UNIFORM MOTION

1. A particle starts from rest and moves with constant acceleration a. what is the nature of the graph between the time (t) and the displacement.

   (a) straight line

   (b) instant velocity

   (c) average speed

   (d) average velocity

2. A particle starts with velocity u and moves with constant acceleration a .what is the nature of the graph between the time (t) and the displacement (x).

   (a) straight line

   (b) symmetric parabola

© Asymmetric parabola

(d) Rectangular hyperbola.

3. For motion on a curved path with constant acceleration

[magnitude of displacement /distance covered

(a) >1

(b) ≥ 1

(c) ≤ 1

(d) <1

4. A particle moving with uniform speed can possess :

(a) radial acceleration

(b) tangential acceleration

© both radial and tangential accelerations

(d) neither radial nor tangential acceleration

5. A car accelerates from rest for time t_1 at constant rate a_1 and then it retards at the constant rate a_2 for time t_2 and comes to rest. t_1/t_2 =

(a) a_1/a_2

(b) a_2/a_1

(c) a_1^2/a_2^2

(d) a_2^2/a_1^2

6. What is the angle between instantaneous displacement and acceleration during the retarded motion

(a) Zero

(b) $\pi/4$

(c) $\pi/2$.

(d) π.

7. the velocity graph of a motion starting from rest with uniform acceleration is a straight line:

   (a) Parallel to time –axis.

   (b) parallel to velocity axis

   © not passing through origin

   (d) having none of the above characteristics.

8. The slope of the velocity time graph for retarded motion is:

   (a) Positive

   (b) negative

   (c) zero

   (d) can be +ve, -ve or zero.

9. Which of the following can be zero when the particle is in motion for some time ?

(a) Displacement

(b) Distance covered

© speed

(d) none of the above

10. Which of the following statement is false for motion with uniform velocity

(a) The motion is along a straight line path.

(b) The motion is always in the same direction

© Magnitude of displacement < distance covered

(d) Average velocity is equal to the instantaneous velocity.

11. A particle is moving on a straight line path with constant acceleration directed along the direction of

instantaneous velocity. Which of the following statements about the motion of particle is true.

(a) Particle may reverse the direction of motion.

(b) distance covered = magnitude of displacement

(c) average velocity is less than average speed

(d) average velocity = instantaneous velocity.

12. if the displacement of a particle is zero, then what can we say about its distance covered ?

(a) it must be zero.

(b) it cannot be zero.

© it is negative

(d) it may or may not be zero.

13. a particle moves with uniform velocity. Which o fthe following statements about the motion of the particle is true.

(a) its speed is zero.

(b) its acceleration is zero.

© its acceleration is opposite to the velocity.

(d) its speed may be variable

14. A car travels a distance S on a straight road in two hours and then return to the starting point in the next here hours. Its average velocity is :

(a) S/5

(b) 2S/5

(c) (S/2)+(S/3)

(d) none of the above.

15. A particle starts with initial velocity $10ms^{-1}$.. it covers a distance of 20 m along a straight into two seconds. What is the acceleration of the particle.

(a) zero

(b) $1\ ms^{-2}$.

(c) $10ms^{-2}$

(d)$20\ ms^{-2}$.

16. A particle moves along a straight line path. After sometime it comes to rest. The motion is with an acceleration whose direction with respect to the direction o velocity is

(a) positive throughout motion

(b) negative throughout motion

(c) first positive then negative

(d) first negative then positive

17. The time elapsed is plotted along X-axis and the acceleration is plotted along the Y-axis. The area between the graph and the X-axis gives.

(a) Average velocity

(b) distance covered

(c) differences in velocities

(d) difference in accelerations

18. The velocity ν and displacement r of a body are related as : $\nu^2 = kr$ where k is constant.

What will be the velocity after 1 second. Given that the displacement is zero at t=0.

(a) $\sqrt{kr}$

(b) $kr^{3/2}$.

(c) kr

(d) data is not sufficient

Numerical bank

19. The position of a particle moving on a straight line path is given by

$x = 12+18t+9t^2$ meter its velocity at t = 2 s is

(a) 84 ms^{-1}.

(b) 72 ms^{-1}.

(c) 54 ms^{-1}.

(d) 36 ms^{-1}.

20. The displacement of a particle is given by $\sqrt{x} = t+1$. which of the following statements about its velocity is true.

(a) it is zero.

(b) it is constant but not zero.

(c) it increases with time

(d) it decreases with time.

21. The acceleration a of a particle varies with time t as a = bt +c . where b and c are constants. What will be the velocity of the particle which starts from rest after the time t.

(a) $bt+(1/2)ct^2$.

(b) $ct+(1/2)bt^2$.

(c) $bt+ct^2$.

(d) $ct+bt^2$.

22 The distance covered by a particle moving along a straight line path with uniform acceleration is given by : x

$= 6+6t+10t^2$. metre. What is the initial velocity of the particle.

(a) 6 ms^{-1}.

(b) 7 ms^{-1}.

(c) 8 ms^{-1}

. (d) 9 ms^{-1}.

23 A particle starts from the rest & moving with constant acceleration covers a distance x1 in the 3rd second x_2 in the 5th second. The ratio x_1/x_2 =

(a) 3/5

(b) 5/9

(c) 9/25

(d) 25/81

24. A particle moves along X-axis in such a way that its coordinate X varies with the time t according to the expressions $x = (8 - 5t + 8t^2)$ meter. The initial velocity of the particle is

(a) -5 m/s.

(b) 8 m/s.

(c) -8m/s.

(d) +16 m/s.

25. The initial velocity of a particle moving along a straight line is 10 m/s and its retardation is 2 ms^{-2}. the distance moved by the particle in the fifth second of its motion is :

(a) 1m.

(b) 19m.

(c) 50m

(d) 75 m.

26 A ball is dropped from the top of tower 100m high. Simultaneously another ball is thrown upward with a sped of 50 ms^{-1}. after what time do they cross each other.

(a) 1s

(b) 2s

(c) 3s

(d) 4s.

27 Two bodies are dropped from different heights h_1 & h_2. The ratio of the times taken by them to reach the ground will be

(a) $h_2^2 : h_1^2$.

(b)) $h_1 : h_2$.

(c)) $\sqrt{h_1} : \sqrt{h_2}$.

(d) none of the above

28. A body is released from the top of a tower of height H meter. After 2 seconds it is stopped and then instantaneously released. What will be its height after next 2 seconds.

(a) (H-5) meters.

(b) (H-10) meters.

(c) (H-20) meters.

(d) (H-40) meters.

29 The displacement of particle after time t is given by $x = (k/b^2)(1-e^{-bt})$, where b and k are constants what is the acceleration of the particle.

(A) ke^{-bt}.

(b) $-ke^{-bt}$.

(c) $(k/b^2)e^{-bt}$.

(d) $(-k/b^2)e^{-bt}$.

30 a particle starts from the rest and moves with a constant acceleration a for time t and covers a distance x_1. it continues to move with the same acceleration and covers a distance x_2 in the next time interval t. which of the following relations is correct.

(a) x_2-x_1.

(b) x_2-2x_1.

(c) x_2-3x_1.

(d) x_2-4x_1.

UNIFORM MOTION (NUMERICALS) ASSIGNMENT

1. A body is dropped from the top of a tower and falls freely. The distance covered by it after n seconds is directly proportional to

   (a) n^2.

   (b) n

   (c) 2n-1

   (d) $2n^2$-1

2. in the above question, the distance covered in the nth second is proportional to

   (a) n^2.

   (b) n

(c) 2n-1

(d) $2n^2$-1

3. in q. 1 the velocity of the body after n seconds is proportional to

(a) n^2.

(b) n

(c) 2n-1

(d) $2n^2$-1

4. A ball dropped from a height h reaches the ground in time T. what is its height at time T/2.

(a) h/8

(b) h/4

(c) h/2

(d) 3h/4.

5. The distance time graph of a particle at time t makes an angle 45^0 with the time axis. After one seconds it makes an angle 60^0. with the tie axis. What is the acceleration of the particle.

(a) √3-1

(b) √3+1

(c) √3`

(d) 1.

6. A car accelerates from rest at 5 ms^{-2} and then retards to rest at $3m^{-2}$.the maximum velocity of the car is $30ms^{-2}$. what is the distance covered by the car ?

(a) 150 m

(b) 240m

(c) 300 m

(d) 360 m.

7. The displacement time graph for the two particles A and B are straight lines inclined at angles 30^0 and 60^0 with the time axis. The ratio of the velocities $V_A : V_B$ will be

(A) 1:2

(b) 1:√3

(c) √3:1

(d) 1:3

8 The velocity 'u' of the body moving along a straight line with constant retardation 'a' reduces by 75% in time t. what is the time taken in doing so ?

(A) u/4a

(b) 3u/4a

(c) 4u/3a

(d) u/3a.

9. The acceleration of the particle , starting from rest , varies with time according to the relation : $a = -A\omega^2 \sin \omega t$.the displacement of this particle at a time t will be

(a) $-(1/2)(A\omega^2 \sin \omega t)t^2$.

(b) $(A\omega \sin \omega t)$.

(c) $(A\omega \cos \omega t)t$.

(d) $A \sin \omega t$.

10. A particle is moving eastwards with a velocity of 5 m/s. in 10 seconds the velocity changes to 5 m/s. northwards. The average acceleration in this time is

(a) Zero

(b) $1/\sqrt{2}$ m/s^2. towards north-west.

(c) 1/3 m/s^2. towards north-west.

(d) $1\sqrt{2}$ m/s^2. towards north-east.

11 a car can be stopped over a distance x when its momentum is ‘p’ . what will be the stopping distance when the momentum is 2p.

(a) x

(b) 2x

(c)4x

(c) 8x.

12. The displacement x and time t are related as $t = px^2+qx+r$, when p,q,r, are constants. What is the relation between velocity ν and the acceleration a ?

(a) $a \propto \nu$

(b) $a \propto \nu^2$.

(c) $a^2 \propto \nu$

(d) $a^2 \propto \nu^2$.

13. The distance covered by a particle moving on a straight line path at any instant is given by $t = ax^2 + bx$.. if the instantaneous velocity of the particle be ν. What is the acceleration of the particle.

(a) $2a\ \nu^3$.

(b) $-2a\ \nu^3$.

(c) $2a\ \nu^2$.

(d) $-2a\ \nu^2$.

14. A particle moves so that the displacement x at time t is given by $x^2 = 1 + t^2$.what is its acceleration.``

(a) $1/x$

(b) t^2/x^3.

(c) $1/3 - t^2/x^3$.

(d) $t^2/x^3 + t^2/x^3$.

15. A car starts from rest and moves with constant acceleration . The ratio of the distance covered in the nth second to that in n seconds is :

(a) $1/2n^2 – 1/n$

(b) $1/2n^2 + 1/n$

(c) $2/n – 1/n^2$.

(d) $2/n + 1/n^2$.

16. The height y and the distance x along the horizontal plane of a projectile on a certain planet are given by

$$y = (8t - 10t^2) \text{ meter and } x = 6t \text{ meter}$$

where t is in seconds . the velocity with which the projectile is projected , is :

(a) 8 m/s.

(b) 6 m/s.

(c) 10 m/s.

(d) not obtained from data

17. the position (x & y) co-ordinates of particle at the instant t are $\sqrt{2}$l t and $2t-4t^2$. respectively. What is the initial speed of the particle

(a) 0

(b) 3 m/s.

(c) 4 m/s.

(d) 5m/s.

18. A shell is fired from a cannon with a velocity V m/s at an angle θ with the horizontal direction. At the highest point in its path explodes into two pieces of equal mass . one

of the pieces retraces its path to the canon then the speed of the other piece immediately after explosion is :

(a) $3V \cos\theta$

(b) $2V \cos \theta$

(c) $3/2\ V \cos\theta$

(d) $\sqrt{3}/2 \cos \theta$.

19. A train starts from the rest ad acquires with a speed ν with uniform acceleration α. Then it comes to stop with uniform retardation β. What will be the average velocity of the train?

(a) $\alpha\beta / (\alpha+\beta)$

(b) $(\alpha+\beta) / \alpha\beta$

(c) $\nu/2$

(d) ν

20. A rocket is fired vertically from the ground . it moves upwards with constant acceleration $10ms^{-2}$ for 30 seconds after which the fuel is consumed. After what time form the instant o firing the rocket will attain the maximum height ? take g = 10 ms^{-2}.

(a) 30 s

(b) 45s

(c) 60 s

(d) 75 s.

21. The displacement of a particle is given by $\sqrt{x} = 2t$ what is the nature of motion of the particle ?

(a) accelerated

(b) with uniform velocity

(c) retarded

(d) at rest

22. A car accelerates from the rest at constant rate for the first 10 s and covers a distance y in the next 10 s at the same acceleration. Which of the following is true.

(a) x =3y

(b) y =3x

(c) x =y

(d) y = 2x.

23. A person throws ball into the air one after another at an interval of one second. The next ball is thrown when the velocity of the ball thrown earlier is zero. To what height the ball rise ? take g = 10 ms^{-2}.

(a) 5m

(b) 10m

(c) 20 m

(d) 40 m.

24. A train accelerates from the rest at a constant rate α for some times and then it retards to rest at the constant rate β. If the total distance covered by the particle is x, then what is the maximum velocity of the train .

(a) $[\{\alpha+\beta) / 2\alpha\beta \}x]^{1/2}$.

(b) $[\{\alpha-\beta) / 2\alpha\beta \}x]^{1/2}$.

(c) $[\{2\alpha\beta / (\alpha+\beta) \}x]^{1/2}$.

(d) $[\{2\alpha\beta / (\alpha-\beta) \}x]^{1/2}$.

25. A train accelerates from rest at a constant rate α for distance x_1 and time t_1. after that it retards to rest at constant rate β for distance x_2 and time t_2. which of the following relation is correct?

(a) $x_1/x_2 = \alpha/\beta = t_1/t_2$.

(b) $x_1/x_2 = \beta/\alpha = t_1/t_2$.

© $x_1/x_2 = \alpha/\beta = t_2/t_1$.

(d) $x_1/x_2 = \beta/\alpha = t_2/t_1$.

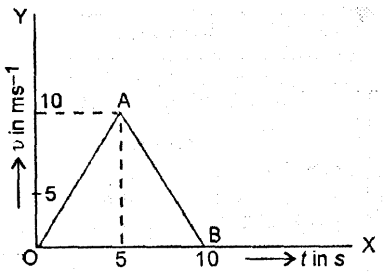
26. A ball is dropped from the top of the tower of height h. it covers a distance of h/2 in the last second of its motion How long does the ball remain in air.

(a) $\sqrt{2}$s

(b) $(2+\sqrt{2})$ s

(c) 2s

(d) $(2-\sqrt{2})$ s.



GRAPHICAL BANK

27. the speed time graph of a particle is shown in the fig.

what is the distance traveled from t =5s to t =10s.

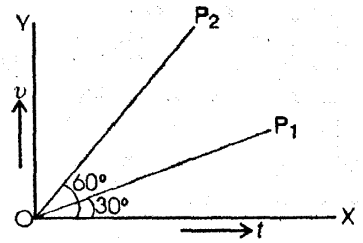
(a) 100m

(b) 50 m

(c) 25m.

(d)12.5 m

28. The velocity time graph of the two particle P_1 & P_2 are shown in fig. the ratio of the distance covered by them at any instant is : x_2/x_1 =



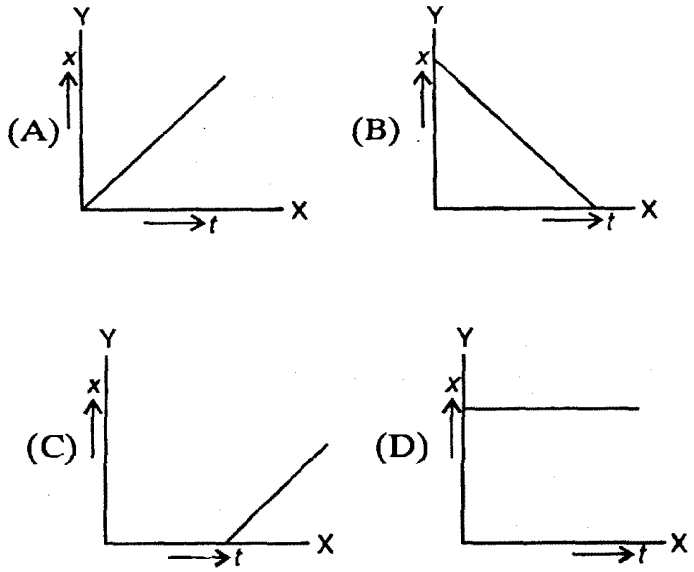
(a) 3

(b) √3

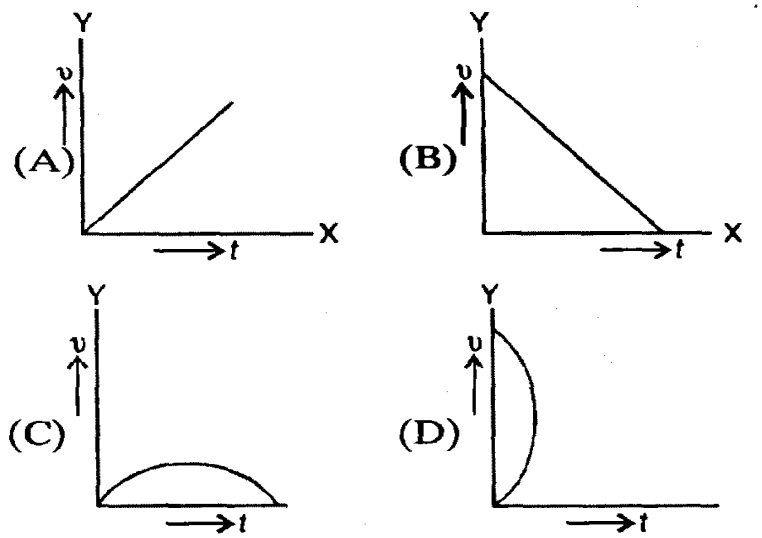
(c) 2

(d) √2

29. which of the following graph can not be the distance graph.



