analyze the DNA from species as diverse as bacteria and humans? Because
(a) all cells are identical.
(b) every organism has the same amount of DNA.
(c) the DNA sequences of all organisms are the same.
(d) DNA has a consistent structure in all organisms.

2. A gene is said to be cloned if
(a) the DNA sequence of the gene is known.
(b) the function of the gene is known.
(c) there is a DNA probe for the gene.
(d) the gene has been isolated and copied.
3. Introduction of one or more genes into an organism which normally does not possess them or their deletion by using artificial means (not by breeding) comes under a branch. called ________ .
(a) molecular biology
(b) cytogenetics
(c) genetic hybridization
(d) genetic engineering
4. DNA fragments are separated using gel electrophoresis
(a) because DNA is pulled through the gel toward the negative end of the field.
(b) because larger DNA fragments move faster through the gel than smaller DNA fragments.
(c) to identify and isolate DNA fragments.
(d) to synthesize DNA for cloning.
5. DNA ligases are enzymes that can be used to
(a) chop a large DNA molecule into small fragments.
(b) copy DNA fragments.
(c) insert the DNA from one species into the DNA of another species.
(d) separate DNA fragments based on their size.
6. Imagine a gel through which DNA fragments have moved in response to an applied electrical current. The band on this gel that is farthest from the top (that is, from the place where the DNA fragments were added to the "well") represents the
(a) shortest fragments of DNA.
(b) longest fragments of DNA.
(c) restriction enzyme used to cut the DNA into fragments.
(d) ligase used to bind the DNA fragments together.
7. A biologist intends to use a polymerase chain reaction to perform a genetic task. The biologist probably is trying to
(a) discover new genes.
(b) clone a gene.
(c) cut DNA into many small fragments.
(d) isolate DNA from a living cell.
8. In genetic engineering, genes can be inserted from one organism into another or back into the original organism uses which of the following techniques?
(a) Polymerase chain reaction
(b) Gene gun
(c) DNA hybridization
(d) Gel electrophoresis
9. Biolistics (gene-gun) is suitable for
(a) DNA finger printing.
(b) Disarming pathogen vectors.
(c) Transformation of plant cells.
(d) Constructing recombinant DNA molecules.
10. The linking of antibiotic resistance gene with the plasmid vector became possible with
(a) DNA ligase
(b) endonucleases
(c) DNA polymerase
(d) exonucleases
11. Plasmid present in bacterial cells are
(a) circular double helical DNA molecules.
(b) linear double helical DNA molecules.
(c) circular double helical RNA molecules.
(d) linear double helical RNA molecules.
12. What must be done before placing DNA into the electrophoretic chamber ?
(a) It must be ground up with mortar and pestle.
(b) It must be cut by restriction endonucleases.
(c) It must be treated with RNAase .
(d) None of the above
13. Which of the following has the ability to transform normal cells into cancerous cells in animals ?
(a) *Agrobacterium tumefaciens*
(b) Retroviruses
(c) DNA-viruses
(d) Plasmids
14. What are the properties of a good vector?
(a) It should be ideally more than 10 kb in size.
(b) It should be able to replicate autonomously.
(c) It should have suitable marker genes.
(d) It should not be easy to isolate and purify.
15. A kind of biotechnology involving manipulation of DNA is called
(a) DNA replication
(b) genetic engineering
(c) denaturation
(d) renaturation

34 Biotechnology and its Applications

Fill in the Blanks :

1. *Bacillus thuringiensis* (*Bt*) strains have been used for designing novel ___________.
2. *Cry* protein is obtained from ___________.
3. RNA interference (RNAi) technique has been devised to protect the plants from nematode is silenced by ______ produced by the host plant.
4. The first human drug made using recombinant DNA technology was ___________.
5. *E. coli* are used in production of ___________.
6. The first clinical gene therapy was given in 1990 to a 4 years old girl with enzyme deficiency of ___________.
7. The site of production of ADA in the body is ___________.
8. Genes of interest can be selected from a genomic library by using ___________.
9. DNA or RNA segment tagged with a radioactive molecule is called ___________ .

True/ False :

1. *Bt* protein exists as active toxin in the *Bacillus.*
2. Human insulin is being commercially produced from a transgenic species of *Agrobacterium tumefaciens.*
3. The proteins encoded by the genes *cry* I *Ac* and *cry* II *Ab* control cotton bollworms.
4. The anticoagulant hirudin is being produced from transgenic *Brassica napus* seeds.
5. "*Flavr Savr*" variety of tomato has enriched the production of ethylene which improves its taste.
6. Golden rice, a genetically engineered rice has high vitamin A (retinol) content.
7. The current interest in the manipulation of microbes, plants and animal has raised serious ethical issues.
8. DNA from one organism will not bond to DNA from another animal.
9. *Bt* cotton is resistant to bollworm infestation.
10. Disarmed pathogen vectors are also used in transfer of R-DNA into the host.

Conceptual MCQs :

1. Flavr Savr is the transgenic variety of
   (a) cotton (b) rice
   (c) tomato (d) potato
2. Biopiracy is related to which of the following ?
   (a) Traditional knowledge
   (b) Biomolecules and regarding bioresources genes isolated from bioresources
   (c) Bioresources
   (d) All of the above
3. Cultivation of Bt cotton has been much in the news. The prefix "Bt" means
   (a) Barium treated cotton seeds
   (b) Carrying an endotoxin gene from *Bacillus thuringiensis.*
   (c) Produced by biotechnology method
   (d) Bigger thread variety of cotton with tensile strength.
4. Golden rice is a promising transgenic crop, when released for cultivation, it will help in
   (a) producing petrol like fuel from rice.
   (b) alleviation of vitamin A.
   (c) pest resistance.
   (d) herbicide tolerance.
5. *Bacillus thuringiensis* (Bt) strains have been used for designing novel
   (a) biofertilizers
   (b) bio-metallurgical technique
   (c) biomineralurgical process
   (d) bioinsecticidal plants.

6. The transgenic animals are those which have
(a) foreign DNA in some cells.
(b) foreign DNA in all of their cells.
(c) foreign RNA in all of their cells.
(d) both (a) and (c).

7. The transgenic plants are the plants having
(a) no gene.
(b) genes in transposition.
(c) genes with no function to perform.
(d) genes of an other organism.

8. Recombinant DNA technology can be used to produce quantities of biologically active form of which one of the following products in *E.coli*?
(a) Luteinizing hormone
(b) Ecdyson
(c) Rifamycin
(d) Interferon

9. Which of the following combinations of risk are associated with genetically modified food ?
I. Toxicity
II. Allergic reaction
III. Antibiotic resistance in micro-organisms present in alimentary canal. –
(a) I and II (b) I, II and III
(c) I and III (d) II and III

10. Which one of the following is commonly used in transfer of foreign DNA into crop plants?
(a) *Meloidogyne incognita*
(b) *Agrobacterium tumefaciens*
(c) *Penicillium expansum*
(d) *Trichoderma harzianum*

11. What is **true** about *Bt* toxin?
(a) *Bt* protein exists as active toxin in the *Bacillus*
(b) The activated toxin enters the ovaries of the pest to sterilise it and thus prevent its multiplication.
(c) The concerned *Bacillus* has antitoxins.
(d) The inactive protoxin gets converted into active form in the insect gut.

12. The most common substrate used in distilleries for the production of ethanol is
(a) corn meal (b) soya meal
(c) ground gram (d) molasses

13. Maximum number of existing transgenic animals is of :
(a) fish (b) mice
(c) cow (d) pig

14. Continuous addition of sugars in 'fed batch' fermentation is done to:
(a) produce methane
(b) obtain antibiotics
(c) purify enzymes
(d) degrade sewage

15. Consider the following statements (A-D) about organic farming:
(A) Utilizes genetically modified crops like *Bt* cotton
(B) Uses only naturally produced inputs like compost
(C) Does not use pesticides and urea
(D) Produces vegetables rich in vitamins and minerals
Which of the above statements are correct?
(a) (B), (C) and (D)
(b) (C) and (D) only
(c) (B) and (C) only
(d) (A) and (B) only

16. In history of biology, human genome project led to the development of :
(a) biotechnology
(b) biomonitoring
(c) bioinformatics
(d) biosystematics

17. Read the following four statements (A-D) about certain mistakes in two of them
(A) The first transgenic buffalo, Rosie produced milk which was human alpha-lactal albumin enriched.
(B) Restriction enzymes are used in isolation of DNA from other macro-molecules.
(C) Downstream processing is one of the steps of R-DNA technology.
(D) Disarmed pathogen vectors are also used in transfer of R-DNA into the host.
Which are the two statements having mistakes?
(a) Statement (B) and (C)
(b) Statement (C) and (D)
(c) Statement (A) and (C)
(d) Statement (A) and (B)

18. Tobacco plants resistant to a nematode have been developed by the introduction of DNA that produced (in the host cells)
(a) both sense and anti-sense RNA
(b) a particular hormone
(c) an antifeedant
(d) a toxic protein

19. Silencing of mRNA has been used in producing transgenic plants resistant to:
   (a) bollworms
   (b) nematodes
   (c) white rusts
   (d) bacterial blights
20. How many varieties of rice has been estimated to be present in India?
   (a) 2,000 (b) 20,000
   (c) 200,000 (d) 2,000,000

Assertion/ Reason :

DIRECTIONS (Qs. 1-5): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion**: Bt toxin does not kill bacteria.
   Reason: Bt toxin exist in inactive pro-toxin, it gets activated when ingested by insects.
2. **Assertion**: The clone having the mutated gene will not appear on the photographic film
   Reason: The probe will not be complementary with mutated gene.
3. **Assertion**: Plasmid is an autonomously extra chromosomal circular DNA found in bacterial cells.
   Reason: Plasmid is a boon to biotechnology.
4. **Assertion**: Insulin is different from proinsulin.
   Reason: Insulin is synthesized as proinsulin.
5. **Assertion**: Second generation vaccines are always safer to use.
   Reason: They are produced by genetic engineering.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column - I	Column - II
(A) *Escherichia coli*	I. *nif* gene
(B) *Bacillus thuringiensis*	II. Interferon
(C) *Rhizobium meliloti*	III. *Bt* toxin
(D) *Agrobacterium tumefaciens*	IV. Vector

(a) A – II; B – I; C – (IV); D – III
(b) A – II; B – I; C – (III); D – IV
(c) A – II; B – III; C – I; D – IV
(d) A – IV; B – I; C – II; D – III

2.

Column - I	Column - II
(A) GMO	I. Increased shelf life
(B) Flavr - Savr tomato	II. Bioresources
(C) Biopiracy	III. rDNA
(D) *E.coli*	IV. Insulin

(a) A – III; B – I; C – II; D – IV
(b) A – II; B – I; C – III; D – IV
(c) A – II; B – III; C – I; D – IV
(d) A – IV; B – I; C – II; D – III

3.

Column - I	Column - II
(A) Gene therapy	I. *Rhizobium*
(B) Biofertilizer	II. *Cry* gene
(C) *Bt* cotton	III. SCID
(D) Humulin	IV. Diabetes

(a) A – II; B – I; C – IV; D – III
(b) A – III; B – I; C – II; D – IV
(c) A – II; B – III; C – I; D – IV
(d) A – IV; B – I; C – II; D – III

4.

Column - I	Column - II
(A) Golden Rice	I. *Cry* protein
(B) *Bt* toxin	II. Rich in vitamin A
(C) RNAi	III. First trangenic cow
(D) Rosie	IV. Gene silencing

(a) A – II; B – I; C – IV; D – III
(b) A – II; B – I; C – III; D – IV
(c) A – II; B – III; C – I; D – IV
(d) A – IV; B – I; C – II; D – III

5.

Column - I	Column - II
(A) Forensic science	I. AIDS
(B) ELISA	II. Radioactive DNA/RNA
(C) Probe	III. Emphysema
(D) α-1-antitrypsin	IV. DNA fingerprinting

(a) A – II; B – I; C – IV; D – III
(b) A – II; B – I; C – III; D – IV
(c) A – II; B – III; C – I; D – IV
(d) A – IV; B – I; C – II; D – III

Critical Thinking Type Questions :

1. Transgenic plants are the ones
(a) generated by introducing foreign DNA into a cell and regenerating a plant from that cell.
(b) produced after protoplast fusion in artificial medium.
(c) grown in artificial medium after hybridization in the field.
(d) produced by a somatic embryo in artificial medium.

2. Transgenic animals has been successfully used for producing
(a) transgenic mice for testing safety of polio vaccine before use in humans.
(b) transgenic models for studying new treatments for certain cardiac diseases.
(c) transgenic cow – rosie which produces high fat milk for making ghee.
(d) animals like bulls for farm work as they have super power.

3. Silencing of mRNA has been used in producing transgenic plants resistant to
(a) bollworms (b) nematodes
(c) white rusts (d) bacterial blights

4. Which one of the following techniques made it possible to genetically engineer living organism ?
(a) Recombinant DNA techniques
(b) X-ray diffraction
(c) Heavier isotope labelling
(d) Hybridization

5. Which of the following Bt crops is being grown in India by the farmers?
(a) Cotton (b) Brinjal
(c) Soyabean (d) Maize

6. A transgenic food crop which may help in solving the problem of night blindness in developing countries is
(a) golden rice (b) *Bt* soyabean
(c) *flavr - savr* tomato (d) starlink maize

7. Which of these is used as vector in gene therapy for SCID?
(a) Arbovirus (b) Rotavirus
(c) Retrovirus (d) Parvovirus

8. The genetic defect, adenosine deaminase (ADA) deficiency may be cured permanently by
(a) administering adenosine deaminase through injection
(b) bone marrow transplantation
(c) enzyme replacement therapy
(d) introducing isolated gene from marrow cells producing ADA into the cells at early embryonic stages

9. Genetically engineered bacteria have been successfully used in the commercial production of
(a) human insulin (b) testosterone
(c) thyroxine (d) melatonin

10. Main objective of production/use of herbicide resistant GM crops is to
(a) eliminate weeds from the field without the use of manual labour.
(b) eliminate weeds from the field without the use of herbicides.
(c) encourage eco-friendly herbicides.
(d) reduce herbicide accumulation in food articles for health safety.

11. Biotechnology deals with industrial scale production of biopharmaceuticals and biological products using genetically modified
(a) microbes only
(b) fungi only
(c) plants and animals only
(d) all of the above

12. *Cry* II *Ab* and *cry* I *AC* produce toxins that control
(a) cotton bollworms and corn borer respectively.
(b) cotton borer and cotton bollworms respectively.
(c) tobacco budworms and nematodes respectively.
(d) nematodes and tobacco budworms respectively.

13. What is the disadvantage of using porcine insulin (from pig) in diabetic patients?
(a) It leads hypercalcemia.
(b) It is expensive.
(c) It may cause allergic reactions.
(d) It can lead to mutation in human genome.

14. Which technique would to be completely curative in SCID ?
(a) Gene therapy in adult stage.
(b) Gene therapy in embryonic stage.
(c) Bone marrow transplantation.
(d) Enzyme replacement therapy.

15. Which of the following is based upon the principle of antigen-antibody interaction?
(a) PCR (b) ELISA
(c) r-DNA technology (d) RNA

16. Deliberate alteration of genome for treatment of disease is called
(a) transformation rescue
(b) imprinting
(c) exon shuffle
(d) gene therapy

35 Organism and Population

Fill in the Blanks :

1. Deep (>500m) in the oceans, the environment is perpetually dark and its inhabitants are not aware of the existence of a celestial source of energy called_________.
2. _____ is any attribute of the organism (morphological physiological, behavioural) that enables the organisms to survive and reproduce in its habitat.
3. _______________ is the number of individuals of the population who left the habitat and gone elsewhere during the time period under consideration.
4. _____________ in birds is an interesting example of parasitism in which the parasitic bird lays its eggs in the nest of its host and the host incubates them.
5. Seagulls fiercely defend the areas around their nests in their cliff-top breeding colonies. Within the colony, they would show a _____ dispersion pattern.
6. An oak tree produces thousands of acorns, but very few grow into mature oak trees. The oak tree exhibits a _____ survivorship curve.
7. In wild populations, individuals most often show a _____ pattern of dispersion.
8. Plants are____ organisms, they frequently show a ______ spatial distribution, and their population density is most appropriately expressed in terms of ______ .
9. The maximum expansion rate of a population under the best conditions is referred to as _____. There are abundant resources that last forever and no limits on growth.
10. 1000 A.D. to the present can be generally characterized by ____ growth among human populations. Hence, before 1000 AD._____ growth was exhibited.

True/ False :

1. Abiotic and biotic components interact constantly with each other.
2. Tuna fish are rarely caught beyond tropical latitude in the ocean.
3. Temperature progressively decreases from pole to equator.
4. Photoperiodic requirement is essential for many plants for flowering.
5. Red algae can live in deeper water of sea because of having pigment, phycoerythrin.
6. All birds and mammals, and very few lower vertebrates and invertebrates are capable of osmoregulation and thermoregulation.
7. The smaller animals have larger surface area relative to their volume.
8. Some xerophytic plants have special photosynthetic pathway (CAM) that enables their stomata close during day.
9. *Opuntia*, have no leaves, they are reduced to spines.