30. Which of the following cannot be the speed time graph



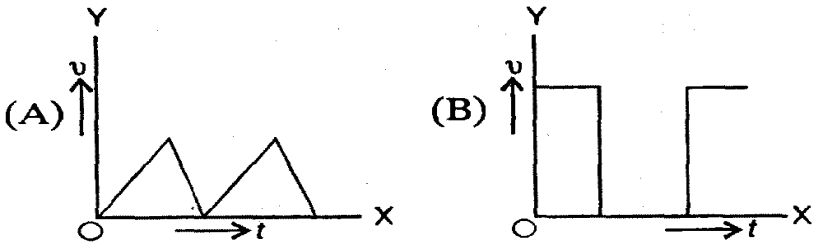
(a)

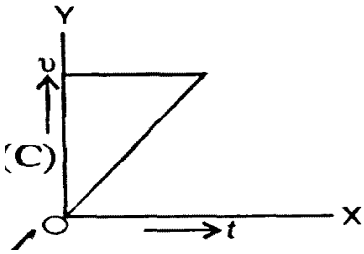
(b)

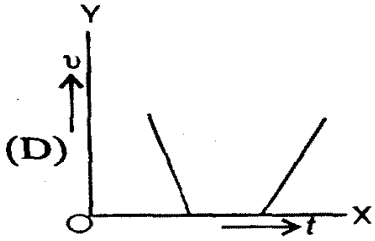
(c)

(d)

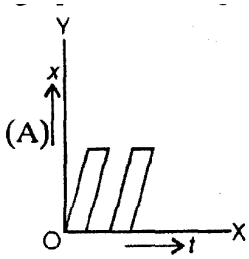
31. Which of the following velocity graph is not possible

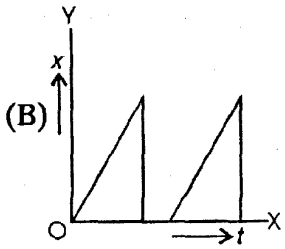


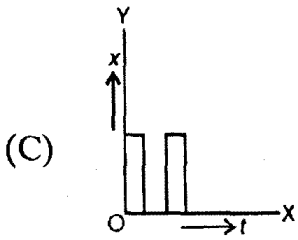


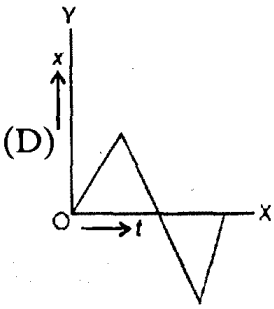


32. Which of the following displacement graph is not possible.

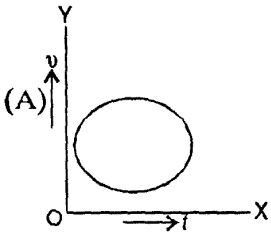


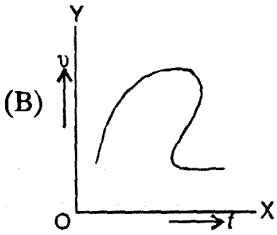


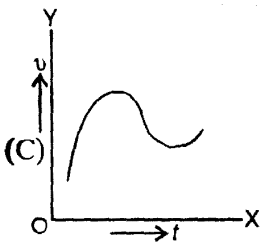


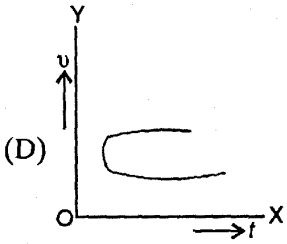


33. Which of the following velocity time graph is possible.



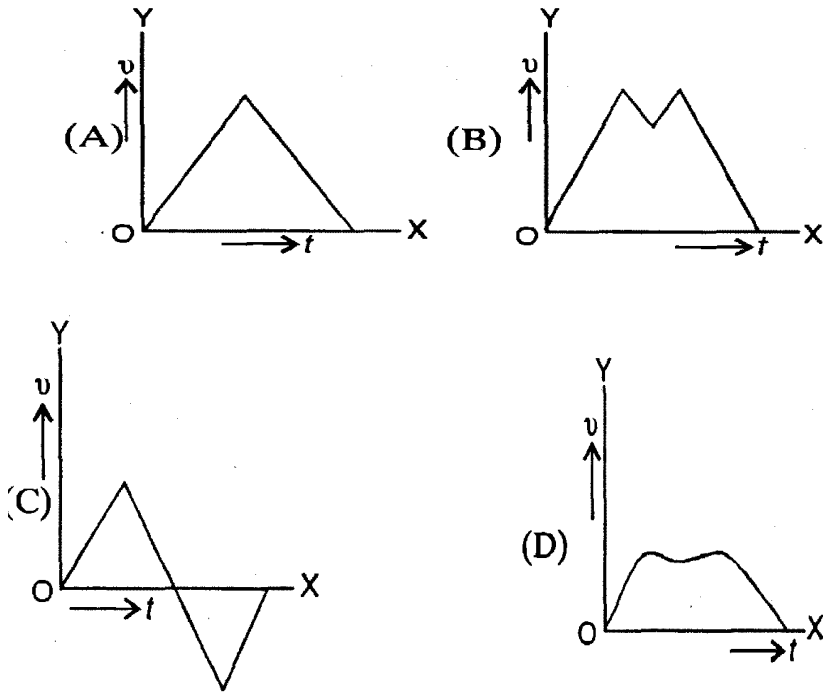




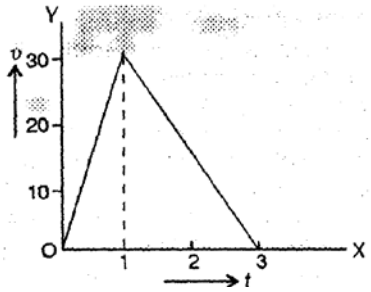


(a) (b) (c) (

34. Which of the following speed graphs is not possible.



35. Figure shows the displacement time graph of a body. What is the ratio of the speed in the first second that in the next two seconds?



(a) 1:2

(b) 1:3

(c)3:1

(d) 2:1

KINETIC THEORY OF GASES

1 If N be the Avogadro's number and R be the gas constant, then Boltzmann constant is given by:

(A) RN

(B) R/N

(C) N/R

(D) 1/RN.

2. Brownian motion has played a convincing role in establishing:

(A) Kinetic theory of gases.

(B) Mechanical equivalence of heat.

(C) Elastic nature of molecular collisions.

(D) None of the above.

3. Which of the following is NOT an assumption of kinetic theory of gases

(A) All molecules of gas are identical.

(B) Gas molecules are like rigid body.

(C) All gases are perfect gases.

(D) Duration of molecular collision is negligible.

4. In kinetic theory of gases, it is assumed that molecular collisions are:

(A) Inelastic.

(B) For negligible duration.

(C) One dimensional (head on)

(D) Unable to exert mutual force.

5. Brownian motion is due to

(A) Collisions of suspended particles with the liquid molecules.

(B) Collisions of suspended particles. With each other.

(C) Intermolecular force.

(D) Some reason other than those mentioned above.

6. Which of the following is NOT the property of Brownian motion ? The Brownian motion is

(A) Continuous

(B) random.

(C) Due to molecular collision with the walls

(D) regular

7. A cylinder contains 2 kg of air at a pressure 105 Pa. if 2 kg more air is pumped into it. Keeping the temperature constant, the pressure will be:

(A) 10^5 Pa

(B) 2×10^5 Pa.

(C) 0.5×10^5 Pa

(D) 10^{10} Pa

8. The kinetic theory of molecular motion appears as:

(A) Potential energy

(B) heat.

(C) Temperature

(D) none of the above

9. ‘P’ is the pressure and ‘d’ is the density of gas at constant temperature, then [

(A) $P \propto d$

(B) $P \propto 1/d$

(C) $P \propto \sqrt{d}$

(D) $P \propto 1/\sqrt{d}$

10. At constant pressure the rams velocity 'c' is related to density 'd' as

(A) $c \propto d$

(B) $c \propto 1/d$

(C) $c \propto \sqrt{d}$

(D) $c \propto 1/\sqrt{d}$

11. The rms speed of the molecules of a gas at a pressure 10^5 PA and temperature 0^oC is 0.5 km s^{-1}. if the pressure is kept constant but temperature is raised to $819^oC$the velocity will become :

(A) 1 km s^{-1}.

(B) 1.5 km s^{-1}.

(C) 2 km s^{-1}.

(D) 5 km s^{-1}

12. Two gases A and B having the same temperature T. same pressure p and same volume V are mixed . if the temperature of the mixture remains unchanged then the volume occupied by it is V. then pressure of the mixture will be :

(A) p/2.

(B) p

(C) 2p

(D) 4p.

13. Which of the following law s can be basis of separating a mixture of gases ?

(A) Avogadro's law

(B) Graham's law of diffusion

(C) Boyle's law

(D) Charle's law

14. A gas molecule of mass m is incident normally on the wall of containing vessel with the velocity u. after the collision the momentum of the molecule will be

(A)zero.

(B) ½ mu.

(C) mu

(D) 2 mu.

15. Under same temperature & pressure , the rate of diffusion ® of gas is related to the density of the gas as :

(A) R∝ 1/d.

(B) R∝ d.

(C) $R \propto 1/\sqrt{d}$.

(D) $R \propto \sqrt{d}$.

16. The molecular motion ceases at :

(A) 273 K.

(B) $273^{o}C$

(C) – 273 K

(D) $-273^{o}C$

17. The mean kinetic theory of a mono atomic gas molecule is :

(A) zero.

(B) ½ kT.

(C) kT.

(D) 3/2 kT

18. The energy associated with each degree of freedom of a gas molecule is :

(A) zero.

(B) ½ kT.

(C) kT.

(D) 3/2 kT.

19. A hotter gas implies higher average value of

(A) internal energy

(B) total energy

(C) kinetic energy

(D) heat constant.

20. The number of degrees of freedom for translatory motion are

(A) same for all types of molecules.

(B) less for multi atomic molecules.

(C) more for multi atomic molecules.

(D) dependent upon the nature of translatory motion.

SCALARS & VECTORS.

1. What is the maximum number of components into which a vector can be split

(a) two

(b) three

(c) four

(d) any number of components

2. the minimum no. of vectors of equal magnitude required to produce zero resultant is

(a) 2

(b)3

(4) 4

(d) more than 4.

3. The minimum number of vectors of unequal magnitude required to produce a zero resultant is:

(a) 2

(b) b

(3) 4

(d) more than 4.

4. Given that $\vec{R} = \vec{P}+\vec{Q}$. which of the following relation s necessarily valid?

(a) P<Q

(b) P>Q

(c) P = Q

(d) none of the above.

5. The magnitude of the sum of the two vectors is equal to the difference of their magnitudes . What is the angle between the vectors.

(a) 0^0 .

(b) 45^0 .

(c) 90^0 .

(d) 180^0 .

6. A particle is moving along a circular path with constant speed ν. What is the change in speed when the particle completes one fourth of revolution?

(a) Zero

(b) ν

(c) $\sqrt{2}\,\nu$

(d) $\nu/\sqrt{2}$.

7. What is the angle between P and the resultant of (P + Q) and (P- Q) ?

(a) Zero

(b) $\tan^{-1} P/Q$

(c) $\tan^{-1} Q/P$

(d) $\tan^{-1} (P-Q) / (P+Q)$

8. 100 coplanar forces each equal to 10N act on a body.

Ech force makes angle $\pi/50$ with the proceeding force.

What is the resultant of the forces

(a) 1000 N

(b) 500 N

(c) 250 N

(d) zero.

9. There are N coplanar vectors each of magnitudes V. Each vector is inclined to the preceding vector at angle $2\pi/N$. What is the magnitude of their resultant?

(a) NV

(b) V

(c) V/N

(d) Zero.

10. Which of the following forces can be applied on a body so as not to cause acceleration of the body

(a) 6,7,15

(b) 8,7,16

(c) 5,12,20

(d) 9,10,12.

11. it is found that a body hangs properly when a force of 20 N east and another force of 30N north acts on it. What is the magnitude of the single force that an do the same.

    (a) 10N

    (b) 36 N

    (c) 50 N

    (d) None of the above.

12. The unit vector along i +j is

    (a) K

    (b) i+j

    (c) (i+j)/√2

    (d) (i + j) /2

13. What is the projection of 3i+4k on the y-axis.

(a) 3

(b) 4

(c) 5

(d) none of the above

$\vec{\ } \quad \vec{\ } \qquad \vec{\ } \quad \vec{\ }$

14. what is the angel between P + Q and P x Q?

(a) 0

(b) $\pi/4$

(c) $\pi/2$

(d) π.

$\vec{\ }\vec{\ } \qquad \vec{\ }\vec{\ }$

15. what is the angle between P+Q and QxP

(a) zero

(b) $\pi/2$

(c) π

(d) none of the above

16. Given that both P and Q are greater than 1. The magnitude of PxQ cannot be :

(a) equal to PQ

(b) less than PQ

(c) more than PQ

(d) equal to P/Q.

17. A particle of mass m moving with velocity ν northwards, collides with another particle of mass m moving with velocity ν eastwards . after the collision the two particles coalesce. What is he velocity of the new particle ?

(a) $\sqrt{2}\,\nu$ north east

(b) $\nu/\sqrt{2}$ north east

(c) 2ν north east

(d) $\nu/2$ north east

18. Which of the following pairs of displacements cannot be added to produce a resultant displacement of 2 m.

(a) 1m & 1m

(b) 1m & 2m

(c) 1m & 3m.

(d) 1m & 4 m.

19. Given that $|\vec{P}+\vec{Q}| = |\vec{P}-\vec{Q}|$. This can be true when :

(a) $\vec{P}=0$

(b) $\vec{Q} = 0$

(c) Neither P nor Q is a null vector.

$\vec{\ }$ $\vec{\ }$

(d) P is perpendicular to Q.

$\vec{\ }$ $\vec{\ }$ $\vec{\ }$ $\vec{\ }$ $\vec{\ }$

20. The angle between P & Q is θ, R = P +Q makes angle $\theta/2$ with P. Which of the following is true.

(a) P = 2Q

(b) 2P =Q

(c) PQ=1

(d) none of the above

21. Given that P +Q = R and P =8, Q = 15, R = 17, what is the angle P and Q.

(a) $\tan^{-1}$ (8/15)

(b) $\tan^{-1}$ (17/15)

(c) $\tan^{-1}$ (8/17)

(d) none of the above.

22. The velocity of a particle 6 ms^{-1} eastwards changes to 8 ms^{-1} northwards in 10s. What is the magnitude of the average acceleration during this interval of time?

(a) 1.4 ms^{-2}.

(b) 1 ms^{-2}.

(c) 0.2 ms^{-2}.

(d) none of the above

23. Given that P = 12, Q =5 and R=13. also P+Q = R. The angle between P and Q is

(a) 0

(b) $\pi/4$

(c) $\pi/2$

(d) π.

24. Which of the following vectors is perpendicular to i P cos θ +j Q sinθ ?

$\hat{i}$ $\hat{j}$

(a) iP sinθ + j Q cos θ.

$\hat{i}$ $\hat{j}$

(b) i Q sinθ + j P cos θ.

$\hat{i}$ $\hat{j}$

(c) i P cosθ + j Q sin θ.

$\hat{i}$ $\hat{j}$

(d) i Q cosθ - j P sin θ.

$\vec{P}$ $\vec{Q}$

25. Resultant of two vectors P & Q is inclined at 45^0 to either of them. What is the magnitude of the resultant

(a) P+Q

(b) P-Q

(c) $[P^2+Q^2]^{1/2}$.

(d) $[P^2-Q^2]^{1/2}$.

$\vec{\rightarrow}\vec{\rightarrow}$ $\vec{\rightarrow}$ $\vec{\rightarrow}$

26. if P.Q = | P x Q |. The angle between P & Q is

(a) zero

(b) $\pi/2$

(c) π

(d) none.

27. Three forces are represented by the sides of a triangle in the ratio 100 :173:200. the ratio between the sides of a triangle are

(a) 90^0,30^0, 60^0 .

(b) 60^0,60^0, 60^0 .

(c) $90^0, 15^0, 75^0$.

(d) $60^0, 45^0, 75^0$.

28. The resultant of P and Q is perpendicular to P. what is the angle between P & Q?

(a) $\cos^{-1}(P/Q)$

(b) $\cos^{-1}(-P/Q)$

(c) $\sin^{-1}(P/Q)$

(d) $\sin^{-1}(-P/Q)$

29. Given that $\vec{P} + \vec{Q} = \vec{R}$ and $P + Q = R$. The angle between P & Q is

(a) 0

(b) $\pi/4$

(c) $\pi/2$

(d) π

30. A man walks for sometime with velocity ν due east. Then he walks for same time with velocity ν due north . the average velocity of the man is :

(a) 2ν

(b) $\sqrt{2}\nu$

(c) ν

(d) $\nu/\sqrt{2}$.

PROJECTILE MOTION

Conceptual questions

1. Which of the following is the essential characteristic of a projectile?

(a) initial velocity inclined to the horizontal.

(b) zero velocity at the highest point.

© constant acceleration perpendicular to the velocity

(d) none of the above

2. which of the following does not effect the maximum height attained by the projectile ?

(a) magnitude of initial velocity

(b) acceleration of the projectile

(c) angle of the projection

(d) mass of the projectile

3. A ball is thrown horizontally from the top of a tower . what happens to the horizontal component of its velocity.

(a) increases

(b) decreases

(c) remains unchanged

(d) first increases then decreases

4. a ball is thrown horizontally and another is just dropped from the top of a tower. which will reach the ground first

(a) first ball

(b) 2nd ball

(c) both will reach simultaneously

(d) depends upon the masses of the balls

5. A projectile is thrown with a velocity u. the maximum possible range of the projectile is

(a) $4u^2/g$.

(b) $u^2/2g$.

(c) u^2/g.

(d) $2u^2/g$.

6. A projectile is fired with speed u making angle θ with the horizontal . its potential energy at the highest point is

(a) $(1/2)\ mu^2 \sin^2\theta$

(b) $(1/2)\ mu^2 \cos^2\theta$

© $(1/2)\ mu^2$

(d) $(1/2)\ mu^2 \sin^2 2\theta$

7. if the time of flight of projectile is doubled what happens to the maximum height attained.

(a) halved

(b) remains unchanged

(c) doubled

(d) becomes four times.

8. a body is projected horizontally from the top of a tower with initially velocity 18 ms^{-1}. it hits the ground at angle 45^0. what is the vertical component of velocity when it strikes the ground.

(a) 9 ms^{-1}.

(b) $9\sqrt{2}$ ms^{-1}.

(c) 18 ms^{-1}.

(d) $18\sqrt{2}$ ms^{-1}.

9. A projectile has ν_x = 20m/s. and ν_y = 10 ms. what will be the angle made by the velocity of the body with the vertical.

(a) $\tan^{-1}$ (2.0)

(b) $\tan^{-1}$ (1.5)

(c) $\tan^{-1}$ (1.0)

(d) $\tan^{-1}$ (0.5)

10. The projectile goes farthest away from the earth, when the angle of projection is

(a) 0^0.

(b) 45^0.

(c) 90^0.

(d)180^0.

11. What is the least velocity at which a ball can be thrown through a distance 40 m.

(a) 5 ms^{-1}.

(b) 10 ms^{-1}.

(c) 15 ms^{-1}.

(d) 20 ms^{-1}.

12. a projectile is thrown at an angle of 40^0 with the horizontal and its range is R_1. another projectile is thrown at an angle 40^0 with the vertical and its range R_2. what is the relation between R_1 & R_2.

(a) $R_1 = R_2$.

(b) $R_1 = 2R_2$.

(c) $R_2 = 2R_1$.

(d) $R_1 = 4R_2./5$

13. Two projectiles are fired at different angles with the same magnitude of velocity such that they have same range, at what angles they might have been projected?

(a) 10^0 & 50^0.

(b) 25^0 & 65^0.`

(c) 35^0 & 75^0.

(d)none of the above.

14. The distance traveled by a body dropped from the top of a tower is proportional to

(a) mass of the body

(b) weight of the body

© height of the tower

(d) square of the time elapsed.

15. A bullet is fired horizontally with a velocity of 200 ms^{-1}. if the acceleration due to gravity is 10 ms^{-2}., in the first second it fall through a height of

(a) 5m

(b 10m

(c) 20 m

(d) 200 m.

16. in case of a projectile , what is the angle between the instantaneous velocity and acceleration at the highest point.

(a) zero

(b) 45^0 .

(c) 90^0.

(d) 180^0

17. The projectile has the minimum value of the time of flight when the angle of projection is

(a) 90^0.

(b) 60^0.

(c) 45^0.

(d) 30^0.

18. A projectile is fired at 30^0. with momentum p, neglecting friction, the change in kinetic energy when it returns to the ground will be

(a) zero

(b) 30%

(c) 60%

(d) 100%

19. in the above questions , the change in momentum on return to the ground will be

(a) zero

(b) 30%

(c) 60%

(d) 100%

Numerical bank

20. A projectile of mass m fired with velocity u making angle θ with the horizontal . its angular momentum about the point of projection when it hits the ground is given by

(a) $(2mu \sin^2\theta \cos\theta) / g$

(b) $(2mu^3 \sin^2\theta \cos\theta) / g$

(c) $(mu \sin^2\theta \cos\theta) / g$

(d) $(mu^3 \sin^2\theta \cos\theta) / g$

21. The maximum height attained by the projectile is increased by 5%. Keeping the angle of projection constant. What is the percentage increased in the horizontal range.

(a) 5%

(b) 10%

(c) 15%

(d) 20%

22. The velocity of projection of a body is increased by 2%. Others factors remaining unchanged. What will be the percentage change in the maximum height attained.

(a) 1%

(b) 2%

(c)4%

(d) 8%

23. The range R of a projectile is same when its maximum heights are h_1 & h_2.what is the relation between R , h_1 & h_2?

(a) $R = \sqrt{h_1 h_2}$.

(b) $R = \sqrt{2h_1 h_2}$.

(c) $R = 2\sqrt{h_1 h_2}$.

(d) $R = 4\sqrt{h_1 h_2}$.

24. The friction of he air causes a vertical retardation equal to 10% of the acceleration due to gravity. (take g = $10ms^{-1}$) the maximum height will be decreased by

(a) 11%

(b) 10%

(c)4.5%

(d) 8%

25. in the above question time to reach the maximum height will be decreased by

(a) 19%

(b) 5%

(c) 10 %

(d) none of the above

26. The friction of the air causes vertical retardation equal to one tenth of the acceleration due to gravity (take g = $10ms^{-2}$) the time of flight will be decreased by

(a) 0%

(b)1%

(c)9%

(d) 11%

27. A projectile has time of flight ‘l’ and range R. if the time of flight is doubled , what happens to the range

(A) R/4

(b) R/2

(c) 2R

(d) 4R.

28. two balls of same mass are projected one vertically upwards and the other at angle 60^0. with the vertical. The ratio of their potential energy at the highest point is

(a) 3:2

(b) 2:1

(c) 4:1

(d) 4: 3

29. in the above question the kinetic energy at the highest point for the second ball is K. what is the kinetic energy for the first ball ?

(a) 4K

(b) 3K

(c) 2K

(d) zero

30. A stone thrown upwards with speed u attains maximum height h. another stone thrown upward from the same point with speed 2u. attains maximum height H. what is the relation h & H.

(a) 2h =H

(b) 3h=H

(c) 4h = H

(d) 5h =H

31. A body dropped from the top of a tower covers a distance 7x in the last seconds of its journey, where x is the distance covered in the first second how much time does it take to reach the ground.

(a) 3s.

(b) 4s.

(c) 5s.

(d) 6s.

.33 A ball is thrown down wards with velocity V from the top of a tower and it reaches the ground with speed 3V. what is the eight of the tower.

(a) V^2/g.

(b) $2V^2/g$.

(c) $4V^2/g$.

(d) $8V^2/g$.

33 A ball is projected upwards . The time corresponding to height h while ascending and descending are t_1 & t_2 respectively . what is the speed of projection ? take acceleration due to gravity as 10 m/s^2.

(a) $10t_1$.

(b) $10t_2$

(c) $10(t_1+t_2)$

(d) $5(t_1+t_2)$

34. A ball is dropped from the top of a tower the distance covered by it in the last second is (9/25)th of the height of the tower what is the height of the tower.

(a) 122.5 m

(b) 100.5 m

(c)88.5 m

(d)64.5

35. the instantaneous height y and the horizontal distance x covered by a particle are as follows :

$y = bt^2$., $x = ct^2$.What is the speed of the particle one second after the firing ?

(a) 2(b+c)

(b) 2(b-c)

(c) $2(b^2+c)^{1/2}$

(d) $2(b^2-c^2)^{1/2}$.

36. The range of projectile when fired at 75^0 with the horizontal is 0.5 km . what will be its range when fired at 45^0.

(a) 0.5 km.

(b) 1.0 km

(c) 1.5 km

(d) 2.0 km.

37. A projectile can have the same range R for two angles of projection. If t_1 & t_2 be the times of flight in the two cases then what is the product of two times of flight ?

(a) $t_1t_2 \propto R^2$.

(b) $t_1t_2 \propto R$.

(c) $t_1t_2 \propto 1/R$.

(d) $t_1t_2 \propto 1/R^2$.

38. A projectile is fired with velocity of $10ms^{-1}$. at angle of 60^0. with the horizontal. Its velocity at the highest point is

(a) zero

(b) 5 ms^{-1}.

(c) 8.66 ms^{-1}.

(d) 10 ms^{-1}.

39. The range of a projection is maximum. If the range is R, what is the maximum height.

(a) 2R.

(b) R

(c) R/2

(d) R/4.

40. A projectile is projected with kinetic energy K. it has the maximum possible horizontal range, then its kinetic energy at the highest point will be

(a) 0.25K

(b) 0.5 K

(c) 0.75 K

(d) K.

41. A stone is thrown horizontally with a velocity ν from the top of the tower of height h. what is the change in velocity when the some reaches the ground.

(a) $[u^2+2gh]^{1/2}$.

(b) $[u^2- 2gh]^{1/2}$.

(c) $\sqrt{2gh}$

(d) $[u^2+2gh]^{1/2} – u$

42. A gun fires two bullets at 60^0 & 30^0 with horizontal. The bullet strikes at same horizontal distance. The ratio of maximum height for the two bullets is in the ratio

(a) 2:1

(b) 3:1

(c) 4:1

(d) 1:1

43. A particle of mass ‘m’ is projected with a velocity ν making angle of 45^0 with the horizontal. The magnitude of the angular momentum of the projectile about the point of projection when at the maximum height h is

(a) zero

(b) $m\nu^3 /4\sqrt{2g}$

(c) $m\nu^3 /\sqrt{2g}$

(d) $2m(2gh^3)^{1/2}$.

WORK, POWER & ENERGY

1. The work done against friction , when a body of mass M moves up an inclined plane of angle θ through a distance S is

   (A) Mg $(\sin\theta + \mu \cos \theta)S$.

   (B) $(\mu Mg \sin \theta)S$

   (C) $\mu Mg \cos \theta S$.

   (D) none of the above.

2. When a body of mass M slides down an inclined plane of inclination θ, through distance S, the work done against friction :

   (A) $\mu Mg \cos \theta S$

   (B) $\mu M G \sin\theta S$

(C) Mg ($\mu \sin\theta - \sin\theta$) S.

(D) none fo the above.

3. Which of the following remains constant for an isolated system .

(A) Sum of kinetic energy and potential energy.

(B) Kinetic energy

(C) potential energy

(D) none of the above

4. The slope of the potential energy versus position vector gives

(A) power

(B) work done

(C) force

(D) momentum

5. A particle moves under the influence of a force given by $F = cx$, where c is a constant and x is the distance covered. The energy gained by the particle moving from $x = 0$ to $x = 4$ is :

(A) 2c

(B) 4c

(C) 8c

(D) 16c

6. A vehicle is moving on a rough horizontal road with the velocity ν. The stopping distance will be directly proportional to:

(A) $\sqrt{\nu}$

(B) ν

(C) ν^2.

(D) v^3.

7. A body is acted upon by a force which varies inversely as the distance (x) covered . The work done on the body is proportional t

(A) $\sqrt{x}$

(B) x

(C) x^2.

(D) None of the above.

8. a heavy weight is suspended from a spring Te energy stored in the spring is E. If the weight is raised till the spring comes to its un stretched position and the work done in doing so be W. then gain in gravitational potential energy of the weight will be :

(A) W + E

(B) W – E

(C) W.

(D) E.

9. A block of mass M slides down a rough inclined plane of height h through a slope distance s. I F be the force of the friction then the kinetic energy at the bottom will be

(A) Mgh

(B) Mgs

(C) Mgh – Fs

(D) Mgh + Fs.

10. A body is acted upon by a force which is proportional to the distance covered. If the distance covered by the

denoted by x. then work done by the force will be proportional to

(A) x

(B) x^2.

(C) $x^{3/2}$.

(D) none to the above

11. In which of the following cases the work done increases the potential energy ?

(A) Both conservative and non conservative forces

(B) Non conservative force only.

(C) Conservative force only.

(D) Neither conservative nor non conservative forces.

12. A block of mass M slides down the surface of a bowl of radius R from its sim to the bottom What will be the kinetic energy of the block at the bottom

(A) 2MgR

(B) MgR

(C) MgR / 4.

(D) Mgr/4.

13. A body falls freely under gravity . its velocity is 3 when it has lost potential energy equal to U. What is the mass of the body ?

(A) $U^{2/}\nu^2$.

(B) $2U^2/\nu^2$.

(C) $2U/\nu^2$.

(D) U/ν^2.

14. A rod of mass M and length L is lying on a horizontal table. The work done in making it stand e one end will be

(A) Mgl

(B) Mgl/2.

(C) Mg/4.

(D) 2Mgl

15. A block of mass M slides down a smooth inclined plane of height h through a slope distance s. The kinetic energy of the mass at the bottom will be

(A) Mgh

(B) Mgs.

(C) Mg (h-x)

(D) Mg (h+s)

16. The momentum of a particle is numerically double the kinetic energy. What is the velocity of the particle ?

(A) 1 ms^{-1}.

(B) 2 ms^{-1}.

(C) 4 ms^{-1}.

(D) none of the above

17. A force of 10 N displaces a body by 6 m in 3 seconds. The power of the agency applying the force is :

(A) 1.8 W

(B) 5W

(C) 180 W

(d) none of the above

18. A ball of mass 2 kg moves so that its position x as function of time t is given by $x = t^3/3$. IF x is measured

in meters 7 t in seconds , what is the kinetic energy acquired by the particle in first two seconds.

(A) 16 kJ

(B) 1.6 J

(C) 16 J

(D) 1.6 kJ

19. An electric motor creates a tension of 4500 Newton in a hoisting cable and reels it in at the rate of 2 m/s. what is the power of electric motor

(A) 15 kW

(B) 9kW

(C) 225 watts.

(D) 9000 H.R.

20. A cricket ball is hit at 60^0 to the horizontal with kinetic energy k. when the ball is at the highest point, its kinetic energy will be

(A) zero.

(B) k/4.

(C) k/2.

(D) 3k/4.

21. A body moving at 2 ms^{-1} can be stopped over a distance x. If the kinetic energy of the body is doubled , how long will it go before coming to rest, I the retarding force remains unchanged

(A) x

(B) 2x

(C) 4x

(D) 8x.

22. A man M_1 of mass 80 kg runs up a stair case in 15 s. Another man M2 also of mass 80 kg runs up the same stair case in 20 S. The ratio of the power developed by them will be

(A) 1

(B) 4/3.

(C) 16/9

(D) none of the above.

23. A ball of mass 50 g is thrown upwards . it rises to a maximum height of 100m. At what height its kinetic energy will be reduced to 70%:

(A) 30m

(B) 40m

(C) 60m

(D) 70m

24. A ball is allowed to fall down a height of 10m . if thee is 40% loss of energy due to impact, then after one impact ball will go up to

(A) 10m

(B) 8m

(C) 4m

(D) 6m.

25. A cable pulls a box with force of 5 kN and raises it at the rate of 2 ms^{-1}. What is the power of then engine providing tension to the cable.

(A) 2kW

(B) 2.5 kW.

(C) 5kW

(D) None of the above.

26. Two bodies A and B having mass m and M respectively possess same kinetic energy. Given that M>m. If P_A and P_B be their momenta. Then which of the following statements is true.

(A) $P_A = P_B$.

(B) $P_A > P_B$.

(C) $P_A < P_B$.

(D) it van not be predicted

27. Two bodies A and B having masses m and M respectively possess same momenta. Given that M>m. IF E_A and E_B be their kinetic energies, then which of the following statements is true

(A) $E_A = E_B$.

(B) $E_A < E_B$.

(C) $E_A > E_B$.

(D) it can not be predicted

28. A body starts from rest and acquires a velocity V in time T. then work done on the body in time t will be proportional to

(A) $(V/T)t$

(B) $(V^2/T)t^2$..

(C) $(V^2/T^2)t$..

(D) $(V^2/T^2)t^2$..

29. A body starts from rest and acquires a velocity V in time T. The instantaneous power delivered to the body in time t is proportional to:

(A) (V/T)t.

(B) ((V^2/T)t^2.

(C) (V^2/T^2)t..

(D) (V^2/T^2)t^2..

30. A uniform chain of length L and mass M is lying on a smooth table. One fourth of its length is hanging vertically down over the edge of the table How much work need to be done to pull the hanging part back tot eh table.

(A) MgL

(B) MgL/2

(C) MgL/8

(D) MgL/32

COLLISIONS

1. A rubber ball rebounds after inelastic collision from the floor. Which of the following statements is true ?

   (A) Conservation of energy.

   (B) Conservation of energy remains violated

   (C) Momentum of the ball before collision is equal to that after the collision.

   (D) None of the above.

2. A bullet strikes against a wooden block and is embedded in it, the nature of collisions is

   (A) Elastic.

   (B)Perfectly elastic

   (C) inelastic.

   (D) perfectly inelastic.

3. Which of the following statements is false?

(A) Momentum is conserved in all types of collisions.

(B) Energy is conserved in all types of collisions.

(C) During elastic collisions conservative forces are involved.

(D) Work energy theorem is not applicable to inelastic collisions.

4. A Bullet of mass m is fired with a velocity ν onto a block of wood of mass M and initially at rest. The final velocity of the system will be

(A) [m / (m .+ M)] ν

(B) [M/ (m + M)] ν

(C) [(m +M) /m] ν

(D) [(m + M) /M] ν

5. A ball of mass M moving with velocity ν collides elastically with wall and rebounds .The change in momentum of the ball will be :

(A) Zero.

(B) $M\nu$

(C) 2 $M\nu$.

(D) 4 $M\nu$

6. A show man comes running and stands at the centre at the centre of the rotating platform Considering the platform and the showman a system , which of the following is conserved.

(A) Linear momentum.

(B) Angular momentum.

(C) Kinetic energy

(D) None of the above.

7. A shell of mass M is moving with a velocity V. it explodes into two parts, and one of the parts of mass m is left stationary. What will be the velocity of the other part.

(A) MV/ (M-m)

(B) MV/ (M+m)

(C) mV/ (M-m)

(D) mV/ (M+m)

8. A ball B_1 of mass M is moving with velocity ν along north. It collides with another Ball B_2 of same mass moving with velocity ν along east. After the collisions both balls stick together and move along north east. What will be the velocity of the combination.

(A) ν

(B) 2ν

(C) $\sqrt{2}\nu$

(D) $\nu/\sqrt{2}$

9. A gun of mass M fires a bullet of mass m, what will be the ratio of the recoil energy of the gun to that of the bullet ?

(A) M/m

(B) m/M

(C) m / (m + M)

(D) M/ (M+m)

10. A body is dropped from a height h. after the third rebound it rises to h/2. what is the coefficient the restitution ?

(A) (1/ 2)

(B) $(1 / 2)^{1/2}$.

(C) $(1 / 2)^{1/4}$

(D) $(1/ 2)^{1/6}$.

11. A particle of mass 10 kg moving eastwards with a speed of 5 ms^{-1} collides with another particle of the same mass moving north-wards with the same speed 5 ms^{-1}. The two particles coalesce on collision. The new particle of mass 20 kg will move in the north easterly direction with a velocity

(A) 10 ms^{-1}.

(B) 5 ms^{-1}.

(C) $(5/ \sqrt{2})$ ms^{-1}.

(D) none of these.

12. A bullet is fired on a wooden block. Its velocity reduces by 50% on penetrating 30 cm. How long will it penetrate further before coming to east.

(A) 30 cm

(B) 15 cm

(C) 10 cm

(D) 5 cm

13. A bomb explodes into two fragments of masses 3 kg and 1 kg. total kinetic energy of the fragments is 6 MJ. What is the ratio of the kinetic energies of smaller mass to the larger mass ?

(A) 1/3.

(B) 3.

(C) 1/9.

(D) 9.

14. An automobile engine of mass M accelerates and a constant power P is applied by the engine The instantaneous speed of the engine will be

(A) $[Pt/M]^{1/2}$.

(B) $[2)t/M]^{1/2}$.

(C) $[Pt/2M]^{1/2}$.

(D) $[PT/4M]^{1/2}$.

15. A ball is dropped from a weight h on the ground . if the coefficient of the restitution us e, the height to which the ball goes up after it rebounds for nth time is

(A) he^{2n}.

(B) he^{n}.

(C) e^{2n}/h

(D) h/e^{2n}.

16. A ball of mass m moving with velocity v strikes the bob of a pendulum at res. The mass of the bob is also m. if the collision is perfectly inelastic , the height to which the two will rise is given by :

(A) $\nu^2/8g$.

(b) $\nu^2/4g$.

(C) $\nu^2/2g$

(D) ν^2/g.

17. A body of mass 2 kg is thrown up vertically with K.E. of 490 joules. If the acceleration due to gravity is 9.8 m/s^2 , the height at which the K.E of the body becomes half of its original value is given by :(A)50m

(B) 12. 5m

(C) 25 m

(D) 10m.

18. A bullet of mass 10 g leaves a rifle at a initial velocity of 100 m/s. and strikes the earth at the same level with a velocity of 500 m/s. The work done in joules overcoming the resistance of air will be

(A) 375

(b) 3750

(C) 5000

(D) 500

19. A bullet of mass m and velocity a is fired into a large block of wood of mass M. The final velocity of the system is

(A) $[\alpha / (m + \alpha)]\alpha$

(B) $[(m + M) / m)]\alpha$

(C) $[(m + \alpha) / M]\alpha$

(D) $[m / (m + M))]\alpha$

20. The kinetic energy acquired by a mass m in travelling a certain distance d, starting from rest, under the action of a constant force is directly proportional to

(A) $\sqrt{m}$

(B) independent of m.

(C) $1/\sqrt{m}$.

(D) m.

21. A position dependent force $F = 7 - 2x + 3x^2$ newton

Acts on a small body of mass 2 kg and displaces it from x = 0 to x = 5m. The work done in joules is

(A) 70

(B) 270

(C)35

(D) 135.

22. A bullet of mass a and velocity b is fired into a large block of mass c. the final velocity of the system is

(A) (a + c) / b , b

(B) a / (a + c) , b

(C) (a + b) / c , a

(D) c / (a+ b) , b

23. A ball is dropped from height 10. Ball in embedded in sand 1m and stops .

(A) Only momentum remains conserved. (B) Only kinetic energy remains conserved.

(C) Both momentum and K.E. are conserved (D) Neither K.E. nor momentum is conserved.

24. A bullet is fired and gets embedded in block kept on table, then if tale is frictionless.

(A) Only K.E. is conserved

(B) Only momentum is conserved

(C) Both are conserved

(D) None of these.

25. A moving body of mass m and velocity 3 km/h collides with a resting body of mass 2m and sticks to it. Now the combined starts to move. What will be the combined velocity.

(A) 3 km/h.

(B) 2 km/h.

(C) 1 km/h.

(D) 4 km/h.

26. A ball whose kinetic energy is E, is thrown at an angle of 45o with the horizontal , its kinetic energy at the highest point of its flight will be

(A) E.

(B) F/√2.

(C) E/2.

(D) zero

27. Two bodies of masses m and 4m are moving with equal kinetic energy. The ratio of their linear momentum is

(A) 4 :1

(B) 1 : 1

(C) 1 : 2

(D) 1 : 4

28. A metal ball of mass 2 kg moving with a velocity of 36 km/h has an head on collision with a stationary ball of mass 3 kg, if after the collisions the two balls move together, the loss in kinetic energy due to collision is

(A) 40 J

(B) 60 J

(C) 100 J

(D) 140 J

29. If momentum is increased by 20% then K.E increases by

(A) 44%

(B) 55%

(C) 66%

(D) 77%

30. If a body of mass 200 g falls from a height 200 m and its total P.E is converted into K.E. at the point of contact of the body with earth surface, then what is the decrease in P.E of the body at the contact ?

(A) 200 J

(B) 400 J

(C) 600 J

(D) 900 J

MOTION OF SYSTEM OF PARTICLE AND RIGID BODIES.

QUESTIONS FROM THE COMPETITIVE EXAMS.

1. A bucket tied at the end of a 1.6 m log string is whirled in a vertical circle with constant speed. What should be the minimum speed so that the water from the bucket does not spill when the bucket is at the largest position ?

   (A) 4m/s.

   (B) 6.25 m/s.

   (C) 16 m/s.

   (D) none of the above.

2. The moment of inertia of a circular ring about an axis

assign through its centre and normal to its plane is 200 g x cm^2. then its moment of inertia about a diameter is

(A) 400 g cm^2.

(B) 300 g cm^2.

(C) 200 g cm^2.

(D) 100 gcm^2.

3. A constant torque acting on a uniform circular wheel changes its angular momentum from A_0 to 4 A_0 in 4 seconds. The magnitude of this torque is

(A) $3A_0/4$.

(B) A_0.

(C) $4A_0$.

(D) 12 A_0.

4. An inclined plane makes an angle of 30^0 with the horizontal.. A solid sphere rolling down this inclined plane from rest without slipping has a linear acceleration equal to :

(A) g/3.

(B) 2g/3.

(C) 5g/7

(D) 5g/14.

5. A spherical ball rolls on a table without slipping then the fraction of its total energy associated with rotation is

(A) 2/5

(B) 2/7

(C) 3/5

(D) 3/7

6. A fly wheel rotating a fixed axis has a kinetic energy of 360 J when its angular speed is 30 radians per second. The moment of inertia of the inertia of the flywheel about the axis of rotation is

(A) 0.15 kg m^2.

(B) 0.75 kg m^2.

(C) 0.60 kg m^2.

(D) 0.80 kg m^2.

7. A solid cylinder of mass M and radius R rolls on a flat surface. Its moment of inertia about line of contact is

(A) $2MR^2$.

(B) $3MR^2/2$.

(C) $12MR^2$.

(D) MR^2.

8. A ring of mass m and radius r rotates about an axis passing through its centre and perpendicular to its plane with angular velocity ω. Its kinetic energy is

(A) $\frac{1}{2} mr^2\omega^2$.

(B) $mr\omega^2$.

(C) $mr^2\omega^2$.