Conceptual MCQs :

1. Animals that can tolerate a narrow range of salinity are
   (a) stenohaline (b) euryhaline
   (c) homeotherm (d) none of these
2. Diapause occurs in
   (a) algae (b) fungi
   (c) phytoplanktons (d) zooplanktons
3. Water holding capacity is maximum in :
   (a) gravel (b) silt
   (c) clay (d) sand
4. What is wrong about xerophytes?
   (a) Sunken stomata
   (b) Large number of stomata
   (c) Spiny leaves
   (d) Thick cuticle

5. Mycorrhizae is an example of :
(a) ectoparasite (b) endoparasite
(c) decomposers (d) symbiosis

6. Which does not affect the population density ?
(a) Natality (b) Mortality
(c) Photosynthesis (d) Immigration

7. Which of the following occurs deepest in sea?
(a) Green algae (b) Red algae
(c) Brown algae (d) All of these

8. Plants which grow on the scarcity of water are called :
(a) mesophyte (b) halophyte
(c) xerophyte (d) hydrophyte

9. The formula of exponential growth is
(a) $dN/dt = rN$ (b) $dN/rN = dt$
(c) $rN/dN = dt$ (d) $dt/DN = rN$

10. The maximum growth rate occurs in
(a) lag phase (b) exponential phase
(c) stationary phase (d) senescent phase

11. In the case of peppered moth (*Biston betularia*) the black - coloured form became dominant over the light- coloured form in England during industrial revolution.
This is an example of:
(a) appearance of the darker coloured individuals due to very poor sunlight
(b) protective mimicry
(c) inheritance of darker colour character acquired due to the darker environment
(d) natural selection whereby the darker forms were selected

12. Which one of the following is one of the characteristics of a biological community?
(a) Stratification (b) Natality
(c) Mortality (d) Sex ratio

13. Large woody vines are more commonly found in
(a) temperate forest (b) mangroves
(c) tropical rainforests (d) alpine forests

14. Consider the following four conditions (i) - (iv) and select the correct pair of them as adaptation to environment in desert lizards.
The conditions :
(i) Burrowing in soil to escape high temperature
(ii) Losing heat rapidly from the body during high temperature
(iii) Bask in sun when temperature is low
(iv) Insulating body due to thick fatty dermis
Options :
(a) (iii), (iv) (b) (i)
(c) (iii), (ii), (iv) (d) (i), (ii)

15. *Cuscuta* is an example of
(a) ectoparasitism
(b) brood parasitism
(c) predation
(d) endoparasitism

16. A sedentary sea anemone gets attached to the shell lining of hermit crab. The association is :
(a) Symbiosis
(b) Commensalism
(c) Amensalism
(d) Ectoparasitism

17. A biologist studied the population of rats in a barn. He found that the average natality was 250, average mortality 240, immigration 20 and emigration 30. The net increase in population is :
(a) 15 (b) 05
(c) zero (d) 10

18. Presence of flagellated protozoans in the gut of termites are the example
(a) Symbiosis
(b) Parasitism
(c) Antibiosis
(d) Commensalism

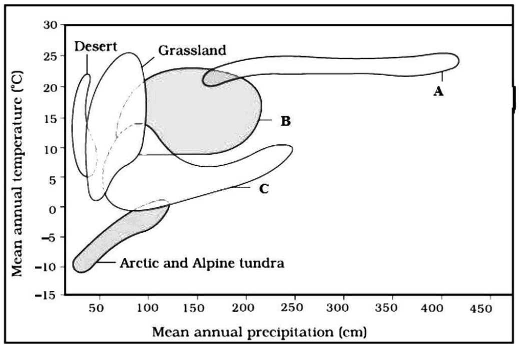
19. Ratio of natality and mortality of a population expressed in percentage is
(a) vital index
(b) growth rate
(b) survival rate
(d) biotic potential

20. Animals from colder climates generally have smaller limbs. This is called
(a) Niche rule (b) Allen's rule
(c) Ehrlich rule (d) None of these.

21. Pyramid of energy in a river ecosystem is
(a) always upright (b) always erect
(c) constant (d) declining

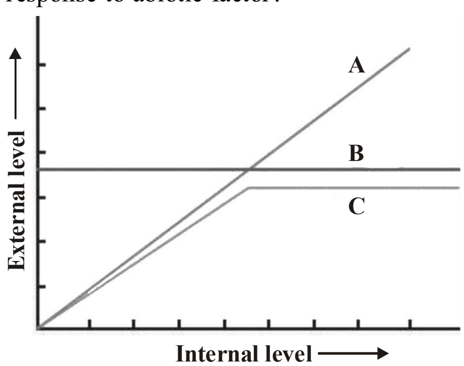
Diagram Based Questions :

1. The given figure flows biome distribution with respect to annual temperature and precipitation. In this few parts are marked as A, B & C. Mark the correct identification from the following picture.



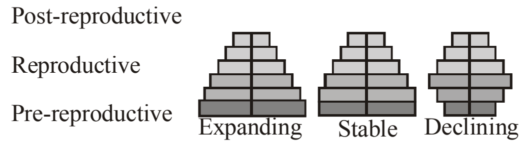
	(A)	(B)	(C)
(a)	Tropical forest	Temperate forest	Coniferous forest
(b)	Temperate forest	Tropical forest	Coniferous forest
(c)	Temperate forest	Coniferous forest	Tropical forest
(d)	Coniferous forest	Tropical forest	Temperate forest

2. The given figure shows the diagram match representation of organismic response. Which option gives the correct identification of three types of organisms (marked as A, B & C) in response to abiotic factor?



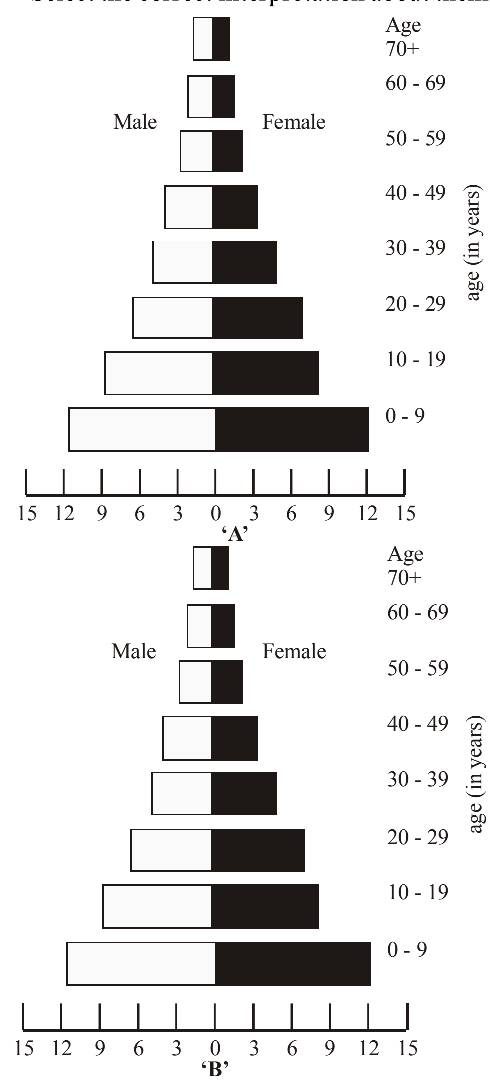
	(A)	(B)	(C)
(a)	Partial regulator	Regulator	Conformers
(b)	Regulator	Conformers	Partial regulator
(c)	Conformers	Regulator	Partial regulator
(d)	Regulator	Partial regulator	Conformers

3. What type of human population is represented by the given age pyramid?



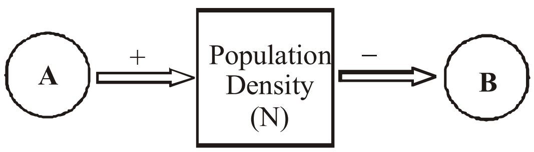
(a) Expanding population
(b) Vanishing population
(c) Stable population
(d) Declining population

4. A country with a high rate of population growth took measures to reduce it. The figure below shows age-sex pyramids of populations A and B twenty years apart.
Select the correct interpretation about them.



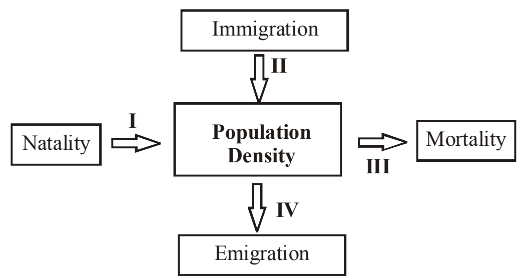
(a) "B" is earlier pyramid and shows stabilized growth rate.
(b) "B" is more recent showing that population is very young.
(c) "A" is the earlier pyramid and no change has occurred in the growth rate.
(d) "A" is more recent and shows slight reduction in the growth rate.

5. The density of a population in a given habitat during a given period, fluctuates due to changes in four basic processes On this basis choose the correct option to fill up A and B boxes in the given diagram.



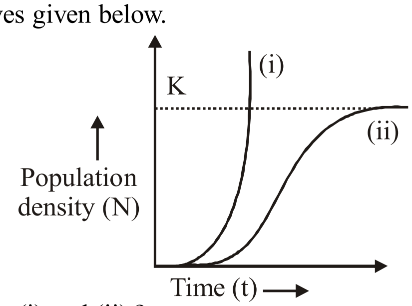
(a) A = Natality + Immigration, B = Mortality + Emigration
(b) A = Natality + Mortality, B = Immigration + Emigration
(c) A = Birth rate + Death rate, B = Mortality + Emigration
(d) A = Natality + Emigration, B = Mortality + Immigration

6. Identify I to IV which affect the population density.



	I	II	III	IV
(a)	Increase	Decrease	Increase	Decrease
(b)	Decrease	Increase	Decrease	Increase
(c)	Increase	Increase	Decrease	Decrease
(d)	Decrease	Decrease	Increase	Increase

7. Study the population growth curves given below.



Which options is the best for curve (i) and (ii) ?

S. No.	Type of (i) curve	Type of (ii) curve	Equation for curve (i)	Equation for curve (ii)
(a)	Logistic curve	Logistic curve	$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$	$\frac{dN}{dt} = rN$
(b)	Exponential curve	Logistic curve	$\frac{dN}{dt} = rN$	$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$
(c)	Logistic curve	Exponential curve	$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$	$\frac{dN}{dt} = rN$
(d)	Exponential curve	Exponential curve	$\frac{dN}{dt} = rN$	$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$

Assertion/ Reason :

DIRECTIONS (Qs. 1-5): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion**: Exotic species introduced in the environment are not native. They become invasive and start spreading fast.
Reason: The invaded land does not have their natural predators

2. **Assertion**: Gause principle states that similar species cannot co-exist for a long time in the same ecological niche.
Reason: Competing for the same critical resources within a environment. One of them will eventually outcompete and displace the other.

3. **Assertion**: Predation is a relation between two organisms in which one organism capture and feed on other.
Reason: In this process, both the organisms get benefit from one-another.

4. **Assertion**: Head louse living on the human scalp as well as laying egg on human hair is catagoriesed as parasite.
Reason: Parasitism is the relation between organisms in which one lives as a parasite on another and harm the host.

5. **Assertion**: Very small animals are rarely found in polar regions
Reason: Relative to their volume, small animals have large surface area. They tend to lose energy very fast when in cold outside.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I		Column-II
A.	Pacific Salmon fish	I.	Produces a small number of large sized offspring
B.	Mammals	II.	Produces a large number of small sized offspring
C.	Oysters	III.	Breed only once in their lifetime
D.	Birds	IV.	Breed many times during their lifetime

(a) A – III; B – IV; C – II; D – I
(b) A – I; B – IV; C – II; D – III
(c) A – IV; B – II; C – I; D – III
(d) A – II; B – IV; C – III; D – I

2.

Column-I Population	Column-II Example
A. Predation	I. *Cuscuta* and hedge plants
B. Commensalism	II. *Balanus* and *Chathamalus*
C. Parasitism	III. Cactus and moth
D. Competition	IV. Orchid and mango

(a) A – III; B – IV; C – I; D – II
(b) A – IV; B – III; C – II; D – I
(c) A – I; B – III; C – II; D – IV
(d) A – III; B – IV; C – II; D – I

3.

	Column I		Column II
A.	Pacific salmon fish	I	Verhulst - pearl logistic growth
B.	$N_t = N_0 e^{rt}$	II	Breed only once in life time
C.	Oyster	III	Exponential growth
D.	$dN/dt = rN\left[\frac{K\cancel{N}}{K}\right]$	IV	A large number of small sized offsprings

(a) A – IV; B – III; C – I; D – II
(b) A – III; B – IV; C – I; D – II
(c) A – III; B – I; C – IV; D – II
(d) A – II; B – III; C – IV; D – I

Critical Thinking Type Questions :

1. Which one of the following do not account for the formation of major biomes?
(a) Annual variation in intensity of temperature.
(b) Annual variation in duration of temperature.
(c) Annual variation in precipitation.
(d) Annual variation in texture of soil.

2. Many freshwater fishes cannot live for long in sea water and *vice-versa* mainly because of the
(a) variation in light intensity.
(b) change in the levels of thermal tolerance.
(c) osmosis.
(d) spectral quality of solar radiation.

3. Factors that are important for aquatic organisms include
(a) chemical composition of water
(b) pH of water
(c) spectral quality of solar radiation
(d) both (a) and (b)

4. Many animals use the diurnal and seasonal variations in light intensity and photoperiod as cues timing of
(a) for age only
(b) reproductive activities only
(c) migration only
(d) all of these

5. To a large extent the vegetation in any area is determined by
(a) temperature and pH.
(b) pH, mineral composition and light.
(c) pH, mineral composition and topography.
(d) types of minerals in soil.

6. Regarding temperature and osmotic concentration nearly all plants are
(a) regulator (b) conformers
(c) partial regulator (d) escaper in time

7. Very small animals are rarely found in polar regions because
(a) they have a smaller surface area relative to their volume.
(b) they have a larger volume relative to their surface area.
(c) they have smaller metabolic rate.
(d) they have a larger surface area relative to their volume.

8. The kangaroo rats of North American deserts do not need to drink water because
(a) they meet their water requirement through internal fat oxidation when the water is a byproduct.
(b) they are able to concentrate urine, to minimize water loss.
(c) they do not have sweat glands.
(d) all of the above

9. Many tribes living in the high altitude of Himalayas have a
(a) higher WBC count than people living in the plains.
(b) lower WBC count than people living in the plains.
(c) higher RBC count than people living in the plains.
(d) lower RBC count than people living in the plains.

10. Population ecology is an important area of ecology because
(a) it determines the interaction among organisms and between the organisms and its physical environment.
(b) evolutionary changes through natural selection take place at the population level.
(c) it links ecology to population genetics and evolution.
(d) it links different types of communities together.

11. Natural selection operates to evolve the desired tracts at
(a) cellular level (b) species level
(c) community level (d) population level

12. If in a pond, there is 20 lotus last year and through reproduction 8 new plants are added, taking current population to 28. The birth rate per year is
(a) 0.2 (b) 0.4
(c) 0.6 (d) 0.8

13. If 4 individuals in a laboratory population of 40 fruitflies died during a specified time interval (*i.e.*, a week), the death rate in the population during that period is
(a) 1 (b) 0.1
(c) 0.01 (d) 0.4

14. In an age pyramid, the number of individuals of reproductive age is lesser than pre-reproductive but higher than post reproductive ones. The population is
(a) growing
(b) declining
(c) stable
(d) can not be predicted

15. If N is the population density at time t, then its density at time t + 1 is
(a) $N_{t+1} = N_t + [(B + I) + (D + E)]$
(b) $N_{t+1} = N_t - [(B + I) + (D + E)]$
(c) $N_{t+1} = N_t + [(B + I) - (D + E)]$
(d) $N_{t+1} = N_t - [(B + I) - (D + E)]$

36 ECOSYSTEM

Fill in the Blanks :

1. Vertical distribution of different species occupying different levels is called ________ .
2. Energy flow in an ecosystem is __________ .
3. Each trophic level has a certain mass of living material at a particular time is known as __________ .
4. Ecosystems are ______ because resources ____ move from one ecosystem to another.
5. Energy pyramids are used to represent energy transfer in an ecosystem because energy is _______ between each trophic level.
6. The greatest amount of energy is available at the _______ of a food chain.
7. The two vegetations of an ecosystem are separated by _______ .
8. Chemosynthetic bacteria found around deep-sea vents are examples of _______ .
9. All life on Earth depends on _______ energy.
10. Because of limitations on resources, organisms must _______ materials in order to survive.

True/ False :

1. An ecosystem is a functional unit of nature and comprises abiotic and biotic components.
2. Abiotic components are organic materials.
3. Removal of 80% tigers resulted in increased growth of vegetation, in food chain.
4. The rate of biomass production is called productivity and is expressed in terms of a kcal m^{-2}.
5. Net primary productivity is rate of production of biomass during photosynthesis.
6. An important characteristic of all communities is that their composition and structure constantly change in response to the changing environmental conditions.
7. The entire sequence of communities that successively change in a given area are called sere(s).
8. Any calculations of energy content, biomass or number has to include one group of organism at that trophic level.
9. The pyramid of biomass in sea is generally inverted.

Conceptual MCQs :

1. Biotic components of an ecosystem include
   (a) producers (b) consumers
   (c) decomposers (d) all of these
2. In a food chain producers form the
   (a) first trophic level
   (b) second trophic level
   (c) last trophic level
   (d) none of these
3. Primary consumers are
   (a) autotrophs (b) carnivores
   (c) herbivores (d) omnivores
4. Which one of the following is a one-way flow rather than cyclic flow?
   (a) Carbon (b) Phosphorus
   (c) Nitrogen (d) Free energy
5. Who are the pioneers in a xerach ?
   (a) Mosses (b) Lichens
   (c) Insects (d) All of these
6. In nature, the cleaners are
   (a) decomposers (b) carnivores
   (c) consumers (d) producers
7. Most stable ecosystem is
   (a) forest (b) grassland
   (c) ocean (d) desert
8. Pyramid of biomass in a grassland is
   (a) inverted (b) spindle shape
   (c) upright (d) none of these

9. Which is not a part of decomposition process?
(a) Humification (b) Fragmentation
(c) Leaching (d) Leaf fall

10. Carbon cycle is a
(a) sedimentary cycle
(b) gaseous cycle
(c) hydrological cycle
(d) none of these

11. Which pyramid is always erect ?
(a) Energy (b) Number
(c) Biomass (d) Food

12. What percentage of PAR is used by green plants ?
(a) 1–5% (b) 2–10%
(c) 5–20% (d) 2–20%

13. Ecosystem is a
(a) self-regulated
(b) self-sustained
(c) segment of environment
(d) all of these

14. Tip of ecological pyramid is occupied by :
(a) producers (b) herbivores
(c) carnivores (d) omnivores

15. Which of the following represents the sedimentary type of nutrient cycle ?
(a) Phosphorus (b) Nitrogen
(c) Oxygen (d) Carbon

16. The **correct** sequence of plants in a hydrosere is:
(a) *Volvox* $\rightarrow$ *Hydrilla* $\rightarrow$ *Pistia* $\rightarrow$ *Scirpus* *Lantana* $\rightarrow$ *Oak*
(b) *Pistia* $\rightarrow$ *Volvox* $\rightarrow$ *Scirpus* $\rightarrow$ *Hydrilla* $\rightarrow$ *Oak* $\rightarrow$ *Lantana*
(c) *Oak* $\rightarrow$ *Lantana* $\rightarrow$ *Volvox* $\rightarrow$ *Hydrilla* $\rightarrow$ *Pistia* $\rightarrow$ *Scirpus*
(d) *Oak* $\rightarrow$ *Lantana* $\rightarrow$ *Scirpus* $\rightarrow$ *Pistia* $\rightarrow$ *Hydrilla* $\rightarrow$ *Volvox*

17. Study the four statements (a–d) given below and select the two correct ones out of them:
(i) A lion eating a deer and a sparrow feeding on grain are ecologically similar in being consumers
(ii) Predator star fish *Pisaster* helps in maintaining species diversity of some invertebrates
(iii) Predators ultimately lead to the extinction of prey species
(iv) Production of chemicals such as nicotine, strychnine by the plants are metabolic disorders

The two correct statements are:
(a) (ii) and (iii) (b) (iii) and (iv)
(c) (i) and (iv) (d) (i) and (ii)

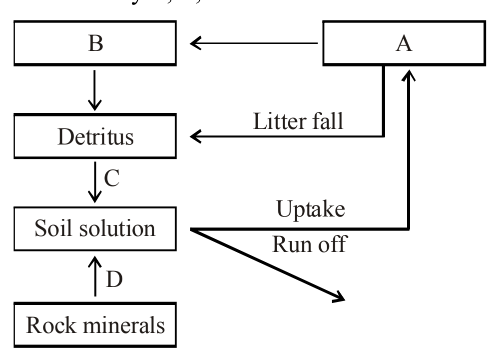
18. Mass of living matter at a trophic level in an area at any time is called
(a) standing crop (b) deteritus
(c) humus (d) standing state

19. Which one of the following animals may occupy more than one trophic levels in the same ecosystem at the same time?
(a) Sparrow (b) Lion
(c) Goat (d) Frog

20. *Pheretima* and its close relatives derive nourishment from :
(a) sugarcane roots
(b) decaying fallen leaves and soil organic matter.
(c) soil insects
(d) small pieces of fresh fallen leaves of maize, etc.

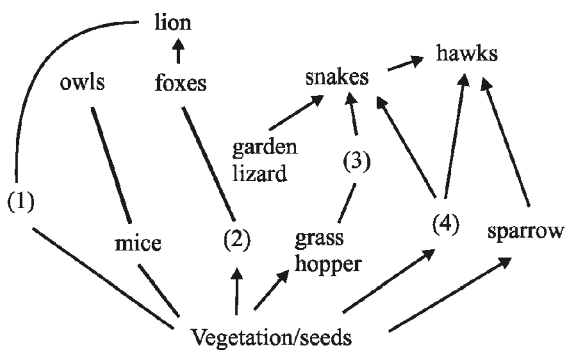
Diagram Based Questions :

1. Refer the given nutrient cycle in a terrestrial ecosystem with few labels marked as A, B, C and D. Identify A, B, C and D.



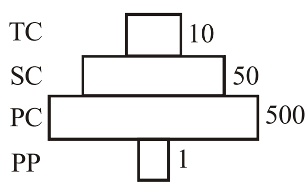
(a) A – Consumers; B – Decomposition; C – Producers; D – Weathering
(b) A – Consumers; B – Weathering; C – Producers; D – Decomposition
(c) A – Producers; B – Consumers; C – Decomposition; D – Weathering
(d) A – Consumers; B – Producers; C – Decomposition; D – Weathering

2. In the given food web few organisms are marked as (1), (2), (3) and (4). Identify (1), (2), (3) and (4).



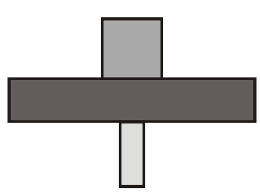
	(1)	(2)	(3)	(4)
(a)	Deer	Rabbit	Frog	Rat
(b)	Dog	Squirrel	Bat	Deer
(c)	Rat	Dog	Tortoise	Crow
(d)	Squirrel	Cat	Rat	Pigeon

3. Given below is an imaginary pyramid of numbers. What could be one of the possibilities about certain organisms at some of the different levels?



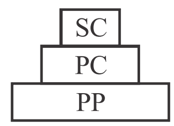
(a) Level PC is "insects" and level SC is "small insectivorous birds".
(b) Level PP is "phytoplanktons" in sea and "Whale" is on top level TC.
(c) Level PP is "pipal trees" and the level SC is "sheep".
(d) Level PC is "rats" and level SC is "cats".

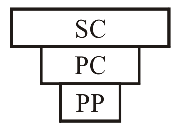
4. Given below is one of the types of ecological pyramids. This type represents

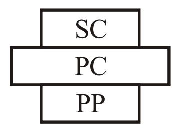


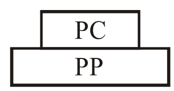
(a) Pyramid of numbers in a grassland
(b) Pyramid of biomass in a fallow land
(c) Pyramid of biomass in a lake
(d) Energy pyramid in a spring

5. Which of the given pyramids represents the variation in biomass at different trophic levels in pond ecosystem?

(a) 

(b) 

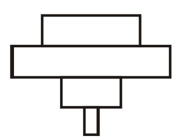
(c) 

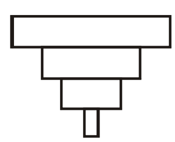
(d) 

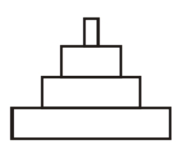
6. Two food chains are given below.

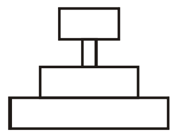
(i) Tree $\rightarrow$ aphid $\rightarrow$ insectivorous bird $\rightarrow$ prey feed on bird
(ii) Phytoplankton $\rightarrow$ zooplankton $\rightarrow$ plankton feeding fish $\rightarrow$ carnivorous fish

Which diagram is a pyramid of energy representing both food chains?

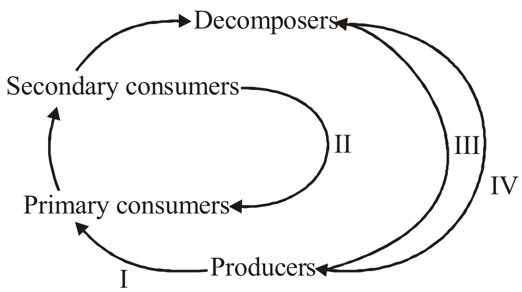
(a) 
Trophic level
4
3
2
1

(b) 
Trophic level
4
3
2
1

(c) 
Trophic level
4
3
2
1

(d) 

7. The given diagram shows (I, II, III, and IV) the flow of materials between different trophic levels. Which arrow is incorrect?



(a) I (b) II
(c) III (d) IV

Assertion/ Reason :

DIRECTIONS (Qs. 1-12): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Leguminous plants are nitrogen fixers.
Reason : Leguminous plants have *Rhizobium* in their root nodules.

2. **Assertion** : Cold blooded animals do not have fat layer.
Reason : Cold blooded animals use their fat for metabolic process during hibernation.

3. **Assertion:** Insectivorous habitat of plants is to cope up O_2 deficiency.
Reason: Insectivorous plants are partly autotrophic and partly heterotrophic.

4. **Assertion** : In a food chain, members of successive higher levels are fewer in number.
Reason : Number of organisms at any trophic level depends upon the availability of organisms which serve as food at the lower level.

5. **Assertion** : Tropical rain forests are disappearing fast from developing countries such as India.
Reason : No value is attached to these forests because these are poor in biodiversity.

6. **Assertion** : Leaf butterfly and stick insect show mimicry to dodge their enemies.
Reason : Mimicry is a method to acquire body colour blending with the surroundings.

7. **Assertion :** Animals adopt different strategies to survive in hostile environment.
Reason : Praying mantis is green in colour which merges with plant foliage.

8. **Assertion** : Nitrogen-fixing enzyme in legume root nodules function at low oxygen concentration.
Reason : Low oxygen concentration is provided by leghaemoglobin.

9. **Assertion** : The sex ratio of Kerala is highest in India.
Reason : In countries like India the population is increasing at a rapid rate.

10. **Assertion :** A network of food chains existing together in an ecosystem is known as food web.
Reason : An animal like kite cannot be a part of a food web.

11. **Assertion :** In tropical rain forests. O-horizon and A-Horizon of soil profile are shallow and nutrient-poor.
Reason : Excessive growth of micro-organisms in the soil depletes its organic content.

12. **Assertion :** A network of food chains existing together in an ecosystem is known as food web.
Reason : An animal like kite cannot be a part of a food web.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column - I	Column - II
(A) Primary succession	I. Autotrophs
(B) Climax community	II. Community that has completed succession
(C) Consumer	III. Colonization of a new environment
(D) Producer	IV. Animals

(a) A – III; B – II; C – IV; D – I
(b) A – III; B – I; C – IV; D – II
(c) A – I; B – III; C – II; D – IV
(d) A – II; B – III; C – IV; D – I

2.

Column - I	Column - II
(A) Standing state	I. Nitrogen, Carbon
(B) Gaseous cycles	II. Amount of nutrients
(C) Standing crop	III. Sulphur, Phosphorus
(D) Sedimentary cycles	IV. Living matter at different trophic levels

(a) A – II; B – I; C – IV; D – III
(b) A – I; B – II; C – III; D – IV
(c) A – III; B – II; C – IV; D – I
(d) A – I; B – IV; C – III; D – II

3.

Column - I	Column - II
(A) Phosphorus	I. Atmosphere
(B) Carbon	II. Producers
(C) Goat	III. Rock
(D) Grasses	IV. T_2

(a) A – III; B – II; C – IV; D – I
(b) A – III; B – I; C – IV; D – II
(c) A – I; B – III; C – II; D – IV
(d) A – II; B – III; C – IV; D – I

4.

Column - I	Column - II
(A) Pioneer community on lithosphere	I. Crustose lichens
(B) Ecological succession	II. Mesophytes
(C) Climax community	III. Ecosystem development
(D) Ecological pyramid	IV. Elton

(a) A – III; B – II; C – IV; D – I
(b) A – III; B – I; C – IV; D – II
(c) A – I; B – III; C – II; D – IV
(d) A – II; B – III; C – IV; D – I

5.

Column - I	Column - II
(A) Presence of 3-4 storey of plant growns in a forest	I. Blue-green algae
(B) A biome having grasses with scattered trees	II. Stratification
(C) Man made ecosystem	III. Savannah
(D) Pioneer in hydrosere	IV. Dam

(a) A – III; B – II; C – IV; D – I
(b) A – III; B – I; C – IV; D – II
(c) A – I; B – III; C – II; D – IV
(d) A – II; B – III; C – IV; D – I

Critical Thinking Type Questions :

1. If CO_2 is removed totally from the biosphere, which organisms will be affected first ?
(a) Consumers
(b) Secondary consumers
(c) Producers
(d) Primary producers

2. The correct order of the process of decomposition is
(a) Catabolism → Fragmentation → Leaching → Humification → Mineralization
(b) Catabolism → Fragmentation → Humification → Leaching → Mineralization
(c) Fragmentation → Humification → Catabolism → Leaching → Mineralization
(d) Fragmentation → Leaching → Catabolism → Humification → Mineralization

3. Productivity at the second trophic level is always
(a) greater than the productivity at the first trophic level.
(b) less than the productivity at the first trophic level.
(c) equal to the productivity at the first trophic level.
(d) extremely variable compared to the productivity at the first trophic level.

4. Which one of the following animals may occupy more than one trophic levels in the same ecosystem at the same time?
(a) Sparrow (b) Lion
(c) Goat (d) Frog

5. The transfer of energy from one trophic level to another is governed by the 2nd law of thermodynamics. The average efficiency of energy transfer from herbivores to carnivores is
   (a) 5% (b) 10%
   (c) 25% (d) 50%
6. The phosphorus cycle differs from the carbon cycle in that
   (a) the phosphorus does not enter living organisms, whereas carbon does.
   (b) the phosphorus cycle does not include a gaseous phase, whereas the carbon cycle does.
   (c) the phosphorus cycle includes a solid phase, whereas the carbon cycle does not.
   (d) the primary reservoir of the phosphorus cycle is the atmosphere, whereas the primary reservoir for the carbon cycle is in rock.
7. Grasslands can support greater grazing rates by herbivores than forests because
   (a) net production of grassland is greater.
   (b) more of the grassland is above the ground.
   (c) grasslands receives more sunlight.
   (d) grasslands produce less woody plant tissue.
8. Which of the following could not be considered an ecosystem ?
   (a) A small pond
   (b) All the fish in a coral reef
   (c) Earth
   (d) A pile of dung in a pasture
9. There is no difference between
   (a) secondary consumers and herbivores.
   (b) primary consumers and herbivores.
   (c) first trophic level and herbivores.
   (d) primary carnivores and second trophic level.
10. Which of the following contribute(s) to the carbon cycle ?
   (a) Respiration and photosynthesis
   (b) Fossil fuel combustion
   (c) Decompostion of dead organisms
   (d) All of these
11. In an upright pyramid of biomass, the herbivores generally occupy which of the following position ?
   (a) First position
   (b) Second position
   (c) Third position
   (d) Fourth position
12. The primary succession refers to the development of communities on a
   (a) freshly cleared crop field.
   (b) forest clearing after devastating fire.
   (c) pond, freshly filled with water after a dry phase.
   (d) newly-exposed habitat with no record of earlier vegetation.
13. Which of the following compartments of the global ecosystem would be characterized by very slow movement of materials within the compartment ?
   (a) Oceans (b) Fresh water
   (c) Atmosphere (d) Land
14. Which one of the following is not used for construction of ecological pyramids?
   (a) Number of individuals
   (b) Rate of energy flow
   (c) Fresh weight
   (d) Dry weight

37 Biodiversity and its Conservation

Fill in the Blanks :

1. More than 70% of all the species recorded so far, are ____ .
2. The taxa believed likely to join the endangered category in near future is called ____ .
3. The area where wild populations, traditional life styles and genetic resources are protected is called ____ .
4. Animals and plants are best protected in ____ .
5. A high density of a protected animal in a National Park can result into ____
6. Diversity of habitat over the total landscape is called ____
7. The highest number of species in the world is represented ____ by
8. Diversity between two communities is called ____ .
9. In cryopreservation germplasm is maintained at ____ .
10. The Cichlid species of Lake Victoria were driven to, or nearly to, extinction by the introduction of _________.

True/ False :

1. Amazonian rain forest has greatest biodiversity on earth.
2. According to Robert May estimates, the global species diversity is 7 million.
3. The number of species in an area increases with the size of the area.
4. Hotspots of biodiversity means areas of the earth that contain many endemic species.
5. Endemic plants and animals are those which are restricted to certain area.
6. Alpha diversity is present between community.
7. Sacred groves are found in Aravali Hills of Rajasthan.
8. Biodiversity loss accurs due to alien species invasion.
9. The major cause of loss of numbers of migratory birds is urbanisation and pesticides.