(D) $\frac{1}{2} mr^2\omega^2$.

9. A solid cylinder of mass M and radius R rolls down an inclined plane of height h without slipping. The speed of its centre of mass when it reaches the bottom is

(A) $\sqrt{(2gh)}$

(B) $\sqrt{(4gh/3)}$

(C) $\sqrt{(3gh/4)}$

(D) √(4g/h)

10. A thin, uniform circular ring is rolling down in inclined plane of inclination 300 without slipping. Its linear acceleration along the inclined plane will be

(A) g/2

(B) g/3.

(C) g/4.

(D) 2g/3.

11. The speed of a homogeneous , solid sphere after rolling down an inclined plane of vertical height h, from rest without sliding is

(A) 10/7 gh

(B) √gh

(C) 6/5 gh

(D) 4/3 gh

12. A solid homogeneous sphere of mass M and radius is moving on a rough horizontal surface, partly rolling and partly sliding. During this kind of motion of the sphere.

(A) total kinetic energy is conserved.

(B) the angular momentum of the sphere about the point of contact with the plane is conserved

(C) only the rotational kinetic energy about the centre of mass conserved.

(D) angular momentum about the centre of mass of conserved.

13. A particle of mass ‘M’ is moving in a horizontal circle of radius ‘R’ with uniform speed ‘V’. when it moves from one point to a diametrically opposite point , its

(A) kinetic energy changes by $MV^2/4$.

(B) momentum does not change.

(C) momentum changes by 2MV.

(D) kinetic energy changes by MV^2.

14. A body moving in a circular motion with constant speed has

(A) constant velocity

(B) constant acceleration

(C) constant acceleration

(D) constant displacement

15. If a sphere is rolling the ratio of its rotational energy to the total kinetic energy is given by

(A) 10 :7

(B) 2:5

(C) 10 : 7

(D) 2 : 7

16. Angular momentum is

(A) Vector (axial)

(B) Vector (polar)

(C) Scalar

(D) None of the above

17 A body of mass m slides down an inclined plane and reaches the bottom with velocity ν. If the same mass were in form of ring which rolls down this incline , velocity of ring of the bottom would have been

(A) $\nu\sqrt{2}$

(B) ν

(C) $\nu/\sqrt{2}$

(D) $\sqrt{(2/5)}\ \nu$

18. Three points masses each of mass m are placed at the corners of an equilateral triangle of side b. The moment of inertia of the system about an axis coinciding with one side of triangle is :

(A) $3\ mb^2$.

(B) mb^2.

(C) $(3/4)mb^2$.

(D) $(2/3)\ mb^2$.

19. A body is rolling without slipping on a horizontal surface and its rotational kinetic energy is equal to the translational kinetic energy. The body is

(A) disc.

(B) sphere.

(C) cylinder

(D) ring.

20. What remains constant in the field of central force

(A) potential energy

(B) kinetic energy

(C) angular momentum

(D) linear momentum

21. if the moment of inertia of a disc about an axis tangentially and parallel to its surface be I, then what will be the moment of inertia about the axis tangential but perpendicular to the surface

(A) (6/5)I

(B) (3/4)I

(C) (3/2)I

(D) (5/4)I.

22. What remains constant when the earth revolves around the sun ?

(A) Angular momentum

(B)Linear momentum

(C) Angular kinetic energy

(D) Linear kinetic energy.

23. What will be the moment of inertia of a thin rod of mass M and length L about an axis passing through its ends and perpendicular to the length?

(A) $ML^2/3$

(B) $ML^2/12$.

(C) $ML^2/2$

(D) ML^2.

24. A body is whirled in a horizontal circle of radius 20 cm. it has angular velocity of 10 rad/s. What is its linear at any point on circular path ?

(A)10 m/s

(B) 2 m/s.

(C) 20 m/s.

(D) √ m/s.

25. There is a change of angular momentum from J to 4J in 4 seconds, then the torque is

(A) (3/4)J

(B) 1 J

(C) (5/4)J

(D) (4/3) J

26. A couple produces

(A) Purely linear motion

(B) Purely rotational motion.

(C) linear and rotational motion.

(D) no motion.

27. A cylinder of 500 g and radius 10 cm ahs moment of inertia

(A) 2.5×10^{-3} kg m^2.

(B) 2×10^{-3} kg m^2.

(C) 5×10^{-3} kg m^2.

(D) 3.5×10^{-3} kg m^2.

28. A car when passes through a convex bridge exerts a force point which is equal to

(A) $Mg + (M\nu^2/r)$

(B) $M\nu^2/r$.

(C) Mg.

(D) None of these.

29. In which case application of angular velocity is useful

(A) when a body is rotating

(B) when velocity of a body is in a straight line

(C) when velocity is in a straight line

(D) None of these

30. Which of following is the relation of centripetal force?

(A) $m\nu^2/r$.

(B) $m\nu/r$

(C) $m\nu^3/r$

(D)$m\nu^3/r^2$.

31. A body of mass 100 g is rotating in a circular path of radius r cm with constant velocity. The work done in one

complete revolution is

(A) 100 rJ

(B) (r/100) J

(C) (100/r)J

(D) zero

32. The angular velocity of a particle rotating in a circular orbit 100 times per minute is .

(A) 1/66 rad/s

(B) 10.47 rad/s

(C) 10.47 deg/s

(D) 60 deg/s.

33. A Weightless ladder 20 ft long rests against a frictionless wall at an angle of 600 from the horizontal . A 150 pound man is 4ft from the top of the ladder. A

horizontal force is needed to keep it from slipping.

Choose the correct magnitude from the following.

(A) 17.5 lb

(B) 10.0 lb

(C) 12.9 lb

(D) 15.0 lb.

34. A ball of mass 0.25 kg attached to the end of a string of length 1.96 m is moving in a horizontal circle. The string will back if the tension is more than 25 N. What is the maximum speed with which the ball can be moved ?

(A) 14 m/s.

(B) 3 m/s.

(C) 3.92 m/s.

(D) 5m/s.

35. A body of mass 5 kg s moving in a circle of radius 1 m with an angular velocity of 2 rad/s. The centripetal force , is

(A) 10N

(B) 20N

(C) 30 N

(D) 40 N

36. Three identical metal ball each of the radius r are placed touching each other on a horizontal surface such that an equilateral triangle is formed when centre of mass three balls are joined. The centre of mass of the system is located at

(A) horizontal surface

(B) centre of one of the balls.

(C) line joining centers of any two balls

(D) point of intersection of medians

37. A 500 kg car takes a round turn of radius 50 cm with velocity of 36 km/h. The centripetal force is

(A) 250 N

(B) 650 N

(C) 1000 N

(D) 1200 N.

38. Two racing cars of masses m1 and m2 are moving in circles of radii r1 and r2 respectively . their speeds are such that each makes a complete circle in the same time t. the ratio of the angular speeds of the first to the seconds car is

(A) 1 : 1

(B) $m_1 : m_2$

(C) $r_1 : r_2$

(D) $m_1m_2 : r_1r_2$.

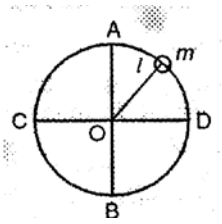
39. The moment of inertia of a disc of mass M and radius R about an axis , which is tangential to the circumference of the disc and parallel to its diameter is

(A) $(3/2)\ MR^2$.

(B) $(2/3)\ MR^2$.

(C) $(5/4)\ MR^2$.

(D) $(4/5)\ MR^2$.



40. A small sphere is attached to a cord and rotates in a vertical circle about a point O. if the average speed of

the sphere is increased, the cord is most likely to break a the orientation .when the mass is at

(A) Bottom point B

(B) the point C

(C) the point D

(D) Top point A.

41. A solid sphere and a hollow cylinder both of the same mass and same external diameter are released from the same height at the same time on an inclined plane. Both roll down without slipping. Which one will reach the bottom first ?

(A) both together

(B) Solid cylinder

(C) One with higher density

(D) Hollow cylinder.

42. A rod of length 1.4 m and negligible mass has two masses of 0.3 kg and 0.7 kg tied to its two ends. Find the location of the point on this rod where the rotational energy is minimum when the rod is located about that point.

(A) 0.98 m from 0.3 kg

(B) 0.7 m from 0.3 kg

(C) 0.98 m from 0.7 kg

(D) 0.7 m to 0.7 kg

43. A body is allowed to slide down a frictionless track freely under gravity. The track ends in a semicircular shaped part of diameter D. What should be the height

from which the body must fall so that it completes the circle ?

(A) D

(B) (5/4)D

(C) (4/5)D

(D) 2D.

44. A body is moving in a circular path with constant speed has

(A) constant acceleration

(B) constant retardation

(C) variable acceleration

(D) variable speed and constant velocity

45. The torque acting on a body is the rotational analogue of

(A) mass of the body.

(B) linear kinetic energy of the body

(C) linear velocity of the body

(D) force in linear motion

(E) linear acceleration

46. If the solid sphere and solid cylinder of same mass and density rotate about their own axis, the moment of inertia will be greater for

(A) solid sphere

(B) solid cylinder

(C) both

(D) equal both.

47. A person is standing on a rotating stool spreading his arms. He suddenly contracts his arms. His

(A) Angular momentum increases.

(B) Moment of inertia increase.

(C) Moment of inertia decreases

(D) Angular momentum decreases

48. A disc is rolling the velocity of its centre of mass is ν cm. which one will be correct.

(A) The velocity of highest point is 2νcm and point of contact is zero.

(B) the velocity of highest point is ν cm point of contact is νcm/

(C) The velocity of the highest point is 2νcm and point of contact is νcm

(D) The velocity of highest point is 2νcm and point of contact is 2νcm.

49. Two particles having masses M and m are moving in a circular path having radius R and r. If their time periods are same then ratio of angular velocity will be

(A) r/R

(B)R/r

(C) 1

(D) $\sqrt{(R/r)}$

50. Initial angular velocity of a circular disc of mass M is ω_1. Then two small sphere of mass m are attached gently to two diametrically opposite points on the edge of the disc. What is the final angular velocity of the disc.

(A) $[(M+m)/M]\omega_1$.

(B) $[(M+m)/m]\omega_1$.

(C) $[M / (M+4m)]\omega_1$.

(D) $[M / (M+2m)]\omega_1$.

51. The minimum velocity (in ms^{-1}) with which a car driver must travels a flat curve of radius 150 m and coefficient of friction 0.6 to avoid skidding is

(A) 60

(B) 30

(C) 15

(D) 25.

52. A solid sphere , a hollow sphere and a ring are released from top of an inclined plane so that they slide down the plane. Then maximum acceleration down the plane is for

(A) solid sphere

(B) hollow sphere

(C) ring

(D) all same

53. Moment of inertia of a circular wire of mass M and radius R about its diameter is

(A) $MR^2/2$.

(B) MR^2

(C) $2\ MR^2$

(D) $MR^2/4$.

54. The angular speed of a flywheel making 120 rev/min is

(A) 4π

(B) $4\pi^2$.

(C) 2π

(D) $2\pi^2$.

55. A solid sphere of radius R is placed on smooth horizontal surface. A horizontal force ‘F’ is applied at height h from the lowest point. For the maximum acceleration of centre of mass, which is correct

(A)h = R

(B)h =2R

(C) h=0

(D) no relation between n and R.

56. A rod of length 3m and its mass acting per unit length is directly proportional t distance x from one of its end then its centre of gravity from that end will be at

(A) 1.5 m

(B) 2m

(C) 2.5 m

(D) 3.0 m

57. A disc is rotating with angular speed ω. If a child sits on it. What is conserved ?

(A) Linear momentum

(B) angular momentum

(C) Kinetic energy

(D) Potential energy

58. Consider a point P at contact point of a wheel on ground which rolls on ground without slipping then value of displacement of point p when wheel competes half of rotation.(if radius of wheel is 1m)

(A) 2m

(B) $\sqrt{(\pi^2+4)}$ m

(C) π m

(D) $\sqrt{(\pi^2+2)}$m

59. A Car is moving with high velocity when it takes a turn. A force acts on it outwardly because of

(A) Centripetal force

(B) Centrifugal force

(C) Gravitational force

(D) All of these

60. the angular momentum of a moving body remains constant if

(A) net external force is applied.

(B) net pressure is applied.

(C) net external torque is applied.

(D) net external torque is not applied.

61. A Scooter is going round a circular road of radius 100m at a speed of 10m/s. The angular speed of the scooter will be

(A) 0.01 rad/s

(B) 0.1 rad/s `

(C) 1 rad/s

(D) 10 rad/s.

62. a solid sphere of mass 50 g and radius 20 cm rolls without slipping wth the velocity 20 cms^{-1}. The total kinetic energy of the sphere will be

(A) 0.014 J

(B) 0.028 J

(C) 280 J

(D) 140 J

63. If 2 kg mass is rotating on a circular path of radius 0.8 m with the angular velocity of 44 rad / sec. if radius of path becomes 1m. Then the angular velocity will be

(A) 28.16 rad/sec

(B) 35.16 rad/sec

(C) 19.28 rad/sec

(D) 8.12 rad/sec

64. A particle performing uniform circular motion has angular momentum L. if its angular frequency is doubled and its kinetic energy halved then the new angular momentum is

(A) L/2

(B) L/4

(C) 2L

(D) 4L

65. A ball rolls without slipping. The radius of gyration of the ball about an axis passing through its centre of mass is K. if radius of the ball be R. then the fraction of total energy associated with its rotational energy will be

(A) K^2/R^2.

(B) $K^2/(K^2+R^2)$

(C) $R^2/ (K^2+R^2)$

(D) $(K^2+R^2) / R^2$.

GRAVITATION

Acceleration due to gravity

1. What is gravitational mass? It is:

(A) A gravitational force exerted by the body.

(B) Gravitational force experienced by the body.

(C) measure of the gravitational force experienced by the body.

(D) measure of the gravitational exerted nor experienced by the body.

2. The gravitational constant depends upon :

(A) size of the bodies.

(B) gravitational mass.

(C) distance between the bodies.

(D) none of the above factors

3. The acceleration due to gravity (on earth) depends upon :

(A) size of the body

(B) gravitational mass of the body.

(C) gravitational mass of the earth.

(D) none of the above factors.

4. The gravitational effect of which of the following causes tidal waves in the sea?

(A) Earth.

(B) moon.

(C)Sun.

(D) None of the above.

5. Suppose, the gravitational attraction of the earth, suddenly disappears (do not ask how) which of the following statement will be true.

(A) Weight of the body will become zero but the mass will remain unchanged.

(B) Weight of the body will remain unchanged but the mass will become zero.

(C) Both mass as well as weight will be zero.

(D) Neither mass nor weight will be zero.

6. The gravitational force of earth on a ball one kilogram is 9.8 N. The attraction of the ball on the earth is :

(A) 9.8 N.

(B) negligible

(C) slightly less than 9.8 N

(D) more than 9.8 N

7. If the gravitational mass of the body on the moon be denoted by M_m and that on the earth by M_e then :

(A) $M_m = 1/6\ M_e$.

(B) $M_m = M_e$.

(C) $M_m = \sqrt{M_e}$.

(D) $M_m = 6\ M_e$.

8. The length of simple pendulum for a given time period is l. if the pendulum is taken to t\a place where acceleration due to gravity is doubled, then for the time period to remain the same its length should be :

(A) 2l.

(B) l

(C) l/2.

(D) 1l4

9. The average magnitude of intensity of the gravitational field on the surface of the earth in SI is about. :

(A) zero.

(B) 10

(C) 100

(D) more than 100.

10. One goes from the centre of the earth to an altitude half the radius of the earth, where will the g be the greatest?

(A) Center of the earth

(B) At a depth half the radius of the earth.

(C) At the surface of the earth.

(D) At an altitude equal to half the radius of the earth.

11. An elevator is rising vertically with an acceleration a. The force exerted by a body of mass M on the floor of the elevator is :

(A) Mg.

(B) Ma.

(C) Mg + Ma.

(D) Mg – ma.

12. A man is carrying a load to his own weight on his head . if he jumps from root of a building , during his fall , the weight experienced by the man will be :

(A) Zero

(B) W

(C) 2W

(D) none of the above.

13. A boy is playing on a swing in sitting position . The time period of oscillations of the swing is T. if the boy stands up, the time period of oscillation of the spring will be :

(A) T.

(B) Less than T.

(C) more than T.

(D) such as cannot be predicted.

14. Let ge and gp be the acceleration due to gravity on the earth and a planet. The radius of the planet as well as its mass is twice that of the earth. Which of the following relations is true ?

(A) $g_p = 4g_e$.

(B) $g_p = 4g_e$.

(C) $g_e = 4g_p$.

(D) $g_e = 2g_p$.

15. You have given 32 identical balls all of equal weight except 1 which is heaver than the others. You are given a beam balance but no weight box. What is the minimum number of weightings required to identify the ball of different weight

(A) 3

(B) 4

(C) 5

(D) 6

16. Two bodies held one above the other at a distance of 50 cm are simultaneously released. What will be their separation after 4 seconds of motion ?

(A) 2.0 m

(B) 1.0m

(C) 0.5 m

(D) 0.25.

17. Given that the acceleration due to gravity at a height h is same as that at the depth d below the surface of the earth. If both h and d are small as compared to the

radius of the earth. Then which of the following relations is correct ?

(A) 2h = d.

(B) h= d

(C) h =2d.

(D) h = d^2.

18. A body of mass M is raised from the surface of the earth to an altitude equal to the radius of the earth . The potential energy gained by he body will be :

(A) MgR/2

(B) MgR.

(C) 2MgR.

(D) None of the above.

19. if the mass and radius of the planet are doubled then acceleration due to gravity on its surface will become.

(A) one fourth

(B) one half.

(C) double

(D) four times.

20. if the radius of the earth decreases by 10% the mass remaining unchanged, what will happen to the acceleration due to gravity ?

(A) Decreases by 19%

(B) Increases by 19%

(C) Deceases by more than 19%

(D) increases by more than 19%

21. Two identical copper spheres each of radius R are in contact with each other. If the gravitational attraction between them is $F\nu$ then which of the following relations is correct ?

(A) $F \propto R^2$.

(B) $F \propto R^4$.

(C) $F \propto 1/R^2$.

(d) $F \propto 1/R^4$.

22. Let g be acceleration due to the gravity on the earth's surface. The gain in the potential energy of an object

of mass m raised from surface of earth to a height equal to radius R of the earth us.

(A) ½ mgR.

(B) 2mgR

(C) mgR.

(D) ¼ mgR.

SATELLITES

23. The synchronous satellite of earth orbits from :

(A) north to south in the polar plane.

(B) south to north in the polar plane.

(C) east to west in equatorial plane.

(D) west to east in equatorial plane.

24. What causes the tail of the comet ?

(A) Centrifugal force pushes away the gases/

(B) Lighter gases are left behind during the orbital motion.

(C) Tail of the comet always exists but becomes visible near the sun.

(D) The radiation pressure from the sun causes the tail.

25. For a satellite to revolve very near to surface of the earth., the orbital velocity should be about :

(A) 3 km s^{-1}.

(B) 8 kms^{-1}

(C) 11 kms^{-1}.

(D) none of the above.

26. A stationary satellite of a planet orbits at :

(A) any height.

(B) a definite height independent of its own mass.

(C) a height depending upon its own mass.

(D) a definite height independent of the mass of the planet.

27. At What angle with the horizontal should a projectile be fire from the top of Mount Everest, with the escape velocity to enable it escape from gravitational pull of the earth ?

(A) Less than 45^0.

(B) 45^0.

(C) More than 45^0.

(D) any angle.

28. A pendulum beats seconds on earth. Its time period on a stationary satellite of the earth will be :

(A) zero.

(B) 1s.

(C) 2s.

(D) infinity.

29. As the radius of the satellite orbit increases , is time period :

(A) decreases

(b)increases.

(C) remains constant

(D) first increases, becomes maximum for stationary satellite and then decreases.

30. To pull in orbit, the satellite should be fired as a projectile with

(a) escape velocity

(B) twice the escape velocity

(C) thrice the escape velocity.

(d) none of the above.

31. The escape velocity for a body projected vertically upwards from the surface of earth is 11 km/s. if the body is projected of 450 with the vertical, the escape velocity will be

(A) 11/√2 km/s.

(B) 11/√2 km/s.

(C) 22 km/s.

(D) 11 km/s.

32. When you move from equator to pole, the value to acceleration due to gravity (g)

(A) increases.

(B) decreases.

(C) remains the same.

(D) increases then decrease.