Conceptual MCQs :

1. An *in situ* method of conservation is
   (a) Botanical garden
   (b) cryopreservation
   (c) tissue culture
   (d) national park
2. Which one is hotspot of biodiversity ?
   (a) Eastern Ghats
   (b) Western Ghats
   (c) Aravali Hills
   (d) All of the above
3. First National Park established in India was
   (a) Bandipur (b) Kanha
   (c) Corbett (d) Periyar
4. Main cause of extinction of species from tropics is
   (a) deforestation (b) pollution
   (c) soil erosion (d) aforestation
5. Which one is helpful *in situ* conservation ?
   (a) Zoological parks
   (b) Botanical gardens
   (c) Wild-life safari parks
   (d) All of these

6. The Convention on Biological Diversity was held in Rio de Janeiro in the year :
(a) 1982 (b) 1992
(c) 2000 (d) 2002

7. Which one is the most species-rich taxomonic group?
(a) Reptilia (b) Annelida
(c) Arthropoda (d) Mammalia

8. What accounts for low biodiversity at the poles ?
(a) Short days (b) Low productivity
(c) Severe climate (d) All of these

9. The species in danger of extinction are placed in
(a) Red list (b) Green list
(c) Blue list (d) Black list

10. Which among the following is an extinct animal?
(a) Kiwi (b) Dodo
(c) Ostrich (d) All of these

11. Which one of the following has maximum genetic diversity in India?
(a) Mango (b) Wheat
(c) Tea (d) Teak

12. Tiger is **not** a resident in which one of the following national park?
(a) Sunderbans (b) Gir
(c) Jim Corbett (d) Ranthambhor

13. Which one of the following is an example of *Ex-situ* conservation?
(a) Wildlife sanctuary (b) Seed bank
(c) Sacred groves (d) National park

14. A collection of plants and seeds having diverse alleles of all the genes of a crop is called
(a) herbarium (b) germplasm
(c) gene library (d) genome

15. Which one of the following shows maximum genetic diversity in India ?
(a) Groundnut (b) Rice
(c) Maize (d) Mango

16. Consider the following statements (A)-(D) each with one or two blanks.
(A) Bears go into __(1)__ during winter to __(2)__ cold weather
(B) A conical age pyramid with a broad base represents __(3)__ human population
(C) A wasp pollinating a fig flower is an example of __(4)___
(D) An area with high levels of species richness is known as __(5)___
Which one of the following options give the correct fill ups for the respective blank numbers from (1) to (5) in the statements
(a) (2) - stable (4) commensalism, (5) marsh
(b) (1) - aestivation, (5) - escape, (3) - stable, (4) - mutualism
(c) (3) - expanding, (4) - commensalism, (5) biodiversity park
(d) (1)- hibernation, (2) - escape, (3) - expanding, (5) hot spot

17. Which one of the following areas in India, is a hotspot of biodiversity?
(a) Eastern Ghats
(b) Gangetic Plain
(c) Sunderbans
(d) Western Ghats

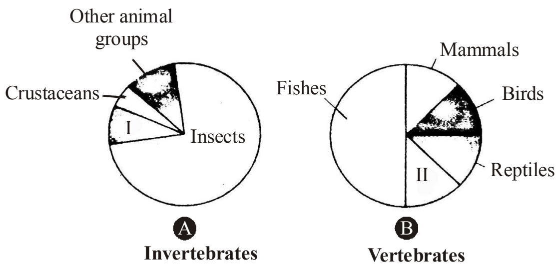
18. If the Bengal tiger becomes extinct
(a) Hyenas and wolves will become scare
(b) The wild area will be safe for man and domestic animals
(c) Its gene pool will be lost for ever
(d) The population of beautiful animals like deers will be stabilized.

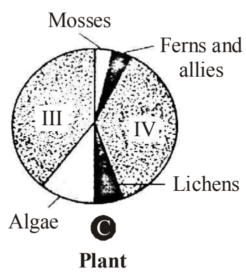
19. A taxon facing an extremely high risk of extinction in wild in the immediate future is called :
(a) critical endangered (b) endangered
(c) vulnerable (d) extinct in wild

20. Indian rhinoceros are protected in
(a) Gir Forest
(b) Kaziranga National Park
(c) Bandipur National Park
(d) Ranthambore National Park

Diagram Based Questions :

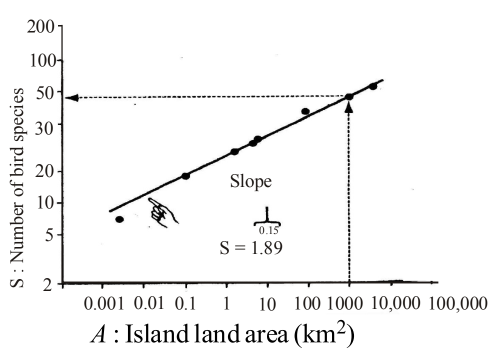
1. Given below are pie diagrams A, B and C related to proportionate number of species of major taxa of invertebrates, vertebrates and plants respectively. Critically study and fill in the blanks I, II, III and IV.





(a) I- Molluscs, II-Amphibians, III-Fungi, IV-Angiosperms
(b) I- Molluscs, II-Amphibians, III-Angiosperms, IV-Fungi
(c) I- Hexapoda, II-Amphibians, III-Fungi, IV-Angiosperms
(d) I- Turtles, II-Amphibians, III-Fungi, IV-Angiosperms

2. Using the figure, determine the percentage of bird species that will be lost if the island's inhabitable land area is reduced from 100,000 km^2 to 1 km^2.



(a) 17 percent of the bird species will be lost.
(b) 20 percent of the bird species will be lost.
(c) All of bird species will be lost.
(d) 93 percent of the bird species will be lost.

3. Which of the following boxes show maximum, greater and minimum diversity ?

A

Animals	Species	Members
Bird	I	1
Bird	II	1
Bird	III	4

B

Animals	Species	Members
Bird	I	2
Bird	II	2
Mammal	III	2

C

Animals	Species	Members
Bird	I	2
Mammal	II	2
Insect	III	2

(a) A- Minimum diversity; B - Greater diversity; C - Maximum diversity
(b) A - Maximum diversity; B - Greater diversity; C - Minimum diversity
(c) A - Maximum diversity; B - Minimum diversity; C - Greater diversity
(d) A - Minimum diversity, B - Maximum diversity, C - Greater diversity.

Assertion/ Reason :

DIRECTIONS (Qs. 1-5): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion**: Nileperch is a large bredator fish, introduced in lake victoria of South Ofrica.

Reason: It begins to threaten the entire fresh water ecosystem by feeding on small herbivorous and detrivorous fish species of lake victoria.

2. **Assertion**: Amphibians is more vunerable to extinction.
Reason: Amphibians are highly sensitive to environmental changes which lead to extinction.
3. **Assertion**: Diversity observed in the entire geographical area caused gamma diversity.
Reason: Biodiversity decreases from high altitude to low altitude.
4. **Assertion**: Endemic plants and animals are those species which are restricted to particular area.
Reason: Endemic species are special as well as more vulnerable to extinction.
5. **Assertion**: Global warming is the major cause of extinction in future.
Reason: The greenhouse effect harmful gases are CO_2, CFCs, and other pollutants.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

Column-I	Column-II
A. Nile Perch in Lake Victoria	I. Obvious reasons for biodiversity conservation
B. Narrowly utilitarian	II. Habitat destruction
C. Main cause for biodiversity loss	III. High endemism
D. Hotspots	IV. Alien species

(a) A – II; B – I; C – IV; D – III
(b) A – IV; B – I; C – II; D – III
(c) A – I; B – III; C – II ; D – IV
(d) A – II; B – I; C – III; D – IV

2.

Column-I	Column-II
A. Term biodiversity	I. Edward Wilson
B. *In-situ* conservation	II. Co-extinction
C. Plant pollinator Mutualism	III. On-site conservation
D. *Ex-situ*	IV. Off-site conservation

(a) A – II; B – I; C – IV; D – III
(b) A – IV; B – I; C – II; D – III
(c) A – I; B – III; C – II ; D – IV
(d) A – II; B – I; C – III; D – IV

3.

Column-I	Column-II
A. Endemism	I. Khasi and Jaintia hills Meghalaya
B. Hotspot of India	II. Advanced *ex-situ* conservation
C. Sacred groove	III. Species found in particular area only
D. Cryopreservation	IV. Zoological park and Botanical garden
E. *Ex-situ* conservation	V. Western Ghats

(a) A – III; B – V; C – I; D – II; E – IV
(b) A – I; B – II; C – III; D – IV; E– V
(c) A – II; B – III; C – IV; D – V; E – I
(d) A – V; B – I; C – IV; D – II; E – III

4.

Column-I	Column-II
A. Narrowly utilitarian argument	I. Conserving biodiversity for major ecosystem services
B. Broadly utilitarian argument	II. Conserving biodiversity for the philosophically or spiritually need to realise that every species has intrinsic value and moral duty to pass our biological legacy in good order to future generation.
C. Ethical argument	III. Conserving biodiversity for direct economic benefits like food, medicine, industrial products etc.

(a) A – I; B – II; C – III
(b) A – III; B – I; C – II
(c) A – II; B – I; C – III
(d) A – I; B – III; C – II

5. | Column-I | Column-II |
|---|---|
| A. Over-exploitation by humans | I. Environmental damage and treat to native species |
| B. Introduction of Nile Perch in Lake Victoria | II. Decline in plant production |
| C. Less solar energy | III. Extinction of more than 2000 species of native birds |
| D. Introduction of *Water Hyacinth* in India | IV. Extinction of Cichlid fish |
| E. Colonization of tropical pacific Islands | V. Extinction of Passenger pigeon |

(a) A – II; B – V; C – IV; D – III; E – I
(b) A – V; B – IV; C – II; D – I; E – III
(c) A – I; B – II; C – III; D – IV; E – V
(d) A – IV; B – I; C – II; D – V; E – III

Critical Thinking Type Questions :

1. Following arrangement is correct from the point of view of decreasing biodiversity in angiosperms (N), fungi (F), pteridophytes (P) and algae (A).
(a) N > F > P > A (b) N > F > A > P
(c) F > N > P > A (d) F > N > A > P
2. India's share in global species diversity is around
(a) 8% (b) 14%
(c) 17% (d) 2.4%
3. If S is species richness, A is area, Z is slope of the line, and the C is Y-intercept, then the species richness will be shown as
(a) $S = C + A^Z$ (b) $S = C + AZ$
(c) $S = C. AZ$ (d) $S = C. A^Z$
4. In your opinion, which is the most effective way to conserve the plant diversity of an area?
(a) By developing seed bank
(b) By tissue culture method
(c) By creating botanical garden
(d) By creating biosphere reserve
5. Animal species should be preserved mainly because
(a) zoologists want to study them.
(b) they are lovely creatures.
(c) they are useful to mankind.
(d) man cannot recreate a species of animals after its destruction.
6. Management of biosphere for providing maximum benefit to the present generation and also maintaining its potential for future generations, is the theme of
(a) afforestation
(b) conservation
(c) deforestation
(d) population
7. All forms of life should be conserved because
(a) they maintain diverse genetic resources.
(b) they have economic values.
(c) they are important for maintaining balance of nature.
(d) they will be otherwise lost.
8. Which one of the following pairs of organisms are exotic species introduced in India?
(a) Nile perch, *Ficus religiosa*
(b) *Ficus religiosa, Lantana camara*
(c) *Lantana camara*, Water hyacinth
(d) Water hyacinth, *Prosopis cinereria*
9. The table below give the populations (in thousands) of ten species (A = J) in four areas (I – IV) consisting of the number of habitats given within brackets against each area. Study the table and answer the questions.

Area and Number of Habitats	Species and their population (in thousands) in the area									
	A	B	C	D	E	F	G	H	I	J
I. (11)	2.3	1.2	0.52	6	–	3	1.1	9	–	10.3
II. (11)	10.2	–	0.62	–	1.5	3	–	8.2	1.1	11
III. (13)	11.3	0.9	0.48	2.4	1.4	4.2	0.8	8.4	2.2	4.1
IV. (12)	3.2	10.2	11.1	4.8	0.4	3.3	0.8	7.3	11.3	2.1

Which area out of I to IV shows maximum species diversity?
(a) I (b) II
(c) III (d) IV

10. Two places in India show maximum biological diversity. One of them is the Western ghats, another is
(a) Eastern ghats (b) North – East India
(c) Coastal region (d) Foot hill of Himalaya

11. How many of the following can not be included in Wildlife – Human, Cultivated plants, Micro-organisms, Fossils and Domesticated animals.
(a) Two (b) Three
(c) Four (d) Five

12. The greatest threat to global biodiversity is
(a) natural disasters such as storms
(b) pollution
(c) overexploitation of natural resources
(d) alteration of habitats by humans

13. Why do migratory species present special preservation challenges?
(a) Because they are endemic, they are especially susceptible to habitat destruction.
(b) Their conservation may require international cooperation when they require habitats in different countries.
(c) They are often prone to population number decline during their long migratory journeys.
(d) They reside in biodiversity hotspots that are most susceptible to habitat degradation.

14. Biosphere reserves differ from national parks and wildlife sanctuaries because in the former
(a) human beings are not allowed to enter.
(b) people are an integral part of the system.
(c) plants are paid greater attention than the animals.
(d) living organisms are brought from all over the world and preserved.

15. Sacred groves are especially useful in
(a) preventing soil erosion.
(b) year-round flow of water in rivers.
(c) conserving rare and threatened species.
(d) generating environmental awareness.

38

ENVIRONMENTAL ISSUES

Fill in the Blanks :

1. To improve the quality of environment (air, water and soil) the Govt. of India passed the 'Environment (Protection) Act' in year _________ .
2. The diameter of particulate matter that causes greatest harm to human health is _________ .
3. FOAM (Friends of the Arcata Marsh) is a group of citizens responsible for the integrated process of _________ .
4. DDT causes egg shell thinning in birds because it inhibits _________ .
5. The waste water from Industries may contain toxic heavy metals having density of more than _________ .
6. Natural ageing of lake by biological enrichment of its water is called _________ .
7. Without Green house effect the average temperature of earth surface would have been _________ .
8. Presence of large amount of nutrients in water also cause excess growth of planktonic (free-floating) algae, called ___________.
9. Slash and burn agriculture, which is commonly known as Jhum cultivation in the north-eastern states of India, leads to _________ .
10. ___________ is a cyclical zero-waste procedure, where waste products from one process are cycled in as nutrients for other processes.

True/ False :

1. Lots of urea and phosphate fertilizer were used in the crops in the vicinity.
2. Phytoplankton populations in the lake declined intially thereby greatly reducing photosynthesis and also causes fish mortality.
3. Cultural eutrophication is an accelerated form of eutrophication.
4. In the presence of prime contaminants, such as nitrates and phosphates, the growth of algae is arrested.
5. The water from electricity generating units enhances the growth of indigenous fauna and flora.
6. Recycled human waste from this can be used as a natural fertilizer.
7. Troposphere, on top of stratosphere, is away from earth surface.
8. The major contribution in green house gases is of CH_4.
9. When organic waste enters into a water body its BOD increases.
10. Plants are efficient absorbers of noise of low frequency.

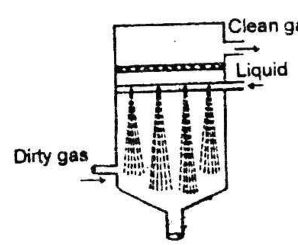
Conceptual MCQs :

1. Air pollution is mostly caused by
   (a) automobile exhausts
   (b) industrial effluents and sewage
   (c) detergents and pesticides
   (d) all of above
2. Greenhouse effect is related to
   (a) green trees in house
   (b) grasslands
   (c) global warming
   (d) greenary in country
3. When huge amount of sewage is dumped into a river the BOD will
   (a) decrease (b) increase
   (c) slightly decrease (d) slightly increase
4. Deforestation causes
   (a) soil erosion
   (b) loss of biodiversity
   (c) disturbance in hydrological cycle
   (d) all of the above

5. Eutrophication causes reduction in
(a) dissolved CO_2
(b) dissolved O_2
(c) dissolved nutrients
(d) none of the above
6. Among the following which one is likely to have highest concentration of DDT in the body ?
(a) Phytoplanktons
(b) Zooplanktons
(c) Fish
(d) Fish-eating bird
7. Thickness of ozone is more at the
(a) equator (b) poles
(c) mountains (d) sea
8. Which of the following is not a greenhouse gas?
(a) O_2 (b) CO_2
(c) N_2O (d) CH_4
9. Montreal Protocol was called to check emission of
(a) e-wastes (b) UV radiation
(c) CFCs (d) All of these
10. Increase in the concentration of pollutant at the higher tropic level is called :
(a) eutrophication
(b) biodegradation
(c) recycling
(d) biomagnification
11. Non-biodegradable waste is :
(a) DDT (b) leather
(c) wool (d) cotton
12. UV radiation from sun is absorbed by :
(a) H_2O (b) CH_4
(c) N_2O (d) O_3
13. Ozone hole refers to
(a) increased concentration of ozone
(b) reduction in thickness of ozone layer in the stratosphere
(c) reduction in the thickness of ozone layer in the atmosphere
(d) hole in the ozone layer.
14. Heating of environment is done by
(a) visible light (b) UV rays
(c) infrared waves (d) radiowaves
15. As a result of global warming, the sea level will
(a) increase (b) decrease
(c) remain the same (d) none of these
16. Global agreement in specific control strategies to reduce the release of ozone depleting substances, was adopted by
(a) The Montreal Protocol
(b) The Koyoto Protocol
(c) The Vienna Convention
(d) Rio de Janeiro Conference
17. Which of the following plant species you would select for the production of bioethanol ?
(a) *Zea mays* (b) *Pongamia*
(c) *Jatropha* (d) *Brassica*
18. Steps taken by the Government of India to control air pollution include
(a) compulsory PUC (Pollution Under Control) certification of petrol driven vehicles which tests for carbon monoxide and hydrocarbons.
(b) permission to use only pure diesel with a maximum of 500 ppm sulphur as fuel for vehicles.
(c) use of non-polluting Compressed Natural Gas (CNG) only as fuel by all buses and trucks.
(d) compulsory mixing of 20% ethyl alcohol with petrol and 20% biodiesel with diesel.
19. The bacterium *Bacillus thuringiensis* is widely used in contemporary biology as
(a) insecticide
(b) agent for production of dairy products
(c) source of industrial enzyme
(d) indicator of water pollution
20. The logistic population growth is expressed by the equation:
(a) $dt/dN = Nr\left(\frac{K-N}{K}\right)$
(b) $dN/dt = rN\left(\frac{K-N}{K}\right)$
(c) $dN/dt = rN$
(d) $dN/dt = rN\left(\frac{N-K}{K}\right)$

Diagram Based Questions :

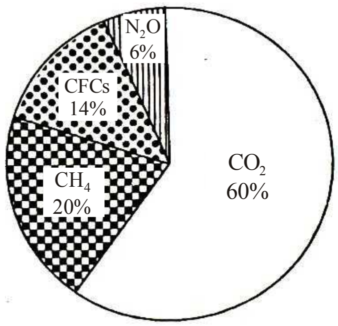
1. According to size of air pollutants, range and types of chemical the device given below is best used to control which of the following pollutants?