33 The acceleration due to gravity on the planet A is 9 times the acceleration due to gravity on planet B. A man jumps to a height of 2m on the surface of A. what is the height of jump by the same person on the planet B : (A) 18m.

(B)6m.

(C) 2/3 m

(D) 2/9 m.

34. 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 be now

(A) F.

(B) F/3.

(C) F/9.

(D) 3F.

35. The density of a newly discovered planet is twice that of earth. The acceleration due to gravity at the surface of the planet is equal to that at the surface of the earth. If the radius of the earth is R, the radius of the planet would be

(A) 4R.

(B) ¼ R

(C) ½ R

(D) 2R.

36. A satellite of mass m revolves around earth of radius R at a height x from its surface. If g is the acceleration due to gravity on the surface of the earth, the orbital speed of satellite is

(A) gx.

(B) gR / (R-x)

(C) gR^2 / (R + x)

(D) $[gR^2 / (R + x)]^{1/2}$.

37. Suppose the gravitational force varies inversely as the nth power f distance . Then the time period of a planet in circular orbit of radius 'R' around the sun will be proportional to

(A) $R^{[(n+1)/2]}$

(B) $R^{[(n-1)/2]}$

(C) R^n.

(D) $R^{[(n-2)/2]}$

38 To have an Earth satellite synchronous with the rotation of the Earth, it must be launched at the proper height moving

(a) from west to east in an equatorial plane

(b) from north to south in a polar plane

(c) from east to west in an equatorial plane

(d) from south to north in a polar plane.

39. Ve and Vp denote the escape velocities from the Earth and another planet having twice the radius and the same mean density as the Earth. Then

(a) $V_e = V_p$

(b)Ve= $V_p/2$

(c) $V_e = 2V_p$

(d) $V_e = V_p/4$

40 satellite is orbiting close to surface of the Earth. Its time period is

(a) $2\pi (R / g)^{1/2}$

(b) $2\pi (2R / g)^{1/2}$

(c) $2\pi (R /2 g)^{1/2}$

(d) $2\pi (4R / g)^{1/2}$

41. If R is the radius of the Earth and g the acceleration due to gravity on the Earth's surface, the mean density of the Earth is

(a) $4\pi G/3gR$

(b) $3\pi R/ 4gG$

(c) $3g / 4\pi RG$

(d) $\pi RG/12$

THERMODYNAMICS.

1. A process in which the heat content of the system remains constant is called :

   (A) isobaric.

   (B) isochoric.

   (C) Isothermal

   (D) none of the above.

2. Indicator diagram is a graph between :

   (A) Pressure & temperature.

   (B) Pressure & volume.

   (C) volume & temperature.

   (D) none of the above pairs.

3. Adiabatic is a graph between :

(A) V & T

(B) T & P

(C) P&V

(D) PV &T

4. The first law of thermodynamics is based on the first law of conservation of :

(A) energy

(B) mass

(C) momentum

(D) none of the above.

5. Isothermal is a process represented by the equation

(A) PV = a constant.

(B) P/V = a constant.

(C) P/T = a constant

(D) P/V^{γ} = a constant.

6. In which of following processes all the three thermodynamic variables , that is pressure , volume and temperature can change ?

(A) Isobaric.

(B) Isothermal

(C) Isochoric.

(D) Adiabatic.

7. In which of the processes the internal energy of the system remains constant.

(A) Adiabatic.

(B) Isochoric.

(C) Isobaric.

(D) Isothermal

8. Which of the following is NOT a reversible process ?

(A) Melting of ice.

(B) Conduction of heat

(C) Isothermal expansion of gas.

(D) Adiabatic expansion of gas.

9. Work done in an isothermal expansion of gas depends upon :

(A) temperature alone.

(B) ratio of the initial and final volumes.

(C) both temperature and the ratio of initial and final volumes.

(D) neither temperature nor ratio of initial and final volumes.

10. What makes a cycle tube burst when left in the sun ?

(A) increase in volume

(B) increase of pressure

(C) increase of volume & pressure both.

(D) Neither increase of pressure nor that of volume.

11. What is the change in internal energy of an gas sample over one complete cycle ?

(A) Positive

(B) Negative

(C) Zero.

(D) depends upon the nature of path

12. What is the value of dp/p for a adiabatic expansion of the gas.

(A) dV/V

(B) –dV/V

(C) γdV/V

(D) none of the above.

13. In which of the following processes the work done is the maximum ?

(A) Isothermal

(B) Isobaric.

(C) Adiabatic.

(D) Isochoric.

14. During an adiabatic expansion of 5 moles of gas, the internal energy decreases by 75J. The work done during the process is :

(A) zero.

(B) 15J

(C) -75J

(D)+75 J

15. In a thermodynamic process with 2 moles of gas, 30 J of heat is released and 22 J of work is done on the gas. Given that the initial internal energy of the sample was 20J. What will be the final internal energy ?

(A) 72J

(B) 32J

(C) 28J

(D) 12J

16. A gas at pressure P has volume V. it is adibatically compressed to V/32. if $(32)^{1.4} = 128$, what is the pressure of gas.

(A) 128p

(B) 63p

(C)32p

(D) 16p

17. The ratio of the heat required to raise the temperature of given volume of diamoic gas to that of mono atomic gas through 5^oC at constant volume is

:(A) 1

(B) 1.5

(C)2

(D) none of the above.

18. Compressed air is contained in a cylinder at room temperature. It suddenly start leaking through a hole. Which of the following correctly describes the behaviour of the gas coming out ?

(A) there is no change in its temperature.

(B) it gets cooler.

(C) it becomes hotter

(D) it may get cooler or become hotter.

19. The ratio of the relative rise in pressure for adiabatic compression to that for isothermal compression is

(A) γ

(B) $1/\gamma$

(C) $1-\gamma$

(D) $1/(1-\gamma)$

20. What is the value of isothermal bulk modulus of an of an ideal gas at one atmosphere pressure

(A) 1.01×10^{12} Nm^{-2} .

(B) 1.01×10^{10} Nm^{-2} .

(C) 1.01×10^6 Nm^{-2} .

(D) 1.01×10^5 Nm^{-2} .

21. During adiabatic expansion, the increase in volume is associated with :

(A) increase in pressure and temperature

(B) decrease in pressure and decrease in temperature.

(C) increase in pressure and decrease in temperature

(D) decrease in pressure and increase in temperature.

22. The adiabatic bulk elasticity depends on

(A) pressure & volume

(B) volume and pressure

(C) atomicity & pressure

(D) none of the above

THERMOMETRY & CALORIMETRY & HYGROMETRY.

1. What does Thermal motion mean ?

   (A) Motion due to heat engine.

   (B) disorderly motion of the body as a whole.

   © Motion of the body that generates heat.

   (D) Random motion of molecules.

2. Heat required to raise the temperature of one gram of water through 1^0C is :

   (a) 0.001 kcal

   (B) 0.01 kcal.

   (C) 0.1 kcal.

   (D) 1.01 kcal.

3. The direction of flow of heat between the two bodies is determined by **[P.885- Q.6]**

   (a) kinetic energy

   (B) total energy

   (C) internal energy

(D) none of the above.

4. Magnitude of joule's mechanical equivalent of heat in SI is :

(A) 4.2×10^7.

(B) 4.2×10^3.

(C) 4.2

(D) 1.

5. Taking the unit of work as joule and the unit of amount of heat as kcal, the magnitude of joule's

mechanical equivalence of heat is :

(A) 1

(B) 4.2

(C) 4.2×10^3.

(D) 4.2×10^7.

6. We need mechanical equivalent of heat because :

(A) it converts work into heat.

(B) in cgs system, heat is not measured in the units of work

(C) in SI, heat is measured in the units of work.

(D) of some reason other than those mentioned above.

7. Two blocks of ice when pressed together join to form one block. This happens because :

(A) melting point rises with pressure.

(B) melting point falls with pressure.

(C) heat is absorbed from outside.

(D) heat is rejected to outside.

8. What happens when pressure is raised on the surface of water ?

(A) Boiling point increases and melting point decreases

(B) Boiling point decrease and melting point increases.

(C) Both boiling point as well as melting point increase.

(D) both boiling point as well as melting point increase.

9. In the pressure cooker the cooking is faster because the increase of vapour pressure.

(A) increases latent heat

(B) decreases latent heat.

(C) decreases boiling point.

(D) increases boiling point.

10. A liquid boils at a temperature. At which the pressure of air on its surface is :

(A) equal to vapour pressure.

(B) less than the vapour pressure.

(C) more than the atmosphere.

(D) equal to 760 mm of HG.

11. A bottle of water at 0^oC is opened on the surface of moon. This of the following correctly expresses the behaviour of water in it.

(A) it will freeze.

(B) it will decompose into H_2 and O_2.

(C) It will boil.

(D) none of the above.

12. The running of fan makes us comfortable during summer because it

(A) cools the air.

(B) increase the conductivity of the air.

(C) reduces the thermal radiations

(D) enhances the rate of evaporation of perspiration.

13. On which of the following laws , the constant volume thermometer works.

(A) Boyle's law

(B) Charle's law

(C) Gay Lussac's law

(D) Dalton's law

14. The normal temperature of average human body is :

(A) $37^{o}C$

(B) $37^{o}F$.

(C) 37K.

(D) none of the above.

15. Which of the following at $100^{o}C$ produces most severe burns.

(A) Hot air.

(B) Water.

(C) steam

(D) Oil.

16. Which types of energy is gained or lost by the molecule when ice melts.

(A) kinetic energy is gained.

(B) kinetic energy is lost.

(C) potential energy is gained.

(D) potential energy is lost.

17. Why do we prefer water as the coolant in the radiators of engines in the motor vehicles.

(A) low density.

(B) High thermal capacity.

(C) Low boiling point

(D) Easy availability

18. Air at the bottom temperature is saturated when 40 g of water vapours are present in the room. If the actual amount of water vapours present in the room be 20 g. what is the relative humidity in the room ?

(A) 20%

(B) 40%

(C) 50%

(D) 80%

19. Relative humidity cannot have a value greater than :

(A) 0.2

(B) 0.5

(C) 0.8

(D) 1.0

20. Temperature remaining the same, we feel hotter on the day when the relative humidity is :

(A) High

(B) low

(C) zero

(D) none of these.

21. The temperature inside a room is raised with the help of an electric heater. What happens to the relative humidity.

(A) increases

(B) Decreases.

(C) Unchanged.

(D) Cannot be predicted.

22. What should be the relative humidity in the air conditioned room.

(A) less than 25%.

(B) Between 25 to 50%.

(C) between 50 to 60%

(D) Above 75%

23. Dew point depends upon :

(A) room temperature

(B) amount of water vapours per unit volume

(C) Volume of the air in the room.

(D) none of the above.

24. Find the change in internal energy of the system when a system absorbs 2 kilo –calorie of heat and at the same time does 500 joules of work

(A) 7900 J.

(B) 8200 J

(C) 5600 J

(D) 6400 J

25. a body in a room cools from 85°C to 80°C in 5 seconds. The time taken to cool from 80°C to 75°C is :

(A) 5 minutes.

(B) less than 5 minutes.

(C) more than 5 minutes.

(D) may be less or more than 5 minutes.

26. Boling water is changing into steam. Under this condition , the specific heat of water is :

(A) zero

(B) one

(C) infinite.

(d) less than one.

27. Two blocks of ice when pressed together join to form one block because :

(A) of heat produced during pressing

(B) of cold produced during pressing

(C) melting point of the ice decreases with increases of pressure

(D) melting point of ice increases with increases in pressure.

28. One mole of an ideal gas requires 207 J heat to raise the temperature by 10K 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

(A) 198.7 J.

(B) 29J

(C) 2215.3J

(D) 124 J

29. Which of the following is different from others.

(A) Wavelength

(B) Velocity

(C) Frequency

(D) Amplitude.

30. Alcohol is more volatile than water because

(A) its boiling point is less than water.

(B) it is a organic compound.

(C) its freezing point is less than water.

(D) its vapour pressure is 2.5 minutes higher than water.

Simple Harmonic Oscillations

1. The phase angle between the projections of uniform circular motion on two mutually perpendicular diameter are :

   (A) zero

   (B) $\pi/2$

   (C) $3\pi/4$

   (D) π.

2. A particle executes SHM with a time period of 2s and amplitude of 5 cm. Maximum magnitude of its velocity is :

   (A) $2.5\ \pi$ cm- s^{-1}.

(B) 5 π cm- s^{-1}.

(C) 10 π cm- s^{-1}.

(D) 20 π cm- s^{-1}.

3. Time period of SHM is given by

$T = 2\pi$ [displacement/acceleration] $^{1/2}$. When

displacement increases , the time period.

(A) increases

(B) decreases

(C) remains unchanged

(D) may increase or decrease.

4. The frequency of SHM is 100Hz. Its time period is

(A) 100s

(B) 1s

(C) 0.1 s

(D) 0.01s

5. if E is the total energy of the particle executing SHM and ‘A’ be the amplitude of the vibratory motion, then E and ‘A’ are related as

(A) $E \propto A$

(B) $E \propto 1/A$

(C) $E \propto A^2$.

(D) $E \propto 1/A^2$.

6. The angle between the instantaneous velocity and the acceleration of a particle executing SHM i

(a) zero

(B) $\pi/2$

(C) π

(D) zero or π.

7. The force constant of SHM is measured in

(a) Nm

(B) Nm^{-1}.

(C)N

(D) some either unit.

8. the dimensions of (force constant / mass) $^{1/2}$. are

the same as that

(A) acceleration

(B) angular acceleration

(C) angular velocity

(D) velocity

9. The relation between velocity and amplitude ‘ν’ the displacement amplitude ‘A’ and the angular frequency ‘ω’ of SHM is

(A) $A = \omega\nu$

(B) $\nu = \omega A$

(C) $A = \omega^2\nu$

(D) $\nu = \omega^2 A$.

10. The relation between the acceleration amplitude

‘a’ the displacement amplitude ‘A’ and the angular frequency ω of SHM is

(A) $A = \omega a$

(B) $a = \omega A$

(C) $A = \omega^2 a$

(D) $a = \omega^2 A$.

11. A mass is attached to a vertically held light spring. The spring extends by 1mm due to the weigh of the mass. The time period of oscillations of the mass will be.

` (A) 1

(B) π

(C) 2π

(D) none of the above.

12. A particle executes simple harmonic motion on a straight line path. The amplitude of oscillation is 2cm. When the displacement of the particle from the mean position is 1cm, the magnitude of its acceleration is equal tot hat of its velocity. The time period in seconds of simple harmonic motion is

(A) $2\pi\sqrt{3}$

(B) $2\pi / \sqrt{3}$

(C) $\sqrt{3}/2\pi$

(D) $1/2\pi\sqrt{3}$

13. Two springs of force constants k_1 & k_2 are connected in series. The spring constant of the combination is

(A) k_1+k_2.

(B) $(k_1+k_2.)/2$

(C) $(k_1+k_2.)/k_1k_2$.

(D) $k_1k_2./k_1+k_2$.

14. Two springs of force constants k1 & k2 are connected to each other in parallel . The spring constant of the combination is :

(A) k_1+k_2.

(B) $(k_1+k_2.)$ /2

(C) $(k_1+k_2.)$ / k_1k_2.

(D) k_1k_2./ k_1+k_2.

15. The graph between time period & length of a simple pendulum is :

(A) straight line

(B) curve

(C) ellipse

(D) parabola

16. A tunnel is bored along the diameter of the earth and a stone is dropped into it. What happens to the stone?

(A) it oscillates between the two ends of the tunnel,

(B) it comes to rest at the centre of the earth.

© it will go out of the other end of the tunnel.

(D) it will come to a permanent stop at the other end of the tunnel.

17. A pendulum is suspended from the ceiling of the compartment of a train. When the train is stationary , the time period of the pendulum is T. if the train accelerates, how will the time period of the pendulum change?

(A) it will increase

(B) it will decrease

© it will remains unchanged

(D) pendulum will not oscillate.

18. A pendulum beating seconds is taken from the earth to a planet having both the mass and radius half as compared to the earth. The time period of the pendulum will be ‘

(A) √2 second

(B) 1seond

(C) 2 second

(D) 4 second.

19. A particle executes simple harmonic motion along a straight line path. Its amplitude is A. The potential energy of the particle is equal to the kinetic energy, when the displacement of the particle from the mean position is :

(A) zero

(B) $\pm$ A/2

(C) $\pm$ A/$\sqrt{2}$

(D) $\pm$ A

20. The potential energy of particle executing SHM varies sinusoidal . if the frequency of the

oscillation of the particle is n, that of potential energy is:

(A) n/2

(B) 1/√2

(C) n

(D) 2n.

21. A particle executes SHM. Its instantaneous acceleration is given by a = -px, where p is a constant and x is displacement from the mean position. The angular frequency of the particle is given by

(A) √p

(B) $1/\sqrt{p}$

(C)p

(D) 1/p.

22. a mass m is attached to two springs of same force constants, in accordance with the following four configurations Answer the question given below. Let T_1, T_2, T_3, T_4 respectively be the time period in the configurations (i),(ii),(iii) &(iv).

In which case the time period is largest

(A) (i)

(B) (ii)

(C) (iii)

(D) (iv)

23. Two pendulums oscillates with a constant phase difference of 90^0. if the time period of one is T, that other will be

(A) T/2

(B)T

(C) 2T

(D) 4T.

24. Two pendulums oscillates with a constant phase difference of 90^0. and same amplitude. The

maximum velocity of one is ν. The maximum value of the other will be

(A) ν

(B) $\sqrt{2}\nu$

(C) 2ν

(D) $\nu/\sqrt{2}$.

25. The energy of the particle executing damped oscillations decreases with time, because work is done against

(A) restoring force

(B) elastic tension

(C) frictional force

(D) both restoring force & friction

26. What determines the frequency of natural oscillations of system?

(A) inertia alone

(B) Elasticity alone

(C) Both inertia & elasticity

(D) Neither inertia nor elastic.

27. A particle starts from rest at time t_1 & moving on a straight line path again comes to rest at of time t_2. which of the followings statements about the nature of the following statement about the nature of motion is correct?

(A) motion may simple harmonic

(B) motion must be periodic

© motion cannot be oscillatory

(D) time acceleration cannot change direction with time.

28. a particle is executing SHM of time period 4 seconds. What time will take in going from y =0 to y= half of the amplitude.

(A) 1 second

(B) 1/3 second

(C) 1/5 second

(D) 1/9 second.

29. The time period of a SHM is 16 seconds . it starts its motion from the equilibrium position. After two seconds its velocity if π m/s.What is its displacement amplitude?

(A) $\sqrt{2}$ m

(B) $2\sqrt{2}$m

(C) $4\sqrt{2}$ m

(D) $8\sqrt{2}$m

30. The angular frequency and amplitude of a simple pendulum are ω and A respectively. At the displacement y from the mean position, the kinetic

energy is K and potential energy is U. what is the ratio of K/U?

(A) $MA^2\omega^2\sin^2\omega t$.

(B) $MA^2\omega^2\cos^2\omega t$.

(C) $(A^2 - y^2)/y^2$.

(D) $y^2 / (A^2 - y^2)$.

31. A tunnel is made along a chord inside the earth and a ball is released in it. What will be the time period of oscillation of the ball?

(A) $2\pi\sqrt{(R/2g)}$

(B) $2\pi\sqrt{(R/g)}$

(C) $2\pi\sqrt{(2R/g)}$

(D) $\pi\sqrt{(R/g)}$

32. if the length of a pendulum is quadrupled , its time period is :

(A) quadrupled

(B) halved

(C) doubled

(D) unchanged.

33. The maximum energy of the particle executing SHM with amplitude A is E. what will be its potential energy at displacement y = A/2.

(A) 0.25 E

(B) 0.50 A

(C)0.71 A

(D) 0.86 A.

34. what is the nature of graph between displacement 9y) and acceleration of SHM.

(A) straight line

(B) parabola

(C) hyperbola

(D) Ellipse.

35. if the watch with a wound spring is taken to the moon, it

(A) runs faster

(B) runs slower

(C) does not work

(D) shows no change.

36. A body executes S.H.M. with an amplitude A. At what displacement from the mea position is the potential energy of the body is one fourth of its total energy?

(A) A/4

(B) A/2

(C) 3A/4

(D) some other fraction of A.

37. a particle moves such that its acceleration , a is given by a = -bx, where x is displacement from

equilibrium position and b is a constant. The period of oscillations is

(A) $2\pi/\sqrt{b}$

(B) $2\pi/\sqrt{b}$

(C) $2\pi/b$

(D) $2\sqrt{(\pi/b)}$.

38. A simple harmonic motion has an amplitude A and time period T. the time period required by it to travel from x =A to x =A/2 is :

(A) T/6

(B) T/4

(C) T/3

(D) T/2.

39. A man is standing at a spring platform .reading of spring balance is 60 kg wt. if man jumps outside platform , then reading of spring balance

(A) first increases then decreases to zero.

(B) decreases

(C) increases

(D) remains same.

40. the total energy of simple harmonic motion is E. what will be the kinetic energy of the particle when displacement is half of the amplitude

(A) (3/4)E

(B) E/2`

(C) E/4

(D) E/3.

41. A simple pendulum of length l is suspended from the roof of a train which moves in a horizontal direction with an acceleration a. Then the time T is given by

(A) $2\pi\sqrt{(1/g)}$

(B) $2\pi\sqrt{[l/\sqrt{(a^2+g^2)}]}$

(C) $2\pi\sqrt{[l+(g+a)]}$

(D) $2\pi\sqrt{[l/(g-a)]}$

42. if the spring is extend to length l, then according to Hooke's law

(A) $F = kl$

(B) $F = k/l$

(C) $F = k^2 l$

(D) $F = k^2/l$

43. The P.E. of a particle executing S.H.M. at a distance x from its equilibrium position is

(A) $\frac{1}{2} m\omega^2 x^2$.

(B) $\frac{1}{2} m\omega^2 a^2$.

(C) $\frac{1}{2} m\omega^2 (a^2 - x^2)$

(D) zero.

44. The frequency of LC circuit is

(A) $(1/2\pi)\sqrt{LC}$

(B) $1/2\pi LC$

(C) $(1/2\pi)\sqrt{(L/C)}$

(D) $(1/2\pi)\ 1/\sqrt{LC}$

45. The time period of a simple pendulum is 2 seconds, if its length is increased by 4 times , then its period becomes

(A) 16S

(B) 12 s

(C) 8s

(D) 4s.

46. To make the frequency double of an oscillator , we have to

(A) double the mass

(B) half the mass

© quadruple the mass

(D) reduce the mass to one-fourth.

47. in a simple harmonic motion (SHM) which of the following does not hold.

(A) The force on the particle is maximum at the ends.

(B) The acceleration is minimum at the mean position

© The potential energy is maximum at the mean position

(d) the kinetic energy is maximum at the mean position

48. a body executing SHM has amplitude of 4 cm. what is the distance at which the body has equal value of both K.E. and P.E.

(A) $2\sqrt{2}$ cm

(B) $1/\sqrt{2}$ cm

(C) $\sqrt{2}$ cm

(D) $\sqrt{2}/6$ cm

49. A spring of spring constant K is halved then the new constant is

(A) 2K

(B) K/2

(C) 4K

(D) K/4

50. A spring is vibrating with frequency n under some mass. If it is cut into two equal parts and same mass is suspended then the frequency is

(A) n/2

(B) n

(c) $n\sqrt{2}$

(D) $n/\sqrt{2}$

51. If the equation of an SHM is : $y = a \sin(4\pi t + \phi)$

how much is its frequency

(A) 2

(B) ½

(C) 2π

(D) $1/2\pi$

52. The total energy of particle performing SHM

depend on

(A) k,A,m

(B) k , A

(C) k, A, x

(D) k, x.

53. A child is sitting on a swing . its minimum & maximum heights from the ground are 0.75 m and 2 m respectively . its maximum speed will be

(A) 10m/s

(B) 5 m/s.

(C) 8 m/s.

(D) 15m/s.

54. if a spring has time period T, and is cut into n equal parts , then the time period of each part will be

(A) T√n

(B) $T/\sqrt{n}$

(C) nT

(D) T.

55. What fraction of the total energy is kinetic energy when the displacement is one half of the amplitude?

(A) 1/8

(B) ½

(C) ¼

(D) ¾

56. When the displacement is one half the amplitude in S.H.M., the fraction of the total energy that potential energy is

(A) ½

(B) ¾

(C) ¼

(D) 1/8

(E) 1/6

57. if the displacement equation of a particle be represented by y = A sinpt + B cos pt, the particle executes

(A) a uniform circular motion

(B) a uniform elliptical motion.

© a SHM

(D) a rectilinear motion.

58. A spring mass system oscillates with a frequency ν. If it is taken in an elevator slowly accelerating upward , the frequency will

(A) increase

(B) decrease

(C) remains same

(D) become zero

59. Time period o a simple pendulum will be double, if the length will

(A) decreases two times

(B) decreases four times

© increases four times

(D) increases two times.

60. Energy of simple harmonic motion depends upon

(A) a

(B) $1/a^2$.

(C) $1/a^2$.

(D) a^2.

Doppler's Effect, Musical Sounds and Accoustics of buildings.

1. When both source and listener move in the same direction with a velocity of sound, the change in

   frequency of the sound as detected by the

   listener is :

   (a) zero

   (b) 25%

   (c) 50%

   (d) none of the above.

2. The velocity of sound is 330 ms^{-1}. To hear a sound with 50% higher frequency , a listener should move towards the stationary source with a velocity equal to :

   (a) 330 ms^{-1}.

   (b) 220 ms^{-1}.

   (c) 165 ms^{-1}.

   (d) 110 ms^{-1}.

3. The wavelength of the sound produced by a source 0.8m. if the sound moves towards the stationary listener a 32 ms^{-1}. what will be the

apparent wavelength of the sound? The velocity of sound is 320 ms^{-1}.

(a) 0.32m

(b) 0. 40 m

(c) 0.72 m

(d) 0.80m

4. A source of sound moves toward a stationary listener with a velocity equal to half the velocity of sound. If the actual frequency of the sound produced by the source be f. then the change in he frequency is :

(a) f/4

(b) f/2

(c)f

(d) none of the above

5. The frequency of the waves emitted from a radar is 750 MHz. The frequency of the waves reflected from the aeroplane as observed at the radar station is increased by 2.5 kHz. What Is the speed of the aero plane.

(a) 4 kms^{-S1}.

(b) 2 kms^{-S1}.

(c) 1 kms^{-S1}.

(d) 0.5 kms^{-S1}.

6. The persistence of sound in a hall is called

(a) resonance

(b) acoustics

(c) reverberation

(d) articulation

7. which of the following does not affect the reverberation time ?

(a) Size of auditorium

(b) frequency of the sound

© nature of the walls

(d)area of the walls, ceiling and the floor

8. The sound waves of frequency more than 20 khz are termed as

   (a) supersonic

   (b) audible

   (c) infrasonic

   (d) ultrasonic.

9. Pitch of a note depends upon :

   (a) frequency

   (b) intensity

   (c) amplitude

   (d) none of the above.

10. Loudness of a note increases with the increases in

    (a) amplitude

    (b) wavelength

    (c) quality

    (d) none of the above.

11. Which of the following does not have a subjective existence.

    (a) Loudness

    (b) intensity

    (c) pitch

    (d) Timbre.

12. Major diatonic scale contains eight :

    (a) Pure tones

    (b) harmonics

    (c) overtones

    (d) tonic.

13. Combination of two tones that gives pleasing effect is termed as

    (a) beat

    (b) concord

    (c) chord

    (d) harmony

14. The note of lowest frequency in a musical scale is called :

    (a) tone

    (b) tonic

    (c) note

    (d) overtone.

15. The frequency of the key note on the equally tempered scale is 24. the frequency of the highest note in it will be :

    (a) 36

    (b) 48

    (c) 60

(d) 72.

16. What causes reverberation ?

(a) Reflection

(b) Refraction

(c) Diffraction

(d) interference

17. A particle is vibrating in a simple harmonic motion with an amplitude o 4cm. At what displacement from the equilibrium position its energy half potential and half kinetic?

(a) 1cm

(b) $\sqrt{2}$cm

(c) 3cm

(d) $2\sqrt{2}$ cm.

18. At what speed should a source of sound move so that the observer find the apparent frequency equal to half of the original frequency ?

(a) $\nu/2$

(b) 2ν

(c) $\nu/4$

(d) ν.

19. The Doppler's effect is applicable for

(a) light waves

(b) sound waves

(c) space waves

(d) both a & b.

20. The velocity of light emitted by a source S and observed by an observer O. who is at rest w.r.t. S, is C. if the observer moves towards S with velocity V, the velocity of light as observed will be

(a) C + V

(b) C –V

(c) C

(d) $\sqrt{[1 - (C^2/V^2)]}$

21. A source of sound is moving away from a stationary observer with a speed equal to the speed of sound. The apparent frequency heard by the observer will be

    (a) n^2.

    (b) 2n.

    (c) n/2.

    (d) unchanged.

22. if T is the reverberation time of an auditorium of volume V, then

    (a) $T \propto 1/V$.

    (b) $T \propto 1/V^2$.

(c) $T \propto V^2$.

(d) $T \propto V$.

23. a radar sends a radio signal of frequency 9×10^9 Hz towards an aircraft approaching the radar. If the reflected wave shows a frequency shift of 3×10^3 hz., the speed with which the aircraft is approaching the radar. , in m/s is (velocity of the radio signal is 3×10^8 m/s)

(a) 150

(b) 100

(c) 50

(d) 25.

24. Doppler effect between a source which is at rest or motion and observer which is at motion or rest is based on.

    (a) relative motion.

    (b) source fixed, observer at motion.

    (c) source moving observer at rest

    (d) none

25. A sound wave of wavelength λ travels towards an obstacle with the speed c. The obstacle itself is moving in the opposite direction with speed ν.

How many compressions strike the obstacle in one second ?

(a) $(c + \nu) / \lambda$

(b) $(c - \nu) / \lambda$.

(c) $(c^2 - \nu^2) / c\lambda$.

(d) $(c^2 - \nu^2) / c$.

26. A source of sound emitting a tone of frequency 200 Hz, moves towards an observer with a velocity V equal to the velocity of sound. .if the observer also moves away from the source with the same velocity V, the apparent frequency heard by the observer is :

(a) 50 Hz.

(b) 100 Hz.

(c) 150Hz.

(d) 200 Hz.

27. An object producing pitch of 400 Hz approaches a stationary person in a straight line with a velocity of sound is 300 meters per second. The person will note a change in frequency of as the object files past him equal to :

(a) 1440 Hz.

(b) 240 Hz

(c) 1200 Hz.

(d) 960 Hz.

28. The frequency of the sound car horn as received by an observer towards whom the car is moving differs from the frequency of the horn by 2.5% .assuming that the velocity of the sound of air is 320 m/s. the velocity of the car is

(a) 8 m/s.

(b) 800 m/s.

(c) 7.5 m/s

(d) 6.0 m/s.

29. A stationary engine is blowing siren at a frequency of 1500 Hz.The speed of sound is 340 m/s. The wind starts blowing at speed of 20 m/s. towards the observer . The frequency of the sound heard by the observer will be

(a) no change

(b) 5 Hz.

(c) 10 Hz.

(d) 15 Hz.

30. A source of sound moves on a circle. Let the frequency heard by the observation is n_1,n_2 and

n_3 when the source is at A, B, and C then

(a) $n_1 > n_2 > n_3$.

(b) $n_2 > n_3 > n_1$.

(c) $n_1 = n_2 = n_3$.

(d) $n_1 = n_2$ and n_3 . = 0

30. A source of sound moving towards a stationary observer with speed 50 ms-1. The frequency observed as 1200 Hz. The apparent frequency ,measured by he observer when the source is moving away after crossing the observer is :

(a) 750 Hz.

(b) 900 Hz.

(c) 1350 Hz

(d) 1200 Hz.

31. The fundamental frequency of an open organ pipe is n. if the pipe is immersed in water vertically so that half of it is inside water, what will be the fundamental frequency of the pipe now ?

(a) n/2.

(b)) 3n/4

(c)n

(d) 2n.

32. Due to Doppler effect , the shift in wavelength observed is 0.1 A for a star producing wavelength 6000 A. Velocity of recession of the star will be

(a) 2.5 km/s.

(b) 10 km/s.

(c) 5 km/s.

(d) 20 km/s.

33. The apparent frequency of a note, when a listener moves towards a stationary source with velocity of 40 m/s, is 200Hz. When he moves

away from the same source with the same speed , the apparent frequency of the same note is 160 Hz. The velocity of sound in air is

(a) 360

(b) 330

(c) 320

(d) 340

34. A whistles revolves in a circle with angular aped ω = 20 rad/sec. using a string of length 50 cm. if the frequency of sound from the whistle is 385 Hz, then what is the minimum frequency

heard by the an observer which is far away from the center

(a) 385 Hz.

(b) 374 Hz.

(c) 394 Hz.

(d) 333Hz.

35. A siren emitting sound of frequency 800 Hz is going away from a static listener with a speed of 30 m/s. frequency of the sound to be heard by the listener is

(a) 733.3 Hz

(b) 644.8 Hz.

(c) 481.2 Hz.

(d) 286.hz.

36. A source is moving towards an observer with a speed of 20 m/s. and having frequency of 240 Hz. The observer is now moving towards the frequency heard by observer will be :

(a) 360 Hz.

(b) 280 Hz.

(c) 270 Hz.

(d) 240 Hz.

37. The wave length of light observed on the earth from a moving star is found to decrease by 0.05% to earth. The star is :

(a) coming closer with a velocity of 1.5×10^4 m/s.

(b) moving away with a velocity of 1.5×10^4 m/s.

©) coming closer with the velocity of 1.5×10^5 m/s.

(d) moving away with the velocity of 1.5×10^5 m/s.

38. A siren emitting sound of frequency 500 Hz is going away from a stationary listener with a

speed of 50 m/s. the frequency of sound to be heard directly from the siren is

(a) 286.5 Hz.

(b) 481 Hz.

(c) 434.2 Hz.

(d) 580 Hz.

39. The source of sound generating a frequency of 3 khz reaches an observer with the speed of 0.5 times the velocity of sound in air. The frequency heard by the observer is

(a) 1 KHz

(b) 2 KHz.

(c) 4 kHz.

(d) 6 KHz

40. A car is moving towards a high cliff. The car driver sounds a horn of frequency f. The reflected sound should heard by the driver has frequency 2f. if ν be the velocity of sound, then the velocity of car , in the same velocity units will be :

(a) $\nu/3$

(b) $\nu/4$

(c) $\nu/2$

(d) $\nu/\sqrt{2}$.

Doppler's effect, Musical sounds & Accoustics Multiples.

BEATS

1. The first overtone produced by a closed organ pipe is of frequency f. the first overtone produced by an open organ pipe of same length will be of frequency

   (a) 2f

   (b) f

   (c) f/2

   (d) none of the above.

2. The distance between two consecutive nodes on a stretched string is 10 cm. it is in resonance with a turning fork of frequency 256 Hz. What is the string ?

   (a) 51.20 ms^{-1}.

   (b) 25.60 ms^{-1}.

   (c) 12.80 ms^{-1}.

(d) 6.40 ms^{-1}.

3. The string of a sono meter is divided into two parts with the help of a wedge. The total length of the string is 1m and the two parts differ in length by 2mm. when sounded together they produced two beats. The frequencies of the notes emitted by the two parts are ::

(a) 499 and 497

(b) 501 and 499

(c) 510 and 503

(d) none of the above.

4. A cylindrical tube open at both ends produces fundamental note of frequency 256 Hz.The tube is dipped vertically in water so that half of it is in water.

The air column in tube will be in (first) resonance with a tuning fork of frequency :

(a) 128 Hz.

(b) 256 Hz.

(c) 512 Hz.

(d) none of the above.

5. A tuning fork produces 5 beats with sonometer wires of 40 cm as well as 44 cm, other factors remaining unchanged. The frequency of the tuning fork is :

(a) 80 Hz.

(b) 88 Hz.

(c) 105 Hz.

(d) 160 Hz.

6. Two tuning forks when sounded together produce 5 beats per second. The first tuning forks is in resonance with 16.0 cm wire of a sono- meter and the second is in the resonance with 16.2 cm wire of the same sono meter. The frequency of the tuning forks are

   (a) 100 Hz, 105 Hz.

   (b) 200 Hz, 205 Hz.

   (c) 300 Hz, 305 Hz.

   (d) 400 Hz., 405 Hz.

7. A vibrating tuning fork of frequency 480 Hz is held at the mouth of a resonant frequency 484 Hz. What is the number of beats produced.?

   (a) 8

   (b) 4

(c) 2

(d) zero.

8. The tuning forks when sounded together give one beat every 0.2 s. what is the difference of frequencies.

(a) 0.2

(b) 2

(c) 5

(d) 10.

9. The fundamental frequency of an open organ pipe is n. if the pipe is immersed in water vertically, so that half of it is inside water, what will be the fundamental frequency of the pipe now

(a) n/2

(b) 3n/4

(c) n

(d) 2n.

10. The distance between two consecutive nodes in a Kundt's tube is

(a) $\lambda/4$.

(b) $\lambda/2$

(c) 2λ

(d) λ

11. A tuning fork of frequency 340 is vibrated just above the tube of 120 cm. height. Water is poured slowly in the tube. What is the minimum height of water necessary for the resonance ? (speed of sound in air = 30 m/sec)

(a) 15cm

(b) 25 cm

(c) 30 cm

(d) 45 cm.

12. A tuning fork of 500 Hz. Is sounded on a resonance tube. The first and the second resonance are obtained at 17 cm and 52 cm. The velocity of sound in m/s is

(a) 170

(b) 350

(c) 520

(d) 850

13. A tuning fork of known frequency 256 Hz. Makes 5 beats per second with the vibrating string of a piano. The beat frequency decreases to 2 beats per second when tension is in the piano string is slightly increased.

The frequency of the piano string before increasing the tension was

(a) 256 + 5 Hz.

(b) 256 + 2 Hz.

(c) 256 – 2Hz.

(d) 256 – 5 Hz.

14. On vibrating a tuning fork of frequency 256 Hz. With another fork A. 6 beats per second are heard. On loading A, again fork A, 6 beats per second are heard. The frequency of A will be

(a) 262 Hz.

(b) 250 Hz.

(c) 268 Hz.

(d) 244 Hz.

15. A tuning fork produces 4 beats per sec. with 49 cm and 50cm lengths of a stretched wire of a sonometer. The frequency of the fork is :

    (a) 693 Hz.

    (b) 396 Hz.

    (c) 296 Hz.

    (d) 196 Hz.

16. The wavelength of a stationary waves produced in a stretched string of length 1 will be

    (a) 2ln

    (b) 2l/n

    (c) $l^2/2n$.

    (d) $n^2/2l$.

17. By which of following waves energy is not carried ?

(a) stationary waves

(b) longitudinal progressive waves.

© transverse progressive waves.

(d) electromagnetic waves.

18. The number of beats produced per second is equal to the

(a) sum of frequencies of two forks.

(b) difference of frequencies of two forks.

(c) ratio of frequency of two forks.

(d) product of frequency of two forks.

19. When a tuning fork of frequency 100 Hz is sounded with an unknown fork , then 2 beats per sec. are produced. On loading the unknown fork with wax. 1

beta per sec is produced. The frequency of the unknown fork is

(a) 101 Hz.

(b) 102 Hz.

(c) 98Hz.

(d) 99 Hz.

COULOMB'S LAW

1. Conservation of electric charge implies that :

(A) charge exists on particles.

(B) charge cannot be destroyed.

(C) Simultaneous creation of equal and opposite charges is permissible.

(D) the number of charged particles in the universe is constant.

2. 10^6 are taken out of a pith ball. The charged on the pith ball will be :

(A) 1.6×10^{-25} C.

(B) 1.6×10^{-19} C.

(C) 1.6×10^{-13} C.

(D) none of these.

3. The minimum amount of charged observed so far is

(A) 1C

(B) 4.8 x 10^{-13} C.

(C) 1.6 x 10^{-19} C.

(D) none of the above

4. A positively charged glass rod is brought near the disc of the uncharged gold leaf electroscope. The leaves diverge. Which of the following statements is correct ?

(A) No charge is present on the leaves.

(B) Positive charge is induced on the leaves.

© Negative charge is induced on the leaves.

(D) Positive charge is induced on one leaf & negative charge is induced on the other leaf.

5. Mid way between the two equal and similar charges , we place the third equal and similar charge . which of the following statements is correct ?

(A) The third charge experienced a net force inclined to the line joining te charges.

(B) The third charge is in stable equilibrium

(C) The third charge is in unstable equilibrium

(D) The third charge experienced a net force perpendicular to the line joining the charges

6. Two charges are placed a certain distance apart a metallic sheet is placed between them. What will happen to the force between the charges

(A) Increases.