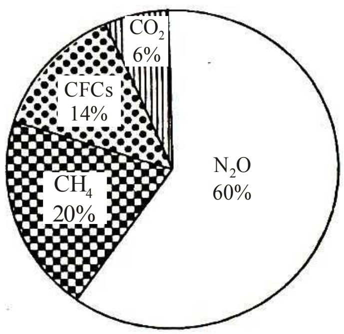
(a) Large particulates
(b) Charged particulate matter
(c) Dissolved gases
(d) Fine particles

2. Which of the following figures shows correct relative contribution of greenhouse gases to global warming?

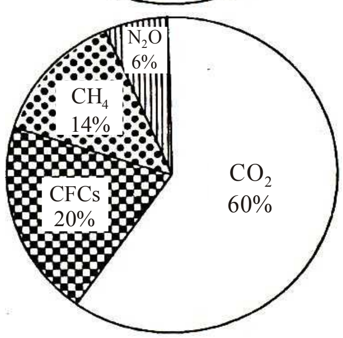
(a)



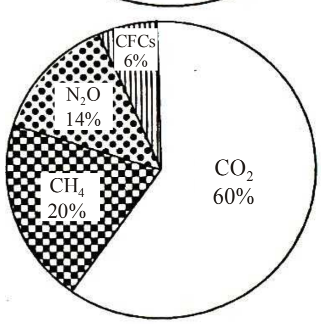
(b)



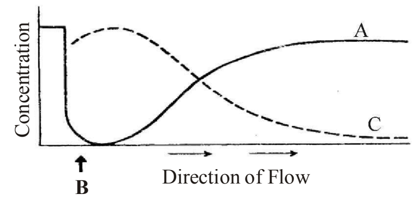
(c)



(d)

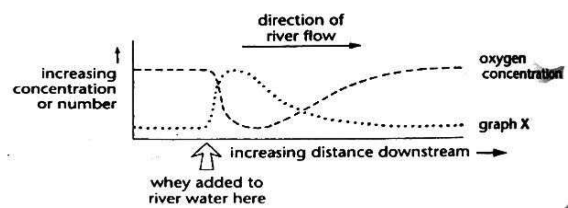


3. The given graph shows the effect of sewage discharge on some important characteristics of a river. few label are marked as A, B and C. Which of the following is correct for the label A, B and C ?



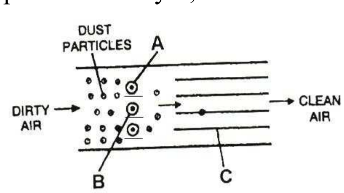
(a) (A) Dissolved oxygen, (B) Point of sewage discharge, (C) BOD
(b) (A) BOD, (B) Point of treated water discharge, (C) Dissolved oxygen
(c) (A) Dissolved oxygen, (B) Point of treated water discharge, (C) BOD
(d) (A) BOD, (B) Point of sewage discharge, (C) Dissolved oxygen

4. The diagram below shows the effect of polluting a river with untreated whey. What does graph X represent?



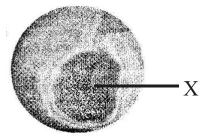
(a) Bacterial count.
(b) Number of fish.
(c) Mass of curds.
(d) Concentration of rennet.

5. The given diagram shows electrostatic precipitator. Identify A, B and C.



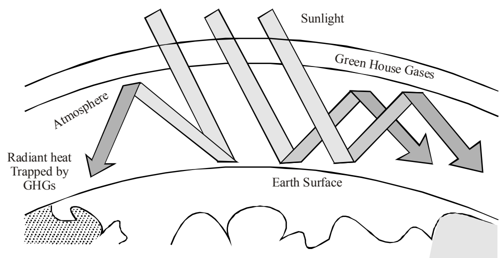
(a) A - Discharge corona, B - Negatively charged wire, C - Collection plate grounded
(b) A - Discharge corona, B - Positively charged wire, C - Collection plate grounded
(c) A - Discharge corona, B - Negatively charged wire, C - Collection plate burnt
(d) A - Uncharge corona, B - Positively charged wire, C - Collection plate never grounded

6. What does 'x' indicate in the given figure?



(a) Greenhouse effect
(b) El Nino Effect
(c) Ozone hole
(d) Marsh meadow stage

7. Which of the following phenomenon is represented by the given figure?



(a) Green house effect
(b) El Nino effect
(c) Ozone hole
(d) Eutrophication

Assertion/ Reason :

DIRECTIONS (Qs. 1-10): *These questions consist of two statements each, printed as assertion and reason. While answering these questions you are required to choose any one of the following five responses.*

(a) If both assertion and reason are true and the reason is a correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
(c) If the assertion is true but reason is false.
(d) If both the assertion and reason are false
(e) If the assertion is false but the reason is true.

1. **Assertion :** Inhabitants close to very busy airports are likely to experience health hazards.
Reason : Sound level of jet aeroplanes usually exceeds 160 dB.

2. **Assertion :** Organochlorine pesticides are organic compounds that have been chlorinated.
Reason : Fenitrothion is one of the organochlorine pesticides.

3. **Assertion :** Agricultural output increased several times after introduction of DDT.
Reason : DDT was the first insecticide used on a wide scale.

4. **Assertion :** Methane, component of green house gases, contributing to global warming is about 20 percent.
Reason : Introduction of multi-point fuel injection engines in automobiles has decreased methane content in the exhausts.

5. **Assertion :** A suspended particulate matter (SPM) is an important pollutant released by diesel vehicles.
Reason : Catalytic converters greatly reduce pollution caused by automobiles.

6. **Assertion :** Presently, the global atmosphere is warming up.
Reason : The depletion of stratospheric ozone layer has resulted in increase in ultraviolet radiations reaching the earth.

7. **Assertion :** Deforestation is one main factor contributing to global warming.
Reason : Besides CO_2, two other gases methane and CFCs are also included under green house gases.

8. **Assertion :** UV radiation causes photo-dissociation of ozone into O_2 and O, thus causing damage to the stratospheric ozone layer.
Reason : Ozone hole is resulting in global warming and climate change.

9. **Assertion :** The concentration of methane in the atmosphere has more than doubled in the last 250 years.
Reason : Wetlands and rice fields are the major sources of methane.

10. **Assertion (A)** : Pollution is always caused by human activities.
Reason (R) : Pollution is not different from contamination.

Matching Based Questions :

DIRECTIONS : *Each question has four statements (A, B, C and D) given in Column I and five statements (1, 2, 3, 4 and 5) in Column II. Any given statement in Column I can have correct matching with one statement given in Column II. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.*

1.

	Column-I		Column-II
A.	DDT	I.	CH_4, CO_2
B.	Platinum-palladium and Rhodium	II.	SO_2
C.	Acid rain	III.	Biological magnification
D.	Global warming	IV.	Catalytic converter

(a) A – IV; B – III; C – II; D – I
(b) A – I; B – III; C – II; D – IV
(c) A – II; B – III; C – IV; D – I
(d) A – III; B – IV; C – II; D – I

2.

	Column-I		Column-II
A.	Catalytic converter	I.	Particulate matter
B.	Electrostatic precipitator	II.	Carbon monoxide and nitrogen oxides
C.	Earmuffs	III.	High noise level
D.	Land fills	IV.	Solid wastes

(a) A – I; B – II; C – III; D – IV
(b) A – II; B – I; C – III; D – IV
(c) A – IV; B – III; C – II; D – I
(d) A – III; B – II; C – IV; D – I

3.

	Column-I		Column-II
A.	Environment (Protection) Act	I.	1987
B.	Air (Prevention and Control of Pollution) Act	II.	1986
C.	Water (Prevention and Control of Pollution) Act	III.	1980
D.	Concept of Joint Forest Management of Govt. of India	IV.	1974

(a) A – IV; B – III; C – II; D – I
(b) A – II; B – I; C – IV; D – III
(c) A – I; B – II; C – III; D – IV
(d) A – I; B – III; C – II; D – IV

4.

	Column-I (Organisms)		Column-II (Concentration of DDT)
A.	Zooplankton	I.	2 ppm
B.	Small fish	II.	0.04 ppm
C.	Large fish	III.	0.5 ppm
D.	Fish-eating birds	IV.	25 ppm

(a) A – II; B – III; C – I; D – IV
(b) A – III; B – II; C – I; D – IV
(c) A – II; B – III; C – IV; D – I
(d) A – II; B – I; C – III; D – IV

5.

	Column-I		Column-II
A.	Ahmed Khan	I.	Spreading information and help on the practice of integrated organic farming
B.	Ramesh Chandra Dagar	II.	Protecting wildlife
C.	Amrita Devi Bishnoi	III.	A plastic sack manufacturer of Bangalore developed polyblend

(a) A – III; B – I; C – I
(b) A – II; B – I; C – I
(c) A – I; B – II; C – II
(d) A – III; B – II; C – II

6.

	Column-I		Column-II
A.	UV	I.	Biomagnification
B.	Biodegradable organic matter	II.	Eutrophication
C.	DDT	III.	Snow blindness
D.	Phosphates	IV.	BOD

(a) A – II; B – I; C – IV; D – III
(b) A – III; B – II; C – IV; D – I
(c) A – III; B – IV; C – I; D – II
(d) A – III; B – I; C – IV; D – II

7.

	Column-I		Column-II
A.	Colloidal materials	I.	Typhoid, Jaundice, Cholera
B.	Water-borne diseases	II.	Irreparable computes and other electronic goods
C.	E-wastes	III.	Faecal matter bacteria, cloth and paper fibres
D.	Manure	IV.	Troposphere
E.	Bad 'Ozone'	V.	Cattle excreta (dung)

(a) A – I; B – III; C – II; D – V; E – IV
(b) A – III; B – I; C – V; D – II; E – IV
(c) A – III; B – I; C – II; D – V; E – IV
(d) A – III; B – I; C – V; D – IV; E – II

Critical Thinking Type Questions :

1. CNG is better than petrol/ diesel, since
(a) CNG burns more efficiently.
(b) CNG burns more completely.
(c) CNG cannot be adulterated.
(d) All of the above

2. In clean water, the concentration of
(a) BOD is low but DO is high.
(b) Both BOD and DO are high.
(c) BOD is high but DO is low.
(d) Both BOD and DO are low.

3. Fishes die by sewage because
(a) of its bad smell.
(b) it replaces food material of fishes.
(c) it increases oxygen competition among fishes.
(d) CO_2 is mixed in large amount in water.

4. A lake affected by high levels of artificial eutrophication will have
(a) high nutrient levels, large phytoplankton populations, and low oxygen levels at depth.
(b) high levels of nutrients, low phytoplankton levels, high oxygen levels in surface waters.
(c) low nutrient levels, large phytoplankton populations, and low oxygen levels at depth.
(d) low nutrient levels, low phytoplankton populations, and high oxygen levels at depth.

5. Two lakes, A and B are identical in all aspects except that lake A has higher temperature. Which of the following is true ?
(a) A has higher rate of oxygen dissolution.
(b) B has higher rate of oxygen dissolution.
(c) Oxygen dissolution of both is the same.
(d) Both the lakes have same BOD.

6. Today the concentration of green house gases is very high because of
(a) use of refrigerator.
(b) increased combustion of oils and coal.
(b) deforestation.
(d) all of the above

7. Which constituent of the atmosphere is likely to change if the forest cover is removed ?
(a) O_2 level is increased
(b) CO_2 level is increased
(c) O_2 level is significantly increased
(d) CO_2 level is significantly decreased

8. If the forest cover is reduced to half, what is most likely to happen on a long term basis?
(a) Tribals living in these areas will starve to death.
(b) Cattle in these and adjoining areas will die due to lack of fodder.
(c) Large areas will become deserts.
(d) Crop breeding programmes will suffer due to a reduced availability of variety of germplasm.

9. Which of these is not an advantage of CNG over diesel?
(a) Burns more efficiently.
(b) It is cheap.
(c) Cannot be siphoned off by thieves.
(d) Easy to lay down pipelines for delivery.

10. Motor vehicles equipped with catalytic converter are advised to use unleaded petrol because
(a) lead causes inactivation of catalyst.
(b) lead reduces the emission of poisonous gases.
(c) lead is a heavy metal.
(d) lead decreases the efficiency of vehicle.

11. Which of the following steps is not taken for reducing vehicular pollution?
(a) Use of unleaded petrol.
(b) Use of high-sulphur petrol and diesel.
(c) Use of catalytic converters in vehicles.
(d) Application of stringent pollution-level norms for vehicles.

12. Biomagnification refers to increase in concentration of the toxicant at successive trophic levels. This happens because
(a) a toxic substance accumulated by an organism can not be metabolized.
(b) a toxic substance accumulated by an organism can not be excreted.
(c) a toxic substance is passed on to the next trophic level.
(d) all of the above

13. Which of the following statements is/are correct about 'Eco San' toilets?
(a) It is a sustainable system for handling human excreta or faecal matter by using dry 'composting toilets'.
(b) These are very useful for the rural areas where sewer systems are not possible.
(c) These toilets are hygienic, efficient, practical & most effective for the disposal of human waste.
(d) All of the above

14. Which one of the following statement pertaining to pollutants is correct?
(a) DDT is a non-biodegradable pollutant.
(b) Excess fluoride in drinking water causes osteoporosis, hardening of bones, stiff joints.
(c) Excess cadmium in drinking water causes black foot disease.
(d) Methylmercury in water may cause "Itai Itai" disease.

15. The effect of todays radioactive fall out will be harmful to children of future generation because
(a) infants are more susceptible to radiations.
(b) susceptibility to radiation increase with age.
(c) mutated genes are frequently recessive.
(d) contamination of milk supply is not cumulative.

Solutions

Free e-Book
Note: Detailed explanations to some of the selective problems are given separately in the form of e-book. To access this e-book for free refer to the Second Page of the book

Chapter 1 : The Living World

Fill in the Blanks : 1. One **2.** Yoked key **3.** division **4.** subspecies **5.** Kew, England **6.** order **7.** English and French **8.** Adolf Meyer **9.** 9 **10.** Family **11.** genus **12.** classification

True/ False **: 1.** True **2.** True **3.** True **4.** False **5.** True **6.** False **7.** True **8.** True

Conceptual MCQs : 1. (a) **2.** (c) **3.** (c) **4.** (d) **5.** (d) **6.** (b) **7.** (d) **8.** (d) **9.** (a) **10.** (c) **11.** (c) **12.** (b) **13.** (a) **14.** (c) **15.** (a) **16.** (a) **17.** (b) **18.** (d) **19.** (a) **20.** (b)

Assertion/ Reason : 1. (*) 2. (*) 3. (*) 4. (*) 5. (*) 6. (*) 7. (*) 8. (a) **9.** (b) **10.** (c) **11.** (b) **12.** (b) **13.** (a) **14.** (b) **15.** (b) **16.** (a) **17.** (a) **18.** (b) **19.** (b)

Matching Based Question : 1. (b) **2.** (a) **3.** (c) **4.** (b) **5.** (b) **6.** (c) **7.** (c) **8.** (c)

Critical Thinking Type Questions : 1. (d) **2.** (b) **3.** (c) **4.** (a) **5.** (c) **6.** (d) **7.** (b) **8.** (c) **9.** (a) **10.** (a)

Chapter 2 : Biological Classification

Fill in the Blanks : 1. 2. Neurospora **3.** Capsomers **4.** RNA or DNA **5.** basidiomycetes **6.** chymosynthetic autotrophic bacteria **7.** Bacteriphage **8.** Capsid **9.** Single stranded RNA **10.** Provirus

True/ False **: 1.** True **2.** True **3.** True **4.** True **5.** False **6.** True **7.** False

Conceptual MCQs : 1. (c) **2.** (c) **3.** (b) **4.** (c) **5.** (b) **6.** (d) **7.** (b) **8.** (d) **9.** (a) **10.** (a) **11.** (b) **12.** (d) **13.** (c) **14.** (a) **15.** (d) **16.** (b) **17.** (a) **18.** (d) **19.** (b) **20.** (d)

Diagram Based Question : 1. (b) **2.** (a) **3.** (a) **4.** (c) **5.** (b) **6.** (a)

Assertion/ Reason : 1. (a) **2.** (e) **3.** (c) **4.** (b) **5.** (b) **6.** (c) **7.** (a) **8.** (b) **9.** (a) **10.** (d) **11.** (a) **12.** (a)

Matching Based Question : 1. (d) **2.** (d) **3.** (a) **4.** (a) **5.** (a) **6.** (d) **7.** (a) **8.** (d) **9.** (c) **10.** (c)

Critical Thinking Type Questions : 1. (a) **2.** (b) **3.** (c) **4.** (c) **5.** (b) **6.** (d) **7.** (d) **8.** (d) **9.** (d) **10.** (c)

Chapter 3 : Plant Kingdom

Fill in the Blanks : 1. Bentham and Hooker **2.** cytotaxonomy **3.** anisogamous **4.** Cones **5.** antheridia, archegonia **6. 7.** moss

True/ False **: 1.** False **2.** False **3.** False **4.** False **5.** True **6.** False **7.** True **8.** True

Conceptual MCQs : 1. (a) **2.** (b) **3.** (b) **4.** (a) **5.** (a) **6.** (c) **7.** (b) **8.** (a) **9.** (a) **10.** (b) **11.** (c) **12.** (b) **13.** (d) **14.** (b) **15.** (b) **16.** (d) **17.** (d) **18.** (d) **18.** (b) **20.** (a)

Diagram Based Question : 1. (a) **2.** (a) **3.** (b) **4.** (d) **5.** (b) **6.** (a)

Assertion/ Reason : 1. (e) **2.** (a) **3.** (a) **4.** (a) **5.** (c) **6.** (c) **7.** (a) **8.** (a) **9.** (b)

Matching Based Question: 1. (b) **2.** (a) **3.** (b) **4.** (a) **5.** (a) **6.** (b) **7.** (a) **8.** (b) **9.** (b)

Critical Thinking Type questions Questions : 1. (b) **2.** (b) **3.** (c) **4.** (d) **5.** (c) **6.** (b) **7.** (d) **8.** (b) **9.** (a) **10.** (d) **11.** (b) **12.** (b) **13.** (d)

Chapter 4 : The Living World

Fill in the Blanks : 1. radially symmetrical **2.** bilateral **3.** eight **4.** parapodia **5.** mollusca **6.** radially symmetrical, bilaterally symmetrical **7.** three **8.** Choanocytes

True/ False **: 1.** False **2.** False **3.** False **4.** False **5.** False **6.** True **7.** True **8.** True **9.** True

Conceptual MCQs : 1. (c) **2.** (a) **3.** (a) **4.** (c) **5.** (b) **6.** (b) **7.** (b) **8.** (c) **9.** (a) **10.** (a) **11.**(c) **12.** (b) **13.** (a) **14.** (d) **15.** (c) **16.** (d) **17.** (b) **18.** (d) **19.** (d) **20.** (a)

Diagram Based Question : 1. (a) **2.** (a) **3.** (b) **4.** (a) **5.** (b) **6.** (d) **7.** (b) **8.** (a) **9.** (c) **10.** (a)

Assertion/ Reason : 1. (a) **2.** (b) **3.** (a) **4.** (b) **5.** (b) **6.** (b) **7.** (c) **8.** (c) **9.** (a) **10.** (a)

Matching Based Question : 1. (b) **2.** (d) **3.** (d) **4.** (c) **5.** (c) **6.** (b) **7.** (a)

Critical Thinking Type questions Questions : 1. (b) **2.** (a) **3.** (a) **4.** (d) **5.** (c) **6.** (c) **7.** (b) **8.** (a)

Chapter 5 : The Living World

Fill in the Blanks: 1. sugarcane **2.** nodes, internodes and nodes **3.** Pistia and Eichhornia **4.** reticulate, parallel **5.** light **6.** angiosperms and sexual **7.** bisexual **8.** hilum **9.** anther

True/ False **: 1.** True **2.** True **3.** True **4.** True **5.** True **6.** True **7.** False **8.** True **9.** False

Conceptual MCQs : 1. (c) **2.** (a) **3.** (d) **4.** (a) **5.** (d) **6.** (a) **7.** (a) **8.** (d) **9.** (a) **10.** (a) **11.** (a) **12.** (a) **12.** (a) **14.** (d) **15.** (d) **16.** (d) **17.** (a) **18.** (c) **19.** (d) **20.** (a)

Diagram Based Question : 1. (d) **2.** (a) **3.** (a) **4.** (a) **5.** (a) **6.** (d) **7.** (a) **8.** (c)

Assertion/ Reason : 1. (a) **2.** (c) **3.** (c) **4.** (b) **5.** (a) **6.** (b) **7.** (b) **8.** (c) **9.** (a)

Matching Based Question : 1. (b) **2.** (c) **3.** (d) **4.** (a) **5.** (d) **6.** (c) **7.** (c) **8.** (d) **9.** (b)

Critical Thinking Type questions Questions : 1. (c) **2.** (c) **3.** (a) **4.** (c) **5.** (b) **6.** (c) **7.** (d) **8.** (c) **9.** (c) **10.** (c) **11.** (a) **12.** (b) **13.** (a) **14.** (d)

Chapter 6 : Anatomy of Flowering Plants

Fill in the Blanks : 1. parenchyma **2.** dead, without **3.** collenchyma **4.** roots, stems, leaves **5.** lateral meristems**. 6.** cork cambium and cork, **7.** sclerenchymatous **8.** sieve tubes **9.** exarch

True/ False : 1. True **2.** True **3.** True **4.** False **5.** False **6.** False **7.** False **8.** True

Conceptual MCQs : 1. (c) **2.** (d) **3.** (a) **4.** (b) **5.** (d) **6.** (a) **7.** (c) **8.** (c) **9.** (d) **10.** (d) **11.** (b) **12.** (b) **13.** (c) **14.** (c) **15.** (c) **16.** (b) **17.** (b) **18.** (d) **19.** (d) **20.** (b)

Diagram Based Question : 1. (c) **2.** (a) **3.** (a) **4.** (a) **5.** (c) **6.** (d) **7.** (a)

Assertion/ Reason : 1. (e) 2. (b) **3.** (a) **4.** (d) **5. (e) 6.** (b) **7.** (d) **8.** (a) **9.** (a)

Matching Based Question : 1. (d) **2.** (d) **3.** (b) **4.** (a) **5.** (d) **6.** (c) **7.** (a) **8.** (b) **9.** (a)

Critical Thinking Type questions Questions : 1. (a) **2.** (a) **3.** (b) **4.** (b) **5.** (c) **6.** (d) **7.** (b) **8.** (d) **9.** (c) **10.** (c)

Chapter 7 : Structural Organisation in Animals

Fill in the Blanks : 1. squamous epithelium **2.** fibroblasts **3.** cartilage cells **4.** cartilage **5.** insecta; arthropoda **6.** cardiac muscles

True/ False : 1. False **2.** False **3.** True **4.** True **5.** True **6.** True **7.** True **8.** True

Conceptual MCQs : 1. (c) **2.** (d) **3.** (c) **4.** (a) **5.** (c) **6.** (b) **7.** (c) **10.** (a) **13.** (d) **14.** (b) **15.** (b) **16.** (a) **17.** (c) **18.** (b) **19.** (c) **20.** (a)

Diagram Based Question : 1. (a) **2.** (d) **3.** (a) **4.** (a) **5.** (c) **6.** (b) **7.** (b)

Assertion/ Reason : 1. (e) 2. (a) **3.** (d) **4.** (c) **5.** (a) **6.** (b) **7.** (a) **8.** (c) **9.** (c)

Matching Based Question : 1. (c) **2.** (b) **3.** (c) **4.** (a) **5.** (b) **6.** (a)

Critical Thinking Type questions Questions : 1. (d) **2.** (c) **3.** (c) **4.** (b) **5.** (c) **6.** (b) **7.** (c) **8.** (c) **9.** (b) **10.** (b)

Chapter 8 : Cell : The Unit of Life

Fill in the Blanks : 1. nuclear membrane **2.** ribosomes **3.** mesosome **4.** Golgi apparatus **5.** Elaioplasts **6.** ribosome **7.** 52, 40 **8.** phosphoglyceride

True/ False : 1. True **2.** True **3.** True **4.** True **5.** False **6.** True **7.** True **8.** True **9.** True **10.** True **11.** False

Conceptual MCQs :

1. (d) **2.** (b) **3.** (a) **4.** (c) **5.** (a) **6.** (b) **7.** (b) **8.** (a) **9.** (a) **10.** (b) **11.** (c) **12.** (a) **13.** (b) **14.** (b) **15.** (b) **16.** (b) **17.** (a) **18.** (a) **19.** (b) **20.** (d) **21.** (b)

Diagram Based Question : 1. (a) **2.** (a) **3.** (b) **4.** (a) **5.** (a) **6.** (a) **7.** (b)

Assertion/ Reason : 1. (b) **2.** (c) **3.** (b) **4.** (a) **5.** (a) **6.** (a) **7.** (a) **8.** (c) **9.** (a) **10.** (a) **11.** (d)

Matching Based Question : 1. (a) **2.** (a) **3.** (a) **4.** (a) **5.** (b) **6.** (c) **7.** (a) **8.** (a) **9.** (b)

Critical Thinking Type questions Questions : 1. (c) **2.** (c) **3.** (d) **4.** (a) **5.** (c) **6.** (a) **7.** (d) **8.** (c) **9.** (c) **10.** (c)

Chapter 9 : Biomolecules

Fill in the Blanks : 1. glycine **2.** zwitterion **3.** peptide bonds **4.** nucleotide **5.** haemoglobin **6.** ester bond **7.** ½ Vmax **8.** high, high

True/ False : 1. True **2.** True **3.** False **4.** False **5.** False **6.** True **7.** False **8.** True **9.** True

Conceptual MCQs : 1. (b) **2.** (c) **3.** (a) **4.** (d) **5.** (a) **6.** (c) **7.** (b) **8.** (b) **9.** (d) **10.** (a) **11.** (c) **12.** (c) **13.** (d) **14.** (a) **15.** (c) **16.** (a) **17.** (b) **18.** (a) **19.** (d) **20.** (d)

Diagram Based Question : 1. (c) **2.** (c) **3.** (c) **4.** (c) **5.** (c) **6.** (a) **7.** (b)

Assertion/ Reason : 1. (c) **2.** (a) **3.** (b) **4.** (b) **5.** (a) **6.** (d) **7.** (c) **8.** (c)

Matching Based Question : 1. (b) **2.** (a) **3.** (a) **4.** (b) **5.** (a) **6.** (b) **7.** (c)

Critical Thinking Type questions Questions : 1. (d) **2.** (a) **3.** (d) **4.** (a) **5.** (b) **6.** (c) **7.** (c) **8.** (a) **9.** (a) **10.** (c) **11.** (d) **12.** (a) **13.** (b) **14.** (b) **15.** (b) **16.** (d)

Chapter 10 : Cell Cycle and Cell Division

Fill in the Blanks : 1. prophase **2.** telophase **3.** zygotene **4.** pachytene **5.** diplotene **6.** diakinesis **7.** Kinetochore

True/ False : 1. False **2.** False **3.** True **4.** True **5.** True **6.** True **7.** True

Conceptual MCQs : 1. (c) **2.** (b) **3.** (d) **4.** (b) **5.** (c) **6.** (d) **7.** (a) **8.** (d) **9.** (b) **10.** (a) **11.** (b) **12.** (a) **13.** (a) **14.** (d) **15.** (d) **16.** (c) **17.** (c) **18.** (b) **19.** (b) **20.** (b)

Diagram Based Question 1. (b) **2.** (c) **3.** (a) **4.** (d) **5.** (a) **6.** (c) **7.** (d)

Assertion/ Reason : 1. (c) **2.** (a) **3.** (c) **4.** (b) **5.** (a) **6.** (c) **7.** (a) **8.** (a) **9.** (b) **10.** (d) **11.** (d)

Matching Based Question : 1. (c) **2.** (a) **3.** (a)

Critical Thinking Type questions Questions : 1. (b) **2.** (a) **3.** (d) **4.** (d) **5.** (a) **6.** (a) **7.** (a) **8.** (b) **9.** (d) **10.** (c) **11.** (c) **12.** (b) **13.** (c) **14.** (b) **15.** (a) **16.** (c) **17.** (a) **18.** (c)

Chapter 11 : Transport in Plants

Fill in the Blanks : 1. Imbibition **2.** symplast **3.** active absorption **4.** source, sink **5.** phloem **6.** phloem sap, translocated **7.** pressure flow hypothesis **8.** hypertonic **9.** Osmosis

True/ False : 1. True **2.** True **3.** True **4.** True **5.** True **6.** False **7.** False **8.** True

Conceptual MCQs : 1. (d) **2.** (d) **3.** (d) **4.** (b) **5.** (b) **6.** (b) **7.** (d) **8.** (d) **9.** (d) **10.** (b) **11.** (a) **12.** (b) **13.** (c) **14.** (a) **15.** (d) **16.** (c) **17.** (d) **18.** (b) **19.** (d) **20.** (d)

Diagram Based Question : 1. (a) **2.** (c) **3.** (c) **4.** (c) **5.** (b) **6.** (d)

Assertion/ Reason : 1. (a) **2.** (c) **3.** (b) **4.** (a) **5.** (c) **6.** (a) **7.** (a) **8.** (a) **9.** (a) **10.** (c)

Matching Based Question : 1. (b) **2.** (c) **3.** (c) **4.** (c) **5.** (b)

Critical Thinking Type questions Questions : 1. (c) **2.** (b) **3.** (c) **4.** (a) **5.** (a) **6.** (a) **7.** (d) **8.** (b) **9.** (c)

Chapter 12 : Mineral Nutrition

Fill in the Blanks : 1. macronutrients, micronutrients **2.** Magnesium **3.** leghaemoglobin **4.** nitrogenase, N_2-fixers **5.** passive absorption **6.** *Pseudomonas* **7.** 10% **8.** enzyme

True/ False : 1. False **2.** True **3.** True **4.** True **5.** False **6.** True

Conceptual MCQs : 1. (a) **2.** (a) **3.** (d) **4.** (d) **5.** (b) **6.** (c) **7.** (b) **8.** (b) **9.** (a) **10.** (b) **11.** (a) **12.** (c) **13.** (a) **14.** (b) **15.** (a) **16.** (c) **17.** (a) **18.** (a) **19.** (c) **20.** (a)

Diagram Based Question : 1. (a) **2.** (c) **3.** (b) **4.** (b)

Assertion/ Reason : 1. (b) **2.** (c) **3.** (b) **4.** (a) **5.** (c) **6.** (a) **7.** (b)

Matching Based Question : 1. (b) **2.** (a) **3.** (c) **4.** (a) **5.** (d)

Critical Thinking Type questions Questions : 1. (d) **2.** (a) **3.** (d) **4.** (b) **5.** (c) **6.** (a) **7.** (a) **8.** (c) **9.** (b) **10.** (a) **11.** (a) **12.** (a) **13.** (a)

Chapter 13 : Photosynthesis

Fill in the Blanks : 1. purple & Green sulphur bacteria **2.** P_{700}, P_{680} **3.** Z-Scheme **4.** Phosphoenol pyruvate **5.** light exposure **6.** PEPcase **7.** mesophyll **8.** Photorespiration **9.** Blackman

True/ False : 1. True **2.** False **3.** True **4.** True **5.** True **6.** True **7.** True **8.** False

Conceptual MCQs : 1. (d) **2.** (d) **3.** (a) **4.** (b) **5.** (d) **6.** (d) **7.** (d) **8.** (d) **9.** (d) **10.** (b) **11.** (b) **12.** (b) **13.** (a) **14.** (a) **15.** (d) **16.** (c) **17.** (d) **18.** (b) **19.** (c) **20.** (b)

Diagram Based Question : 1. (d) **2.** (a) **3.** (a) **4.** (a) **5.** (d) **6.** (d) **7.** (a) **8.** (a)

Assertion/ Reason : 1. (b) **2.** (b) **3.** (b) **4.** (b) **5.** (c) **6.** (a) **7.** (a) **8.** (a) **9.** (c) **10.** (b) **11.** (c) **12.** (d)

Matching Based Question : 1. (a) **2.** (b) **3.** (d) **4.** (a) **5.** (a)

Critical Thinking Type Questions : 1. (d) **2.** (a) **3.** (d) **4.** (d) **5.** (d) **6.** (a) **7.** (a) **8.** (c) **9.** (d) **10.** (b) **11.** (d) **12.** (d)

Chapter 14 : Respiration in Plants

Fill in the Blanks : 1. ATP **2.** cytosol; pyruvate; mitochondrion **3.** Pyruvic acid **4.** two **5.** oxaloacetic acid **6.** 0 **7.** Oxygen **8.** Cyt. a_3

True/ False : 1. True **2.** False **3.** True **4.** True **5.** True **6.** True **7.** True **8.** False

Conceptual MCQs : 1. (b) **2.** (b) **3.** (b) **4.** (b) **5.** (b) **6.** (d) **7.** (c) **8.** (b) **9.** (c) **10.** (c) **11.** (d) **12.** (a) **13.** (c) **14.** (c) **15.** (c) **16.** (b) **17.** (b) **18.** (c) C C **19.** (c) **20.** (a) **21.** (b)

Diagram Based Question : 1. (a) **2.** (a) **3.** (c) **4.** (b) **5.** (b) **6.** (d) **7.** (c)

Assertion/ Reason : 1. (a) **2.** (b) **3.** (a) **4.** (b) **5.** (b) **6.** (c) **7.** (a) **8.** (b) **9.** (c) **10.** (d)

Matching Based Question : 1. (d) **2.** (c) **3.** (b) **4.** (d)