(B) Decreases

(C) Remains unchanged

(D) May increase or decrease depending on the nature of the metal.

7. Two charge of 2μC & 5 μC are placed 2.5 apart. The ratio of the Coulomb's force experienced by them is :

(A) 1:1

(B) 2 :5

(C) $\sqrt{2} : \sqrt{5}$

(D) 4 : 25.

8. The dielectric constant of an insulator cannot be :

(A) 1.5

(B) 3

(C) 4.5

(D) ∞

9. The ratio of the force between two charges in vacuum at a certain distance apart to that between the same charges, the same distance apart in a medium of permittivity ε is

(A) ε :1

(B) 1 : ε

(C) ε_0 : ε

(D) none of the above.

10. What happens when charged is place on a soap bubble.

(A) it collapses

(B) its radius increases

(C) its radius decreases

(D) none of the above.

11. There are two charges +3 micro coulomb and +8 micro coulomb . The ratio of the forces acting on them will be

(A) 3 :1

(B) 1 :1

(C) 1 :8

(D) 1 :11

12. What is the charge in the weight of a body which is charged by rubbing ?

(A) Weight always decreases slightly

(B) Weight always increases slightly.

(C) Weight may increases or decreases slightly.

(D) Weight remains precisely the same

13. When a glass rod rubbed with a silk is brought near the gold leaf electroscope , the leaves diverge. What is the charge on the leaves.

(A) Negative

(B) Equal and opposite

(C) Positive

(D) Either positive or negative

14. In the above question if the glass rod is brought in contact with the disc of gold leaf electroscope, the leaves diverge. What is the charge on the leaves.

(A) Negative

(B) Positive.

(C) Either negative or positive

(D) Unpredictable

15. What is the ratio of forces acting on two charges +1 micro coulomb and -5 micro coulomb ?

(A) 1 : 5

(B) 5 : 1

(C) 1 :10

(D) 1 :1

16. Two charges q_1 ,q_2 are placed in vacuum at a distance d, and the force acting between them is F. if a medium of dielectric constant 4 is introduced around them, the force will be :

(A) 4F

(B) 2F

(C) F/2.

(D) F/4.

17. If a soap bubble is charged with negative charged , its radius

(A) will decrease

(B) will increase

(C) will remain same

(D) data is not sufficient.

18. The ratio of the force between two tiny bodies the constant charges in air and in the insulating medium of dielectric constant ‘K’ is

(A) 1 :k

(B) k :1

(C) 1 :k^2.

(D) k^2 :1

19. a body can be negatively charged by

(A) giving excess of electrons to it.

(B) removing some electrons from it.

(C) giving some protons to it

(D) Removing some neutrons from it.

20. When air is replaced by dielectric medium of constant k, the maximum force of attracted between two charges separated by a distance

(A) decreases k times.

(B) remains unchanged.

© increases k times.

(D) increases k^{-1} times.

21. If the distance between two charges is doubled and both the charges are also doubled then the force between them will

(A) be doubled.

(B) remains the same.

(C) become half.

(D) become four time.

22. The ratio of gravitational force of interaction to the electric force of interaction between two electrons of the order of :

(A) 10^{-36}.

(B) 10^{-38}.

(C) 10^{-42}

(D) 10^{-43}.

23. The ratio of the forces between two small spheres with constant charges (a) in air (b) in a medium of dielectric constant K is respectively

(A) 1 :K

(B) K :1

(C) 1:K^2.

(D) K^2:1

24. A force of 40 N is acting between two charges in air. If the space between them is filled with glass with ε_r = 8, what will be the force ?

(A) 15N.

(B) 320N.

(C) 5N.

(D) 32N.

25. Two point charges placed at a certain distance apart in air, interact with a force F. If the air is replaced by a

medium of dielectric constant K, the forces between them becomes/remains :

(A) F

(B) F/K

(C) KF

(D) F/√K.

26. Two charges q_1 ,q_2 are placed in vacuum at a distance d, and the force acting between them is F. if a medium of dielectric constant 4 is introduced around them , the force now will be

(A) 4F.

(B) 2F.

(C) F/2.

(D) F/4.

27. When a body is earth connected , the electrons from the earth flow into the body. This means the body is

(A) Charged negatively.

(B) An insulator

(C) Uncharged.

(D) Charged positively.

28. The ratio of electric force between two electrons to the gravitational force between them is of the order of :

(A) 10^{42}.

(B) 10^{39}.

(C) 10^{36}.

(D) 1.

29. A force F acts between two equal and opposite charges which are placed at a certain distance apart. If 25% of one charge is transformed to the other, then what is the force between them.

(A) F

(B) 9F/16.

(C) 15F/16.

(D) 4F/5.

30. What is the ratio of the charges of two conducting spheres of radii r1 & r2 which have equal surface charge density ?

(A)$(r^2{}_1/r^2{}_2)$

(B) $(r^2{}_2/r^2{}_1)$

(C) (r_1/r_2)

(D) (r_2/r_1)

31. A charge Q is divided into two parts q and Q-q and separated by a distance R. the force of repulsion between them will be maximum when :

(A) q = Q/4.

(B) q =Q/2

(C) q =Q

(D) none of these.

32. Two equal charge are separated by a distance d. A third charge place on a perpendicular bisector at x distance will experience maximum coulomb force when

(A) $x = d/\sqrt{2}$

(B) x = d/2.

(C) $x = q / 2\sqrt{2}$

(D) $x = d / 2\sqrt{3}$.

33. Two equal unlike charges placed 3 cm apart in air attract each other with a force of 40N. the magnitude of each charge in micro coulomb is

(A) 0.2.

(B) 2.

(C) 20.

(D) 200

34. If a charge q is placed at the centre of the joining two equal like charges Q. The system of three will be in equilibrium if q is

(A) –Q/2

(B) –Q/4.

(C) +Q/2.

(D) +4Q.

ELECTROMAGNETIC WAVES.

1. Which of the following has the dimensions of charge ?

(A) $\varepsilon_0 \vec{E} / \vec{dS}$.

(B) $\mu_0 \vec{E} . \vec{dS}$.

(C) $(\mu_0 / \varepsilon_0) \vec{E} . \vec{dS}$.

(D) $(\varepsilon_0 / \mu_0) \vec{E} . \vec{dS}$.

2. Displacement current is set up between the plates of the capacitor when the potential difference across the plates is :

(A) maximum

(B) zero

(C) minimum

(D) varying

3. The frequency of the visible light is of the order of

(A) 10^7.

(B) 10^{11}.

(C) 10^{15}.

(D) 10^{19}.

4. if there were no atmosphere , the average temperature on the surface on the earth would be

(A) lower

(B) higher

(C) Same as now.

5. Which of the following relations is correct?

(A) $\sqrt{\varepsilon}\, E_0 = \sqrt{\mu_0}$.

(B) $E_0 = \sqrt{(\mu_0\varepsilon_0)}B_0$.

(C) $\sqrt{(\mu_0\varepsilon_0)}E_0 = B_0$

(D) $\sqrt{\mu_0}\, E_0=\sqrt{\varepsilon_0}\, B_0$.

6. In the electromagnetic waves , the average energy density associated with the magnetic field is given by

(A) ½ (B^2/μ_0)

(B) ½ $(\mu_0 B^2)$

(C) ½ (B^2/ε_0)

(D) ½ $(\varepsilon_0 B^2)$

7. If the area of telecast of a T.V. telecast to be doubled. Then the height of transmitting antenna will have to be

(A) halved.

(B) doubled

(C) quadrupled

(D) unchanged

8. In a plaze em wave , the amplitude of electric field oscillations of frequency 10^{16} Hz is 48 V/m. What is the amplitude of magnetic field oscillations.

(A) 48 Wb/m^2.

(B) 16 Wb/m^2.

(C) 4 8 x 10^{-8} Wb/m^2.

(D) 16 x 10^{-8} Wb/m^2.

9. The energy of the cm waves is of the order of 15 keV. To which part of the spectrum does it belong ?

(A) γ-rays

(B)X-rays

(C) Infra red

(D) Ultra violet

10. A coil of copper having 1000 turns is placed in a magnetic field perpendicular to its axis. The cross – sectional area of the coil is $0.05m^2$. if it turns through 180^0 in 0.01 second, then the EMF induced in the coil is

(A) 0.4 V.

(B) 0.2 V

(C) 0.04 V

(D) 4V.

11. Weber/m2 is equal to :

(A) volt

(B) henry

(C) tesla

(D) all of these.

12. A step-up transformer operates on a 230 V line supplies a load of 2 ampere. The ratio of the primary and secondary winding is 1 : 25 . the current in the primary is

(A) 15 A

(B) 50 A

(C) 25 A.

(D) 12.5 A

13. 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 / second. The maximum value of e.m.f. in the second coil is :

(A) 2π

(B) 5π

(C) π

(D) 4π

14. A 220 V, 50Hz. A.C. source is connected to an inductance of 0.2 H and a resistance of 20 ohm in series. What is the current in the circuit ?

(A) 10 A

(B) 5 A

(C) 33.3 A

(D) 3.33 A

15. Assertion: In series LCR circuit , the resonance occurs at one frequency only

Reasons : At resonance the inductive reactance is equal and opposite to the capacitive reactance.

(A) if both Assertion and reason are true and the reason is correct explanation of the Assertion.

(B) If both Assertion and Reason are true, but Reason is not correct explanation of the Assertion.

(C) If Assertion is true, but Reason is false.

(D) If Assertion is false, Reason is true.

16. The best material for the core of a transformer , is

(A) stainless Steel

(B) mild steel

(C) hard steel

(D) soft steel.

17. Reactance of a capacitor of capacitance CμF for A.C. of frequency (400/π) Hz is 25Ω. The value of C is

(A) 25

(B) 50

(C) 400

(D) 100

18. an inductance L having a resistance R is connected to an alternating source of angular frequency ω. The quality factor (Q) of the inductance is

(A) R/ωL

(B) $(R/wL)^{1/2}$.

(C) $(\omega L/R)^2$.

(D) ωL/R.

19. The henry is the unit for

(A) resistance

(B) magnetic flux.

(C) magnetic field

(D) inductance

20. In an A.C. circuit , the flowing current is I = 5 sin (100t - π/2) a and the potential difference is V = 200 sin (100t) V. . the power consumption is equal to

(A) 100W

(B) 40 W

(C) 20W

(D) 0 H

21. The negative sign in the equation e = -dϕ/dt indicates

(A) emf is always taken negative

(B) current density is negative

(C) induced emf opposes the cause producing it.

(D) none of the above.

22. The number of turns in the coil are doubled, the emf will get

(A) doubled

(B) halved

(C) quadrupled

(D) none of these.]

23. Electromagnetic waves are transverse in nature is evident by

(A) polarization

(B) interference

(C) reflection

(D) diffraction

24. Which of the following are not electromagnetic waves ?

(A) cosmic rays

(B) gamma rays

(C) β-rays

(D) X-rays.

25. The power factor of an AC circuit having resistance (R) and inductance (L) connected in serried and an angular velocity w is

(A) $R/\omega L$

(B) $R/ (R^2 + \omega^2 L^2)^{1/2}$.

(C) $\omega L/R$

(D) $R/ (R^2 - \omega^2 L^2)^{1/2}$.

26. In an transformer, number of turns in the primary are 140 and that in the secondary are 280. if current in primary is 4A, then that in the secondary is

(A) 4A

(B) 2A

(C) 6A

(D) 10A.

27. The maximum distance up to which TV transmission from A TV tower of height h can be received is proportional to :

(A) $h^{1/2}$.

(B) h

(C) $h^{3/2}$.

(D) h^2.

28. The peak value of alternative current is $5\sqrt{2}$ ampere.

The mean square value of current will be

(A) 5A

(B) 2.5 A

(C) $5\sqrt{2}$ A

(D) none of these.

29. Alternative current can not be measured by D.C.

ammeter because

(A) A.C. can not pass through D.C. Ammeter

(B) A.C. changes direction

(C) average value of current for complete cycle is

zero.(D) D.C. ammeter will get damaged.

30. Which of the following is the unit of displacement

current ?

(A) Cs^{-1}.

(B) Vs^{-1}.

(C) Vm^{-1}.

(D) Cm^{-1}.

QUESTIONS FROM THE COMPETITIVE EXAMS.

1. Equation of position x with time (t) is given by equation x = $3t^3 + 7t^2 + 5t+8$. The acceleration at time t = 1 sec is

(CBSE, PMT 2000]

(1) 1 8m/sec^2.

(2) 32m/sec^2.

(3) Zero

(4) 14 m/sec^2.

2. A man slides down an inclined plane and drops a bag from the position to the ground. If the velocities of man and bag on reaching the ground are V_M and V_B respectively. (IIT, 2001]

(1) $\nu_M > \nu_B$.

(2) $\nu_M < \nu_B$.

(3) $\nu_M = \nu_B$.

(4) Depend on their mass.

3. A ship of mass 3×10^7 kg initially at rest is pulled by a force of 5×10^4 N through a distance of 3 m. Assuming that the resistance due to water is negligible . What will be the speed of the ship.

(1) 0.1 m/sec.

(2) 1.5m / sec.

(3) 5 m/sec.

(4) 60 m /sec. **(ALEEE, 2000)**

4. If for a particle position $x \propto t^2$., then :

(PMT, 2001)

(1) velocity is const.

(2) acceleration is const

(3) acceleration is variable

(4) none.

5. Relation between displacement x and time t is $x= 2-5t+6t^2$. the initial velocity will be : - **(IIT,2000)**

(1) -3 m/sec.

(2) 12 m/sec.

(3) 2 m/sec.

(4) – 5 m/sec.

6. A force pf 100 dyne acts on a mass of 5 gm for 5 seconds . The velocity in 10 sec is

(1) 200 cm/sec.

(2) 200 cm/sec.

(3) 20 cm/sec.

(4) 2 cm/sec **(AIEEE,2001)**

7. Velocity of a body on reaching the point, from which it was projected upwards is **(AIEEE,2000)**

(1) v = 0

(2)v = 2u

(3)v = 0.5 u

(4) v= u

8. A man runs towards a mirror at a speed of 1 5m/s. what is the speed of this image. **CBSE, 2001)**

(1) 7.5 m/s.

(2) 15 m/s.

(3) 30 m/s.

(4) 45 m/s.

9. A coin falls faster than a scrap of paper when dropped

from the same height because for coin :

(1) gravitational acceleration is more

(2) gravitational acceleration is less.**(IIT, 2002)**

(3) air resistance is less.

(4) none of these.

10. A particle starts from rest with constant acceleration .The ratio of space average velocity to the time average velocity is **(AIIMS ,2002)**

(1) ½

(2) ¾

(3) 4/3

(4) 3/2

11. A stone is allowed to fall from the top of a tower and covers half the height of the tower in the last second of

its journey. The time taken by the stone to reach the foot of the tower is **(AIEEE,2001)**

(1) $(2-\sqrt{2})s$

(2) $(2+\sqrt{2})s$

(3) 4s.

(4) $(2 \pm \sqrt{2})s$.

12. The displacement x of a particle moving in one dimension is related to time by the equation $t = \sqrt{(x + 3)}$ where x is in meters and t in seconds. The displacement when velocity is zero is

(1) 0m

(2) 1m

(3) 9m

(4)4m. **(IIT, 2002)**

13. A car moving with a speed of 40 km/h can be stopped by applying brakes after 2m. if the same car is moving with a speed of 80 km/h. what is the minimum stopping distance. **(PMT, 2000)**

(1) 8m

(2) 6m

(3) 4 m

(4) 2m

14. From a building two balls a and B are thrown such that a is thrown upwards and B downwards (both vertically) if ν_A and ν_B are their respective velocities on reaching the ground , then

(1) $\nu_B > \nu_A$.

(2) $\nu_B = \nu_A$.

(3) $\nu_B > \nu_A$. **(AIEEE,2002)**

(4) their velocities depend on their masses.

15. A lift is moving down with acceleration a. A man in the lift drops a ball inside the lift. The acceleration of the ball as observed by the man in the lift and a man standing stationary on the ground re respectively.

(AIEEE, 2002)

(1) g, g

(2) g- a , g-a

(3) g-a, g

(4) a,g

16. Speeds of two identical cars are u and 4u at a specific instant. The ratio of the respective distances in which

the two cars are stopped from that instant is **(AIEEE,2002)**

(1) 1 : 1

(2) 1 : 4

(3) 1 : 8

(4) 1 : 16

17. A spring balance is attached to the ceiling of a lift. A man hangs his nag on the spring and the spring reads 49 N, when the lift is stationary . if lift moves downwards with an acceleration of 5m /s^2. the reading of the spring balance will be **(CBSE,2002)**

(1) 24 N

(2) 74 N

(3) 15 N

(4) 49 N.

18. The co-ordinates of a moving particle at any time t are given by $x = \alpha t^3$. and $y = \beta t^3$. The speed of the particle at time t is given by **(IIT,2003)**

(1) $3t \sqrt{(\alpha^2 + \beta^2)}$

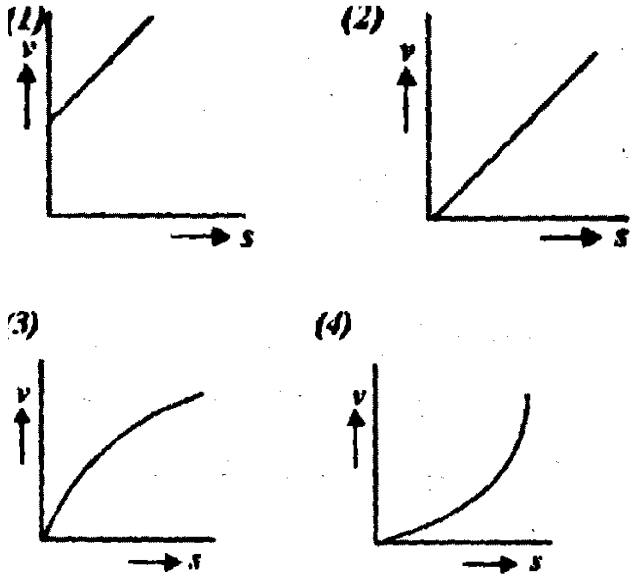
(2) $3t^2 \sqrt{(\alpha^2 + \beta^2)}$

(3) $t \sqrt{(\alpha^2 + \beta^2)}$

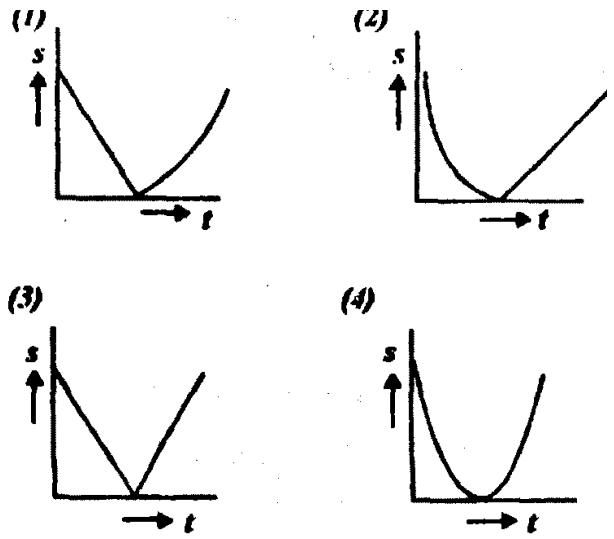
(4) $\sqrt{(\alpha^2 + \beta^2)}$

19. A bode starting from rest moves along a straight line with a constant acceleration. The variation of speed (ν) with distance (s) is represented by the graph.

(AIIMS,2002)



20. A ball is thrown vertically upwards. Which of the following plots represents the speed time graph of the ball during its flight if the air resistance is not ignored. (AIIMS,2003)



21. A particles moves in a line with retardation proportional to its displacement its loss for kinetic energy for any displacement x is proportional to **(IIT,2002)**

(1) $\log_e x$

(2)e^x.

(3) x.

(4) x^2.

22. A ball is released from the top at a tower of height h meters. It takes T seconds to reach the ground. What is the position of the ball at $T^{1/3}$ second. **(PMT,2002)**

(1) 17h/18 meters from the ground.

(2) 17h/9 meters from the ground

(3) 8h/9 meters from the ground

(4) h/9 meters from the ground

23. A particle is moving with a velocity of 5m/s. towards east. After 10 sec, its velocity changes to 5 m/s. towards north. Then its acceleration is **(IIT, 2003)**

(1) zero

(2) $\sqrt{2}$ m/s^2.