Critical Thinking Type Questions : 1. (c) **2.** (d) **3.** (a) **4.** (b) **5.** (a) **6.** (a) **7.** (c) **8.** (b) **9.** (a) **10.** (c) **11.** (c) **12.** (a) **13.** (a) **14.** (b) **15.** (a)

Chapter 15 : Plant Growth and Development

Fill in the Blanks : 1. scarification **2.** linear **3.** plasticity **4.** indole-3-acetic acid **5.** *Gibberella fujikuroi* **6.** gibberellic acid **7.** GA **8.** phototropism **9.** vernalization

True/ False : 1. True **2.** False **3.** True **4.** False **5.** True **6.** True **7.** True **8.** False

Conceptual MCQs : 1. (c) **2.** (a) **3.** (d) **4.** (b) **5.** (b) **6.** (a) **7.** (b) **8.** (d) **9.** (d) **10.** (d) **11.** (b) **12.** (c) **13.** (a) **14.** (d) **15.** (c) **16.** (b) **17.** (c) **18.** (c) **18.** (b) **20.** (c)

Diagram Based Question : 1. (b) **2.** (b) **3.** (b) **4.** (c) **5.** (c) **6.** (a) **7.** (d)

Assertion/ Reason : 1. (b) **2.** (b) **3.** (c) **4.** (a) **5.** (c) **6.** (c) **7.** (d) **8.** (b) **9.** (c) **10.** (c) **11.** (c) **12.** (b)

Matching Based Question : 1. (d) **2.** (a) **3.** (c) **4.** (a) **5.** (c) **6.** (c)

Critical Thinking Type Questions : 1. (d) **2.** (b) **3.** (a) **4.** (a) **5.** (b) **6.** (c) **7.** (b) **8.** (a) **9.** (d) **10.** (b) **11.** (b) **12.** (b) **13.** (a) **14.** (b) **15.** (a)

Chapter 16 : Digestion and Absorption

Fill in the Blanks : 1. active transport **2.** pancreas **3.** Minerals **4.** 3 pairs **5.** premolars **6.** rennin **7.** peristalsis **8.** stomach; hindgut **9.** small intestine **10.** amino acid **11.** 6.5

True/ False : 1. True **2.** False **3.** True **4.** True **5.** False **6.** True **7.** True **8.** True **9.** False

Conceptual MCQs : 1. (a) **2.** (c) **3.** (c) **4.** (d) **5.** (d) **6.** (a) **7.** (c) **8.** (b) **9.** (b) **10.** (c) **11.** (a) **12.** (c) **13.** (b) **14.** (c) **15.** (c) **16.** (d) **17.** (b) **18.** (c) **19.** (d) **20.** (a)

Diagram Based Question : 1. (d) **2.** (a) **3.** (b) **4.** (d) **5.** (a) **6.** (c) **7.** (d) **8.** (d)

Assertion/ Reason : 1. (c) **2.** (b) **3.** (a) **4.** (a) **5.** (c)

Matching Based Question : 1. (b) **2.** (a) **3.** (c) **4.** (d) **5.** (a) **6.** (a) **7.** (a)

Critical Thinking Type Questions : 1. (a) **2.** (c) **3.** (a) **4.** (b) **5.** (b) **6.** (d) **7.** (b) **8.** (a) **9.** (b) **10.** (a) **11.** (b)

Chapter 17 : Breathing and Exchange of Gases

Fill in the Blanks : 1. epiglottis **2.** erythrocytes **3.** 5800 ml **4.** spirometer **5.** alveoli **6.** an increase, a drop **7.** medulla oblongata **8.** 4 **9.** 158, 40 **10.** partial pressure of O_2

True/ False : 1. True **2.** False **3.** False **4.** True **5.** False **6.** False **7.** True **8.** False **9.** False **10.** True

Conceptual MCQs : 1. (c) **2.** (b) **3.** (a) **4.** (a) **5.** (d) **6.** (d) **7.** (a) **8.** (d) **9.** (b) **10.** (d) **11.** (b) **12.** (a) **13.** (a) **14.** (a) **15.** (c) **16.** (d) **17.** (a) **18.** (a) **19.** (c) **20.** (b)

Diagram Based Question : 1. (d) **2.** (a) **3.** (b) **4.** (a) **5.** (a) **6.** (d) **7.** (a) **8.** (b) **9.** (d)

Assertion/ Reason : 1. (c) **2.** (a) **3.** (b) **4.** (a) **5.** (c) **6.** (b) **7.** (a) **8.** (a) **9.** (a) **10.** (a) **11.** (a) **12.** (b)

Matching Based Question : 1. (c) **2.** (d) **3.** (d) **4.** (b) **5.** (b)

Critical Thinking Type questions Questions : 1. (c) **2.** (a) **3.** (d) **4.** (b) **5.** (c) **6.** (d) **7.** (b) **8.** (b) **9.** (b) **10.** (c) **11.** (b) **12.** (b)

Chapter 18 : Body Fluids and Circulation

Fill in the Blanks : 1. atherosclerosis **2.** atherosclerosis **3.** left auricle **4.** SA node **5.** SA node **6.** pulmonary aorta **7.** closed, single **8.** lungs **9.** Calcium

True/ False : 1. True **2.** False **3.** True **4.** False **5.** False **6.** False **7.** True **8.** False **9.** False

Conceptual MCQs : 1. (b) **2.** (c) **3.** (b) **4.** (d) **5.** (a) **6.** (b) **7.** (a) **8.** (c) **9.** (c) **10.** (c) **11.** (b) **12.** (b) **13.** (c) **14.** (b) **15.** (d) **16.** (b) **17.** (d) **18.** (b) **19.** (d) **20.** (a)

Diagram Based Question : 1. (c) **2.** (c) **3.** (d) **4.** (c) **5.** (b)

Assertion/ Reason : 1. (a) **2.** (a) **3.** (a) **4.** (b) **5.** (a) **6.** (b) **7.** (d) **8.** (b) **9.** (c) **10.** (b) **11.** (d)

Matching Based Question : 1. (a) **2.** (a) **3.** (b) **4.** (b) **5.** (a) **6.** (c) **7.** (a)

Critical Thinking Type questions Questions : 1. (a) **2.** (a) **3.** (c) **4.** (c) **5.** (a) **6.** (b) **7.** (a) **8.** (c) **9.** (a) **10.** (d)

Chapter 19 : Excretory Products and Elimination

Fill in the Blanks : 1. Calyces **2.** Malpighian Corpuscle **3.** Uricotelic animals **4.** Sodium **5.** Tadpole **6.** albumin **7.** ascending limb of Henle's loop **8.** vasopressin **9.** vasopressin **10.** equal **11.** peritubular capillaries

True/ False : 1. False **2.** True **3.** False **4.** False **5.** True **6.** True **7.** False **8.** False

Conceptual MCQs : 1. (a) **2.** (b) **3.** (d) **4.** (a) **5.** (b) **6.** (d) **7.** (d) **8.** (d) **9.** (a) **10.** (d) **11.** (c) **12.** (b) **13.** (c) **14.** (a) **15.** (a) **16.** (c) **17.** (c) **18.** (c) **19.** (b) **20.** (c)

Diagram Based Question : 1. (b) **2.** (b) **3.** (a) **4.** (b) **5.** (a) **6.** (c) **7.** (d)

Assertion/ Reason : 1. (b) **2.** (c) **3.** (a) **4.** (a) **5.** (c) **6.** (a) **7.** (a) **8.** (a) **9.** (a) **10.** (b) **11.** (d)

Matching Based Question : 1. (a) **2.** (a) **3.** (d) **4.** (b) **5.** (a) **6.** (a)

Critical Thinking Type Questions : 1. (d) **2.** (c) **3.** (b) **4.** (a) **5.** (d) **6.** (a) **7.** (a) **8.** (b) **9.** (a) **10.** (a)

Chapter 20 : Locomotion and Movement

Fill in the Blanks : 1. Pectoral girdle **2.** Pivot joint **3.** Mandible **4.** Two pairs **5.** acetabulum **6.** mitochondria **7.** pelvic girdle **8.** neuromuscular function

True/ False : 1. True **2.** False **3.** True **4.** False **5.** False **6.** True **7.** True **8.** False **9.** True

Conceptual MCQs : 1. (d) **2.** (b) **3.** (d) **4.** (d) **5.** (c) **6.** (d) **7.** (b) **8.** (b) **9.** (d) **10.** (d) **11.** (b) **12.** (c) **13.** (b) **14.** (c) **15.** (d) **16.** (c) **17.** (d) **18.** (c) **19.** (a) **20.** (d)

Diagram Based Question : 1. (c) **2.** (b) **3.** (d) **4.** (d) **5.** (b) **6.** (a) **7.** (a)

Assertion/ Reason : 1. (b) **2.** (b) **3.** (c) **4.** (c) **5.** (b) **6.** (c) **7.** (c) **8.** (c) **9.** (a)

Matching Based Question : 1. (b) **2.** (a) **3.** (b) **4.** (a) **5.** (b) **6.** (d) **7.** (a)

Critical Thinking Type Questions : 1. (d) **2.** (a) **3.** (d) **4.** (c) **5.** (d) **6.** (d) **7.** (d) **8.** (b) **9.** (c) **10.** (c)

Chapter 21 : Neural Control and Co-ordination

Fill in the Blanks : 1. medulla oblangata **2.** fovea **3.** Scala vestibuli **4.** tectorial membrane **5.** blind spot **6.** iris **7.** afferent **8.** hypothalamus **9.** nuclei

True/ False : 1. False **2.** False **3.** False **4.** True **5.** True **6.** True **7.** False **8.** True **9.** False

Conceptual MCQs : 1. (b) **2.** (c) **3.** (b) **4.** (c) **5.** (a) **6.** (b) **7.** (c) **8.** (c) **9.** (c) **10.** (b) **11.** (b) **12.** (a) **13.** (a) **14.** (c) **15.** (c) **16.** (c) **17.** (c) **18.** (b) **19.** (c) **20.** (c)

Diagram Based Question : 1. (a) **2.** (b) **3.** (a) **4.** (a) **5.** (b) **6.** (c) **7.** (a)

Assertion/ Reason : 1. (a) **2.** (a) **3.** (b) **4.** (b) **5.** (c) **6.** (c) **7.** (b) **8.** (a) **9.** (c) **10.** (c)

Matching Based Question : 1. (a) **2.** (a) **3.** (b) **4.** (b) **5.** (c) **6.** (d) **7.** (a)

Critical Thinking Type Questions : 1. (a) **2.** (a) **3.** (c) **4.** (d) **5.** (b) **6.** (d) **7.** (c) **8.** (d) **9.** (b) **10.** (c)

Chapter 22 : Chemical Co-ordination and Regulation

Fill in the Blanks :1. corpus luteum **2.** G H **3.** cretinism **4.** increases **5.** vasopressin **6.** immunological functions. **7.** adrenal **8.** progesterone **9.** testis

True/ False : 1. True **2.** True **3.** True **4.** False **5.** False **6.** False **7.** True **8.** False

Conceptual MCQs : 1. (b) **2.** (a) **3.** (a) **4.** (d) **5.** (c) **6.** (a) **7.** (b) **8.** (b) **9.** (a) **10.** (a) **11.** (b) **12.** (c) **13.** (b) **14.** (d) **15.** (c) **16.** (b) **17.** (c) **17.** (a) **19.** (d) **20.** (b)

Diagram Based Question : 1. (b) **2.** (b) **3.** (b) **4.** (b) **5.** (d) **6.** (a) **7.** (a)

Assertion/ Reason : 1. (a) **2.** (a) **3.** (c) **4.** (b) **5.** (a)

Matching Based Question : 1. (c) **2.** (a) **3.** (a) **4.** (d) **5.** (a) **6.** (c) **7.** (d) **8.** (a) **9.** (c)

Critical Thinking Type Questions : 1. (b) **2.** (c) **3.** (c) **4.** (a) **5.** (c) **6.** (a) **7.** (b) **8.** (a) **9.** (b) **10.** (a) **11.** (d) **12.** (b) **13.** (d) **14.** (b) **. 15.** (a) G H **16.** (d) **17.** (b)

Chapter 23 : Reproduction in Organism

Fill in the Blanks : 1. Life span **2.** Asexual reproduction **3.** A binary fission. **4.** Parthenogenesis **5.** A placental mammals. **6.** A three **7.** A genetically **8.** A Binary fission

True/ False : 1. True **2.** False **3.** True **4.** False **5.** True **6.** True **7.** False **8.** False **9.** False

Conceptual MCQs : 1. (a) **2.** (b) **3.** (b) **4.** (b) **5.** (a) **6.** (c) **7.** (b) **8.** (d) **9.** (b) **10.** (d) **11.** (d) **12.** (d) **13.** (d) **14.** (b) **15.** (d) **16.** (c) **17.** (a) **18.** (c) **19.** (d) **20.** (d)

Diagram Based Questions : 1. (b) **2.** (d) **3.** (b) **4.** (b) **5.** (d) **6.** (d) **7.** (c)

Assertion/ Reason : 1. (b) **2.** (a) **3.** (a) **4. (e) 5.** (c)

Matching Based Questions : 1. (b) **2.** (b) **3.** (d) **4.** (d) **5.** (d) **6.** (c) **7.** (a) **8.** (a)

Critical Thinking Type Questions : 1. (b) **2.** (c) **3.** (b) **4.** (d) **5.** (a) **6.** (d) **7.** (d) **8.** (d) **9.** (c) **10.** (b) **11.** (a) **12.** (c) **13.** (b) **14.** (d) **15.** (d)

Chapter 24 : Sexual Reproduction in Flowering Plants

Fill in the Blanks : 1. bilobed **2.** Placenta **3.** hilum **4.** Anatropous ovule **5.** Synergids **6.** (–196°C) **7.** albuminous **8.** angiospermic plants

True/ False : 1. False **2.** True **3.** True **4.** False **5.** True **6.** True **7.** False **8.** True **9.** False

Conceptual MCQs : 1. (b) **2.** (b) **3.** (c) **4.** (b) **5.** (a) **6.** (c) **7.** (c) **8.** (a) **9.** (a) **10.** (d) **11.** (a) **12.** (a) **13.** (b) **14.** (d) **15.** (c) **16.** (b) **17.** (d) **18.** (a) **19.** (a) **20.** (b)

Diagram Based Questions : 1. (d) **2.** (a) **3.** (b) **4.** (a) **5.** (a) **6.** (d) **7.** (c)

Assertion/ Reason : 1. (a) **2.** (a) **3. (e) 4.** (a) **5.** (d) **6.** (d) **7.** (b)

Matching Based Questions : 1. (c) **2.** (b) **3.** (a) **4.** (b) **5.** (a) **6.** (d)

Critical Thinking Type Questions : 1. (c) **2.** (c) **3.** (b) **4.** (d) **5.** (b) **6.** (b) **7.** (b) **8.** (d) **9.** (a) **10.** (c) **11.** (b) **12.** (a) **13.** (b) **14.** (c) **15.** (b) **16.** (c)

Chapter 25 : Human Reproduction

Fill in the Blanks : 1. Epididymis, the abdomen and urinary bladder. **2.** Uterus **3.** Meiosis I **4.** Spermiogenesis **5.** spermatozoa **6.** 60, 40 **7.** Blastocyst **8.** Zygote **9.** Blastocoel **10.** (chorionic villi) (endometrium)

True/ False : 1. False **2.** True **3.** False **4.** False **5.** True **6.** True **7.** False **8.** True

Conceptual MCQs : 1. (d) **2.** (a) **3.** (a) **4.** (a) **5.** (c) **6.** (b) **7.** (a) **8.** (c) **9.** (c) **10.** (a) **11.** (c) **12.** (d) **13.** (a) **14.** (c) **15.** (b) **16.** (c) **17.** (a) **18.** (a) **19.** (c) **20.** (b)

Diagram Based Questions : 1. (c) **2.** (b) **3.** (b) **4.** (c) **5.** (a) **6.** (a) **7.** (c)

Assertion/ Reason : 1. (c) **2.** (a) **3.** (c) **4.** (b) **5.** (c) **6.** (d)

Matching Based Questions : 1. (b) **2.** (c) **3.** (b) **4.** (d) **5.** (b) **6.** (c) **7.** (d) **8.** (c)

Critical Thinking Type Questions : 1. (c) **2.** (a) **3.** (c) **4.** (d) **5.** (a) **6.** (b) **7.** (c) **8.** (d) **9.** (c) **10.** (c) **11.** (b) **12.** (c) **13.** (c) **14.** (c)

Chapter 26 : Reproduction Health

Fill in the Blanks : 1. tubectomy **2.** 12 **3.** ICSI **4.** ZIFT **5.** progesterone **6.** amniocentesis **7.** 1951

True/ False : 1. True **2.** True **3.** False **4.** True **5.** False **6.** False **7.** True **8.** True

Conceptual MCQs : 1. (a) **2.** (c) **3.** (c) **4.** (d) **5.** (b) **6.** (a) **7.** (a) **8.** (a) **9.** (b) **10.** (a) **11.** (c) **12.** (b) **13.** (d) **14.** (d) **15.** (d) **16.** (a) **17.** (d) **18.** (b) **19.** (a) **20.** (a)

Diagram Based Questions : 1. (a) **2.** (a) **3.** (d) **4.** (b) **5.** (a)

Assertion/ Reason : 1. (a) **2.** (a) **3.** (a) **4.** (c) **5.** (c)

Matching Based Questions : 1. (b) **2.** (b) **3.** (a) **4.** (a) **5.** (d) **6.** (a)

Critical Thinking Type Questions : 1. (c) **2.** (a) **3.** (b) **4.** (a) T **5.** (a) **6.** (d) **7.** (d) **8.** (c) **9.** (c) **10.** (a) **11.** (b) **12.** (a) **13.** (c) **14.** (a) **15.** (b)

Chapter 27 : Heredity and Variation

Fill in the Blanks : 1. Allelomorphs **2.** Segregation **3.** Test cross **4.** Multiple allelism **5.** 4 **6.** 44 autosomes and X sex chromosome **7.** Klinefelter's syndrome **8.** Dominant

True/ False : 1. True **2.** True **3.** False **4.** False **5.** False **6.** True **7.** False **8.** True

Conceptual MCQs : 1. (d) **2.** (a) **3.** (c) **4.** (d) **5.** (b) **6.** (d) **7.** (c) **8.** (b) **9.** (d) **10.** (d) **11.** (d) **12.** (a) **13.** (c) **14.** (b) **15.** (c) **16.** (a) **17.** (a) **18.** (b) **19.** (b) **20.** (d)

Diagram Based Questions : 1. (a) **2.** (a) **3.** (b) **4.** (c) **5.** (a) **6.** (b) **7.** (a) **8.** (c)

Assertion/ Reason : 1. (a) **2.** (c) **3.** (c) **4.** (a) **5.** (c) **6.** (a) **7.** (b) **8.** (c)

Matching Based Questions : 1. (c) **2.** (d) **3.** (a) **4.** (d) **5.** (c) **6.** (c) **7.** (c) **8.** (a)

Critical Thinking Type Questions 1. (b) **2.** (c) **3.** (c) **4.** (b) **5.** (b) **6.** (b)

Chapter 28 : Molecular Basis of Inheritance

Fill in the Blanks 1. promoter, regulator **2.** introns, exons **3.** die, S **4.** recessive, UV light **5.** endergonic, require **6.** DNA, RNA, Protein **7.** introns

True/ False 1. False **2.** True **3.** True **4.** True **5.** True **6.** True **7.** True **8.** True **9.** False

Conceptual MCQs : 1. (c) **2.** (b) **3.** (c) **4.** (b) **5.** (b) **6.** (c) **7.** (c) **8.** (d) **9.** (d) **10.** (a) **11.** (b) **12.** (a) **13.** (c) **14.** (c) **15.** (d) **16.** (d) **17.** (d) **18.** (c) **19.** (c) **20.** (d)

Diagram Based Questions : 1. (a) **2.** (a) **3.** (d) **4.** (b) **5.** (d) **6.** (a) **7.** (c) **8.** (a)

Assertion/ Reason : 1. (d) **2.** (d) **3.** (a) **4.** (a) **5.** (c) **6.** (a) **7.** (a) **8.** (a) **9.** (c)

Matching Based Questions : 1. (d) **2.** (a) **3.** (a) **4.** (b) **5.** (c) **6.** (a) **7.** (b) **8.** (a)

Critical Thinking Type Questions : 1. (a) **2.** (a) **3.** (a) **4.** (c) **5.** (b) **6.** (a) **7.** (b) **8.** (a) **9.** (b)

Chapter 29 : Evolution

Fill in the Blanks : 1. 500 **2.** Aristotle **3.** Milky way, disc **4.** Bible **5.** 750 **6.** Pansmermia **7.** Oparin, Haldane **8.** Cocervates **9.** Oparin, Redi

True/ False 1. True **2.** True **3.** True **4.** True **5.** False **6.** True **7.** False **8.** False

Conceptual MCQs :

1. (b) **2.** (c) **3.** (a) **4.** (c) **5.** (c) **6.** (d) **7.** (c) **8.** (b) **9.** (b) **10.** (a) **11.** (b) **12.** (b) **13.** (a) **14.** (d) **15.** (b) **16.** (c) **17.** (d) **18.** (b) **19.** (b) **20.** (d)

Diagram Based Questions : 1. (a) **2.** (d) **3.** (b) **4.** (d) **5.** (d) **6.** (b) **7.** (b)

Assertion/ Reason : 1. (c) **2.** (a) **3.** (a) **4.** (d) **5.** (a) **6.** (d) **7.** (b) **8.** (c) **9.** (b) **10.** (a)

Matching Based Questions : 1. (d) **2.** (c) **3.** (a) **4.** (b) **5.** (a) **6.** (d)

Critical Thinking Type Questions 1. (c) **2.** (c) **3.** (b) **4.** (d) **5.** (b) **6.** (a) **7.** (b) **8.** (d) **9.** (b) **10.** (b) **11.** (b)

Chapter 30 : Health and Disease

Fill in the Blanks : 1. Prion **2.** Second **3.** Stanley B. Prusiner **4.** BCG **5.** Widal test **6.** Tuberculosis **7.** human chrionic gonadotropin (hCG) **8.** laughing sickness

True/ False : 1. False **2.** True **3.** False **4.** True **5.** False **6.** False **7.** True **8.** True **9.** False

Conceptual MCQs: 1. (d) **2.** (c) **3.** (a) **4.** (a) **5.** (d) **6.** (c) **7.** (c) **8.** (a) **9.** (d) **10.** (a) **11.** (c) **12.** (b) **13.** (b) **14.** (c) **15.** (c) **16.** (c) **17.** (c) **18.** (a) **19.** (d) **20.** (b)

Diagram Based Questions : 1. (d) **2.** (c) **3.** (c) **4.** (a)

Assertion/ Reason : 1. (c) **2.** (c) **3.** (b) **4.** (b) **5.** (b) **6.** (a) **7.** (a) **8.** (a) **9.** (d) **10.** (a) **11.** (d) **12.** (c) **13.** (b)

Matching Based Questions : 1. (c) **2.** (a) **3.** (a) **4.** (d) **5.** (d)

Critical Thinking Type Questions : 1. (c) **2.** (b) **3.** (b) **4.** (c) **5.** (c) **6.** (c) **7.** (a) **8.** (b) **9.** (d) **10.** (a) **11.** (d) **12.** (d) **13.** (c) **14.** (c) **15.** (b) **16.** (c)

Chapter 31 : Strategies for Enhancement in Food Production

Fill in the Blanks : 1. inbreeding; out-breeding **2.** apiculture **3.** agriculture; 62 **4.** genebank **5.** *Parbhani kranti* **6.** totipotency **7.** bio-fortification **8.** micropropagation **9.** somatic hybridization

True/ False : 1. False **2.** True **3.** True **4.** True **5.** True **6.** False **7.** True **8.** False **9.** False **10.** True

Conceptual MCQs : 1. (c) **2.** (c) **3.** (b) **4.** (b) **5.** (a) **6.** (b) **7.** (d) **8.** (c) **9.** (a) **10.** (a) **11.** (d) **12.** (b) **13.** (c) **14.** (d) **15.** (a) **16.** (a) **17.** (c) **18.** (c) **19.** (c) **20.** (a)

Assertion/ Reason : 1. (a) **2. (e) 3.** (a) **4.** (a) **5. (e)**

Matching Based Questions : 1. (b) **2.** (c) **3.** (d) **4.** (b)

Critical Thinking Type Questions : 1. (c) **2.** (a) **3.** (c) **4.** (d) **5.** (a) **6.** (a) **7.** (c) **8.** (d) **9.** (c) **10.** (c) **11.** (a) **12.** (d) **13.** (c) **14.** (d) **15.** (b) **16.** (a) **17.** (a) **18.** (c) **19.** (a) **20.** (d)

Chapter 32 : Microbes in Human Welfare

Fill in the Blanks : 1. fermentors **2.** antibiotics **3.** mycorrhiza **4.** primary sludge **5.** 65% **6.** biochemical oxygen demand **7.** activated sludge treatment **8.** primary treatment **9.** biological process

True/ False : 1. True **2.** False **3.** True **4.** True **5.** True **6.** False **7.** False **8.** True

Conceptual MCQs : 1. (c) **2.** (d) **3.** (c) **4.** (c) **5.** (b) **6.** (d) **7.** (a) **8.** (a) **9.** (d) **10.** (b) **11.** (d) **12.** (c) **13.** (a) **14.** (c) **15.** (d) **16.** (b) **17.** (c) **18.** (a) **19.** (b) **20.** (d) **21.** (d)

Diagram Based Questions : 1. (b) **2.** (b)

Assertion/ Reason : 1. (c) **2.** (d) **3. (a) 4.** (d) **5.** (b) **6.** (c) **7.** (b)

Matching Based Questions : 1. (c) **2.** (b) **3.** (a) **4.** (b) **5.** (a) **6.** (a)

Critical Thinking Type Questions : 1. (a) **2.** (a) **3.** (b) **4.** (d) **5.** (c) **6.** (b) **7.** (a) **8.** (b) **9.** (c) **10.** (b) **11.** (a) **12.** (d) **13.** (c) **14.** (a) **15.** (d)

Chapter 33 : Biotechnology Principles and Processes

Fill in the Blanks : 1. ligase **2.** gel electrophoresis **3.** 42°C **4.** Transformation **5.** gold or tungsten **6.** bioreactor **7.** *Hind* II **8.** *Taq* polymerase **9.** denaturation

True/ False : **1.** True **2.** False **3.** True **4.** True **5.** False **6.** True **7.** True **8.** True **9.** False

Conceptual MCQs : **1.** (a) **2.** (a) **3.** (c) **4.** (d) **5.** (b) **6.** (a) **7.** (b) **8.** (c) **9.** (a) **10.** (d) **11.** (d) **12.** (c) **13.** (d) **14.** 15. (c) **16.** (d) **17.** (a) **18.** (d) **19.** (d) **20.** (d)

Assertion/ Reason : **1.** (a) **2.** (a) **3.** (c) **4.** (b) **5.** (a)

Matching Based Questions **1.** (b) **2.** (c) **3.** (a) **4.** (a) **5.** (a) **6.** (a) **7.** (d)

Critical Thinking Type Questions : **1.** (d) **2.** (d) **3.** (d) **4.** (c) **5.** (c) **6.** (a) **7.** (b) **8.** (b) **9.** (d) **10.** (a) **11.** (a) **12.** (b) **13.** (b) **14.** (b) **15.** (b)

Chapter 34 : Biotechnology and Its Applications

Fill in the Blanks : **1.** bio-insecticidal plants **2.** *Bacillus thuringiensis* **3.** dsRNA **4.** insulin **5.** interferon **6.** adenosine deaminase (ADA) **7.** lymphocytes **8.** DNA probes **9.** probe

True/ False : **1.** False **2.** False **3.** True **4.** True **5.** False **6.** True **7.** True **8.** False **9.** True **10.** True

Conceptual MCQs : **1.** (c) **2.** (d) **3.** (b) **4.** (b) **5.** (d) **6.** (b) **7.** (d) **8.** (d) **9.** (b) **10.** (b) i i **11.** (d) . **12.** (d) **13.** (b) **14.** (c) **15.** (c) **16.** (c) **17.** (d) **18.** (a) **19.** (b) **20.** (c)

Assertion/ Reason : **1.** (a) **2.** (a) **3.** (b) **4.** (a) **5.** (a)

Matching Based Questions **1.** (c) **2.** (a) **3.** (b) **4.** (a) **5.** (d)

Critical Thinking Type Questions : **1.** (a) **2.** (a) **3.** (b) **4.** (a) **5.** (a) **6.** (a) **7.** (c) **8.** (d) **9.** (a) **10.** (d) **11.** (d) **12.** (a) **13.** (c) **14.** (b) **15.** (b) **16.** (d)

Chapter 35 : Organism and Environment

Fill in the Blanks : **1.** Sun **2.** Adaptation **3.** Emigration **4.** Brood parasitism **5.** uniform **6.** Type-III **7.** Clumped **8.** modular, unifor, biomass **9.** biotic potential **10.** exponential, logistic

True/ False : **1.** True **2.** True **3.** False **4.** True **5.** True **6.** True **7.** True **8.** True **9.** True

Conceptual MCQs : **1.** (a) **2.** (d) **3.** (c) **4.** (b) **5.** (d) **6.** (c) **7.** (b) **8.** (c) **9.** (a) **10.** (b) **11.** (d) **12.** (a) **13.** (c) **14.** (b) **15.** (a) **16.** (b) **17.** (c) **18.** (a) **19.** (a) **20.** (b) **21.** (a)

Diagram Based Questions **1.** (a) **2.** (c) **3.** (d) **4.** (d) **5.** (a) **6.** (c) **7.** (b)

Assertion/ Reason : **1.** (a) **2.** (a) **3.** (e) **4.** (b) **5.** (a)

Matching Based Questions **1.** (a) **2.** (a) **3.** (d)

Critical Thinking Type Questions : **1.** (d) **2.** (c) **3.** (d) **5.** (c) **6.** (b) **7.** (d) **8.** (d) **9.** (c) 2 **10.** (c) **11.** (d) **12.** (b) **13.** (b) **14.** (a) **15.** (c)

Chapter 36 : Ecosystem

Fill in the Blanks : **1.** stratification **2.** unidirectional **3.** standing crop **4.** open; can **5.** lost **6.** bottom **7.** ecoline **8.** secondary productivity **9.** solar **10.** recycle

True/ False : **1.** True **2.** False **3.** False **4.** True **5.** False **6.** True **7.** True **8.** True **9.** False

Conceptual MCQs : **1.** (d) **2.** (a) **3.** (c) **4.** (d) **5.** (b) **6.** (a) **7.** (c) **8.** (c) **9.** (d) **10.** (b) **11.** (a) **12.** (b) **13.** (d) **14.** (c) **15.** (a) **16.** (a) **17.** (d) **18.** (a) **19.** (a) **20.** (b)

Diagram Based Questions **1.** (c) **2.** (a) **3.** (a) **4.** (c) **5.** (c) **6.** (c) **7.** (c)

Assertion/ Reason : 1. (a) **2.** (a) **3.** (e) **4.** (d) **5.** (c) **6.** (a) **7.** (a) **8.** (a) **9.** (c) **10.** (b) **11.** (c) **12.** (c)

Matching Based Questions 1. (a) **2.** (a) **3.** (b) **4.** (c) **5.** (d)

Critical Thinking Type Questions : 1. (b) **2.** (d) **3.** (b) **4.** (a) **5.**(b) **6.** (b) **7.** (d) **8.** (b) **9.** (b) **10.** (d) **11.** (b) **12.** (d) **13.** (d) **14.** (c)

Chapter 37 : Biodiversity and Conservation

Fill in the Blanks : 1. animals **2.** Vulnerable **3.** biosphere reserve **4.** national parks **5.** intraspecific competition **6.** γ-diveristy (gamma) **7.** fungi **8.** beta diversity **9.** –196° C **10.** Nile perch

True/ False : 1. True **2.** True **3.** True **4.** True **5.** True **6.** False **7.** True **8.** True **9.** False

Conceptual MCQs : 1. (d) **2.** (b) **3.** (c) **4.** (a) **5.** (d) **6.** (b) **7.** (c) **8.** (d) **9.** (a) **10.** (b) **11.** (b) **12.** (b) **13.** (b) **14.** (c) **15.** (b) **16.** (d) **17.** (d) **18.** (c) **19.** (b) **20.** (b)

Diagram Based Questions 1. (a) **2.** (d) **3.** (a)

Assertion/ Reason : 1. (a) **2.** (a) **3.** (d) **4.** (b) **5.** (b)

Matching Based Questions 1. (b) **2.** (c) **3.** (a) **4.** (b) **5.** (b)

Critical Thinking Type Questions : 1. (d) **2.** (a) **3.** (d) **4.** (d) **5.** (d) **6.** (b) **7.** (a) **8.** (c) **9.** (c) **10.** (b) **11.** (d) **12.** (d) **13.** (b) **14.** (b) **15.** (c)

Chapter 38 : Environmental Issues

Fill in the Blanks : 1. 1986 **2.** $\leq$ 2.5 μm **3.** sewage and water treatment **4.** calcium ATPase **5.** 5 g / cm^3 **6.** eutrophication **7.** –18°C **8.** algal bloom **9.** deforestation **10.** Integrated organic farming

True/ False : 1. True **2.** False **3.** True **4.** False **5.** False **6.** True **7.** False **8.** False **9.** True **10.** True

Conceptual MCQs : 1. (a) **2.** (c) **3.** (b) **4.** (d) **5.** (b) **6.** (d) **7.** (b) **8.** (a) **9.** (c) **10.** (d) **11.** (a) **12.** (d) **13.** (b) **14.** (c) **15.** (a) **16.** (a) **17.** (c) **18.** (a) **19.** (a) **20.** (b)

Diagram Based Questions 1. (c) **2.** (a) **3.** (a) **4.** (a) **5.** (a) **6.** (c) **7.** (a)

Assertion/ Reason : 1. (a) **2.** (c) **3.** (a) **4.** (b) **5.** (b) **6.** (b) **7.** (b) **8.** (c) **9.** (a) **10.** (d)

Matching Based Questions 1. (d) **2.** (b) **3.** (b) **4.** (a) **5.** (a) **6.** (c) **7.** (c)

Critical Thinking Type Questions : 1. (d) **2.** (a) **3.** (c) **4.** (a) **5.** (b) **6.** (d) **7.** (b) **8.** (c) **9.** (d) **10.** (a) **11.** (b) **12.** (d) **13.** (d) **14.** (a) **15.** (c)