(3) $1/\sqrt{2}$ m/s^2.

(4) 1 m/s^2.

24. A particle has displacement of 12 m towards east and 5m towards north then 6 m vertically upward. The sum of these displacements is **(CBSE,2003)**

(1) 12.

(2) 10.04 m.

(3) 14.31 m

(4)none of these

25. A bullet is fired from a rifle recoils freely, then K.E of the rifle is **(AIIMS, 2002)**

(1) less than that of bullet

(2) equal to that of bullet

(3) greater than that of bullet

(4) none of these.

26. A doubly ionized helium ion and a hydrogen ion are accelerated through the same potential. The ratio of the speeds of helium and hydrogen ions is **(AIEEE, 2002]**

(1) 1 : 2

(2) 2 :1

(3) 1 : $\sqrt{2}$

(4) $\sqrt{2}$: 1

27. A particle of mass 'm' moving with velocity 'v' collides in elastically with a stationary particle of mass '2m' The speed of the system after collision will be – **(AIEEE,2003)**

(1) $\nu/2$

(2) 3ν

(3) $\nu/3$

(4) 3ν

28. A boy carrying a box on his head is walking on a level road one place to another on a straight road is doing 'no work' This statement is **(IIT,2003)**

(1) correct

(2) incorrect

(3) partly correct

(4) insufficient data

29. A body of mass 5 kg has momentum of 10 kg m/s. when a force of 0.2 N is applied on it for 10 seconds. What is the change in its kinetic energy **(CBSE,2004)**

(1) 1.1 J

(2) 2.2 J

(c) 3.3 J

(4) 4.4 J

30. A force of 10i-3j+6k acts on a body of 5 kg and it displace it from 6i+5j-3km to 10i – 2j +7km. The work done is **(AIIMS, 2003)**

(1) 121 J

(2)0

(c) 100J

(4) none of these.

31. A bullet of mass m and velocity v is fired into a large block of wood of mass M. the final velocity of the system is **(IIT, 2002)**

(1) $(\nu+m) / (m+ M)$

(2) $[(m+M) / M]\nu$

(3) $[(m+\nu) / M]\nu$

(4) $[m/ (m + M)]\nu$

32. A neutron makes a head on elastic collision with a stationary deuteron . The fractional enegy neutron in the collision is **(PMT,2003)**

(1) 16/18

(2) 8/9

(3) 8/27

(4) 2/3

33. A machine guns fires a bullet of mass 40 g with a velocity 1200 ms^{-1}. The man holding it can exert a maximum force of 144N on the gun. How many bullets can be fire per second at the most.

(1) Three

(2) Four

(3) Two

(4) One (**AIIMS , 2000)**

34. A uniform chain of length 2m is kept on a table such hat a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4kg. what is the work done in pulling the entire chain on the table ?

(IIT,2004)

(1) 1200 J

(2) 3.6 J

(3) 120 J

(4) 7.2 J

35. A force $\vec{F} = (5\vec{i} + 3\vec{j} + 2\vec{k})$ N is applied over a particle

which displaces it from its origin to the

point $\vec{r} = (2\vec{i}-\vec{j})m$. The work done on the particle in joules is **(AIEEE,2004)**

(1) + 13

(2) + 7

(3) + 10

(4) -7

36. The period of revolution of planet A around the sun 8 times that of B. The distance of A from the sun is how many times than that of B from the sun.? **(IIT, 2003)**

(A) 2

(B) 3

(C) 4

(D) 5

37. Who among the following gave first the experimental value of G. **(AIEEE, 2001)**

(A) Cavendish

(B) Copernicus

(C) Brook Teylor

(D) none of these.

The escape velocity of a body depends upon mass as **(IIT , 2002)**

(A) m^0.

(B) m^1.

(C) m^2.

(D) m^3.

38. The kinetic energy needed to project a body of mass m from the earth surface to infinity is

(AIEEE, 2003)

(A) mgR/2.

(B)2mgR.

(C) mgR.

(D) mgR/4.

39. The kinetic energy of a body is increased by 300%. Its momentum will be increased by

(A) 400%

(B) 300%

(C) 200%

(D) 100% (AIEEE, 2002)

40. The coefficient of friction between the tyres and the road is μ. A car is moving with momentum p. What will be the stopping distance due to friction alone. The mass of the car is m

(A) $p^2/2\mu g$

(B) $p^2/2m\mu g$

(C) $p^2/2m^2\mu g$

(D) $p^2/2mg$. **(AIEEE, 2003)**

Physical World & Measurement

1. The velocity of a body is given by the equation :

$$\upsilon = (b/t)+ct^2+dt^3.$$

The dimensional formula for b is

(a) $[M^0LT^0]$

(b) $[ML^0T^0]$

(c) $[M^0L^0T]$

(d) $[MLT^{-1}]$

2. Identify the pair having identical dimensions

(a) Thermal conductivity and Stefan's constant.

(b) Angular velocity and velocity gradient.

© Pressure gradient and surface tension.

(d) Rydberg constant and wavelength

3. Suppose a quantity y can be the dimensionally represented in terms M,L and T, that is $[y] = [M^aL^bT^c]$. The quantity mass

(a) may be represented in terms of L,T and y if a = 0

(b) may be represented in terms of L,T and y if $a \neq 0$.

(c) can always be dimensionally represented in terms of L,T and y.

(d) can never be dimensionally represented in terms of L,T and y.

4. if the size of an atom were enlarged to the tip of a sharp pen then how would be the height of Mount Everest ? (given size of atom = 10^{-11}m,, size of pin = 10^{-5} m, height of Mount Everest = 10^4m.)

(a) 10^{-2}m.

(b) 10^6m.

(c) 10^{10}m.

(d) 10^{11}m.

5. in the equation $X = 3YZ^2$, X and z have dimensions of capacitance and magnetic induction respectively. In MKSQ system, the dimensional formula of Y is

(a) $[M^{-3}L^{-2}T^{-2}Q^{-4}]$

(b) $[ML^{-2}]$

(c) $[M^{-3}L^{-2}Q^{4}T^{-8}]$

(d) $[M^{-3}L^{-2}Q^{4}T^{-4}]$

6. if I is the moment of inertia and ω the angular velocity, what is the dimensional formula of rotational kinetic energy $\frac{1}{2} I\omega^2$.

(a) $[ML^2T^{-1}]$

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

(c) $[ML^2T^{-2}]$

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

7. The unit of coefficient of thermal conductivity is

(a) $Js^{-1}m^{-1}K$

(b) $J^{-1}smK$

(c) $Jm^{-1}s^{-1}K^{-1}$.

(d) $Jcm^{-1}s^{-1}K$

8. if $Y = a+bt+ct^2$, where y is in meter and t in second,

then the unit of c is

(a)m

(b) s^{-2}

(c)ms^{-1}.

(d) ms^{-2}.

9. Which of the following pairs has the same dimensions :

(a) Moment of force & force

(b) Torque and Planck's constant.

© Latent heat and specific heat

(d) Latent heat and gravitational potential.

10. Unit of permittivity $\varepsilon_{\cap}$ is

(a) F

(b) Fm

(c) Fm^{-1}

(d) Am^{-2}.

(e) Am^{-1}.

Here F represents farad, A represents ampere and m represented meter.

11. Dimensional formula $[ML^{-1}T^{-2}]$ corresponds tp

(a) Thrust

(b) Viscosity

(c) modulus of elasticity

(d) moment of force

12. The dimensional formula $[ML^2T^{-2}]$ represents

(a) momentum

(b) moment of force

(c) acceleration

(d) force.

13. Which of the following has the dimensional formula as $[ML^{-1}T^{-2}]$

(a) Stress

(b) pressure

(c) Young's modulus

(d) all of these.

14. g cm s^{-2} stands for the unit of

(a) Energy

(b) force

(c) momentum

(d) acceleration

15. if I is regarded as the fourth dimension, then the dimensional formula of charge in terms of current I is

(a)$[IT^2]$

(b)$[I^0T^0]$

(c) $[I^{-1}T]$

(d) IT.

16. The dimensional formula for Rydberg constant is

(a) $[M^0LT^{-1}]$

(b) $[M^0L^{-1}T^0]$

(c) $[M^0L^0T^0]$

(d) [MLT]

17. The dimensional formula for PV , where P is pressure and V is volume is the same as that of

(a) work

(b) power

(c) Elastic modulus

(d) Pressure.

18. The fundamental unit , which has the same power in the dimensional formulae of surface tension and viscosity.

(a) mass

(b) length

(c) time

(d) none of these.

19. One poise is equal to

(a) 1 Nsm^{-2}.

(b) 0.1 Nsm^{-2}.

(c) 0.01 Nsm^{-2}.

(d) 10 Nsm^{-2}.

20. The quantity having dimensions -2 in the time is

(a) force

(b) pressure

(c) gravitational constant.

(d) all of these

21. in the equation $[P+(a/V^2)]\ (V-b) = RT$, the S.I unit of a is

(a) Nm^2.

(b) Nm^4

(c) Nm^{-3}

(d) Nm^{-2}

22. The physical quantities of which one is a vector and the other is a scalar , having same dimensions are

(a) moment and momentum

(b) power and pressure

(c) impulse and momentum

(d) torque and work.

23. Given that force (F) is given $F = Pt^{-1}+Qt$. here t is time . The unit of P is same as that of

(a) displacement

(b) velocity

(c) acceleration

(d) momentum.

24. given that $r = m^2 \sin pt$, where t represents time , I the unit of m is N, then the unit of r is

(a) N

(b) N^2

(c) Ns

(d) N^2s

25. The dimensional formula of latent heat is

(a) $[M^0L^2T^{-2}]$

(b) $[MLT^2]$

(c) $[ML^2T^{-2}]$

(d) $[MLT^{-1}]$

26. The e.m.f. of a cell is defined as work done per unit charge. The dimensional formula of e.m.f. in terms of charge Q is

(a) $[ML^{-2}Q^{-2}]$

(b) $[ML^{2}T^{-2}Q^{2}]$

(c) $[ML^{2}T^{-2}Q^{-2}]$

(d) $[ML^{2}T^{-2}Q^{-1}]$

27. Coefficient of thermal conductivity has the dimensions :

(a) $[MLT^{-3}K^{-1}]$

(b) $[ML^{3}T^{-3}K^{2}]$

(c) $[ML^{3}T^{-3}K^{-2}]$

(d) $[M^{2}L^{3}T^{-3}K^{2}]$

28. Consider a new system of units in which c(speed of light), h (Planck's constant)and G

(gravitational constant) are taken as fundamental units . Which of the following would correctly represented mass in new system ?

(a) $\sqrt{(hC/G)}$

(b) $\sqrt{(GC/h)}$

(c) $\sqrt{(hG/c)}$

(d) $\sqrt{hGC}$

29. A rectangular beam which is supported at its two ends and loaded in the middle with weight W sags by an amount δ such that $\delta = Wl3/4Yd^3$? Where l,d and Y represent length, depth and elasticity respectively Guess the unknown factor using dimensional considerations

(a) breadth

(b) $(\text{breadth})^2$

(c) $(\text{breadth})^3$.

(d) mass

30. The dimensional formula for self inductance is

(a($[MLT^{-2}]$

(b) $[ML^2T^{-1}A^{-2}]$

(c) $[ML^2T^{-2}A^{-2}]$

(d) $[ML^2T^{-2}A^{-1}]$

31. A Spherometer has 250 equal divisions marked along the peripheri of its disc and one full rotation of the disc advances on the main scale by 0.0625 cm. the least count of the system is

(a) 2.5×10^{-4} cm

(b) 2.5×10^{-3} cm

(c) 2.5×10^{-2} cm

(d) none of these.

32. The main scale of spectrometer is divided into 720 divisions in all. If the vernier scale consists of 30 divisions , the least count of the instrument is (Given 30 vernier divisions coincide with 29 main scale divisions)

(a) 0.1^0.

(b) 1''.

(c) 1'

(d) 0.1''

33. The dimensions of (velocity $)^2$ + radius are the same as that of

(a) Planck's constant

(b) gravitational constant.

(c) dielectric constant

(d) none of these.

34. The dimensional formula of magnetic induction B is

(a) $[M^0ALT^0]$

(b) $[M^0AL^{-1}T^0]$

(c) $[M^0AL^2T^0]$

(d) $[ML^0T^{-2}A^{-1}]$

35 of the following quantities , which one has dimensions different from the remaining three

(a) Angular momentum per unit mass

(b) product of voltage and charge per unit volume

© Energy per unit volume

(d) force per unit area

36. if time T, acceleration A and force F are regarded as base units then the dimension formula of work is

(a) [FA]

(b) [FAT]

(c) $[FAT^2]$

` (d) $[FA^2T]$

37. Which of the following physical quantities has the same dimensional formula as that of energy ?

(a) Power

(b) force

(c) momentum

(d) work

38. The unit of amplification factor is

(a) ohm

(b) mho

(c) AV^{-1}

(d) a non-dimension constant

39. The dimensional formula for entropy is

(a) $[MLT^2K^{-1}]$

(b) $[ML^2T^{-2}]$

(c) $[ML^2T^2K^{-1}]$

(d) $[ML^{-2}T^{-2}K^{-1}]$

40. The dimensional formula for farad is

(a) $[M^{-1}L^{-2}TQ]$

(b) $[M^{-1}L^{-2}T^2Q^2]$

(c) $[M^{-1}L^{-2}TQ^2]$

(d) $[M^{-1}L^{-2}T^2Q]$

41. The spherometer has a least count of 0.005 mm and its head scale is divided into 200 equal divisions . The distance between consecutive threads on the spherometer screw is

(a) 0.005 mm

(b) 1.0 m

(c) 1.0 cm

(d) 0.0025 mm.

42. The dimensional formula for magnetic moment M is

(a) $[M^0 ALT^0]$

(b) $[M^0 AL^{-1}T^0]$

(c) $[M^0 AL^2T^0]$

(d) $[ML^0T^2A^{-1}]$

43. Let Q denotes charge on the plate of a capacitor of capacitance C. The dimension formula for Q^2/C is

(a) $[M^2L^2T^2]$

(b) $[ML^2T^2]$

(c) $[MLT^2]$

(d) $[M^2L^2T]$

44. The dimensional formula of magnetic moment of a current carrying coil is

(a) $[L^2A^{-1}]$

(b) $[L^2A]$

(c) $[L^2A^{-3}]$

(d) $[LA^2]$

45. in the equation $\xi = a \sin(\omega t - kx)$, the dimensional formula for is

(a) $[M^0L^0T^{-1}]$

(b) $[M^0L^1T^{-1}]$

(c) $[ML^0T^0]$

(d) $[M^0L^{-1}T^0]$

46. in Q. 45 the dimension formula for k is

(a) $[M^0L^0T]$

(b) $[M^0LT]$

(c) $[MLT]$

(d) $[M^0L^{-1}T^0]$

47. In Q. 45 the dimension formula of ω/k is

(a) $[M^0LT^{-1}]$

(b) $[M^0L^0T^{-1}]$

(c) $[M^{-1}LT^0]$

(d) $[M^0L^0T^0]$

48. The dimension formula of $[ML^{-1}T^{-2}]$ does not represent the following.

(a) stress

(b) Power

(c) Pressure

(d) Young's modulus.

49. linear momentum and Angular momentum have the same dimensions in

(a) Mass and length

(b) Length and time

(c) Mass and time

(d) mass, length and time.

50. The velocity of a particle is given by

$$\nu = a+(b/t)+ct^2.$$

The unit of b will be

(a) m

(b) ms^2.

(c) ms^{-1}.

(d) ms^{-2}.

51. in the relation $dy/dt = 2a \sin(\omega t+\phi_0)$, the dimension formula for $(\omega t+\phi_0)$ is

(a) $[M^0L^0T^0]$

(b) $[ML^0T^0]$

(c) $[MLT^0]$

(d) [MLT]

52. Which of the following pairs has the same dimensional formula?

(a) Work and potential energy

(b) Density and specific gravity

© Force and momentum

(d) Stress and strain.

53. Turpentine oil if lowing through a capillary tube of length l and radius r . The pressure difference between two ends of the tube is P. The viscosity of the oil is given by :

$$\eta = [p\ (r^2 - x^2)] / 4\nu l$$

here ν is the velocity of oil at a distance x from the axis of the tube from this relation the dimensional formula for η is.

(a) $[ML^{-1}T^{-1}]$

(b) $[MLT^{-1}]$

(c) $[ML^2T^2]$

(d) $[M^0L^0T^0]$

54. The S.I unit for specific resistance is

(a) ohm m^{-2}

(b) ohm meter

(c) kg ohm meter $^{-2}$

(d) $(\text{omh m})^{-1}$.

55. The physical quantity that has no dimension is

(a) strain

(b) angular velocity

(c) linear momentum

(d) angular momentum

56. if the acceleration due to gravity is $10ms^{-2}$ and the units of length and time are changed to kilometer and hour respectively, the numerical value of the acceleration is

(a) 360000

(b) 72000

(c) 36000

(d) 129600

57. The S.I unit of potential energy is

(a) kg $(ms^{-1})^2$.

(b) kg $m(s^{-1})^3$.

(c) $(kgs)^2$ m

(d) $kg^{-1}m^{-1}s^{-1}$.

58. Universal time is based on

(a) rotation of earth on its axis

(b) oscillations of quartz crystal.

(c) Vibrations of cesium atom

(d) earth's orbital motion around the sun.

59. A vernier caliper ha sits main scale 10 cm equally divided into 200 equal parts . its vernier scale of 25 divisions coincides with 12 mm on the main scale the least count for the instrument is

(a) 0.020 cm

(b) 0.002 cm

(c) 0.010 cm

(d) 0.001 cm.

60. The physical quantity which has the dimensional formula $[M^1T^3]$ is

(a) Surface tension

(b) density

(c) solar constant

(d) compressibility

61. Consider the following statements about dimensions

P :force = acceleration due to gravity x mass

Q : electric charge = current x time

R: magnetic flux = electric voltage x time

The correct statements are

(a) R,P only

(b) P,Q only

(c) Q,R only

(d) P,Q &R.

62. The equation of a wave is given by

$Y = A \sin\omega [(x/v) - k]$

Where ω is the angular velocity and ν is the linear velocity. The dimension formula for k is

(a) [LT]

(b) [T]

(c) $[T^{-1}]$

(d) $[T^2]$

63. $21\sqrt{(m/T)}$, where l is the length of a string of linear density m under tension T has the same dimensional formula as that of

(a) mass

(b) time

(c) length

(d) mole.

64. Which of the following cannot be regarded as an essential characteristic of a unit of measurement.

(a) In accessibility

(b) indestructibility

(c) invariability

(d) Reproducibility

65. if the units of force and velocity are doubled , the units of power will

(a) be halved

(b) be doubled

(c) be quadrupled

(d) remain unaffected

66. 1 nanometer/1attometre is equal to

(a) 10^6

(b) 10^8

(c) 10^7

(d) 10^9.

67. Force constant has the same dimensions as

(a) coefficient of viscosity

(b) surface tension

(c) Frequency

(d) impulse.

68. if h is height and g is acceleration due to gravity then the dimensional formula of $\sqrt{(2h/g)}$is same as that of

(a) time

(b)mass

(c) volume

(d) velocity

69. if C is the restoring couple per unit radian twist and I is the moment of inertia , then the dimensional representation of$2\pi \sqrt{(I/C)}$ will be.

(a) $[M^0L^0T^{-1}]$

(b) $[M^0L^0T^1]$

(c) $[M^0L^1T^{-1}]$

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

70. The electrostatic force between two point charges q_1 and q_2 separated by distance r is given by

$$F = k(q_1q_2/r^2)$$

The constant k

(a) depends upon medium between charges only

(b) depends upon systems of units only

(c) depends upon both (a) and (b)

(d) is independent of both (a) and (b)

71. The dimensional formula of the ratio of angular to linear momentum is

(a) $[M^0LT^0]$

(b) [MLT]

(c) $[ML^{-2}T^{-2}]$

(d) $[MLT^{-1}]$

72. The dimension formula for pressure gradient is

(a) $[MLT^{-2}]$

(b) $[ML^{2}T^{-2}]$

(c) $[ML^{-2}T^{-2}]$

(d) $[MLT^{-1}]$

73. $[M^{-1}L^{3}T^{2}]$ is the dimension formula of

(a) gravitational constant

(b) Planck's constant

(c) Surface tension

(d) modulus pf rigidity

74. if L and R denote the inductance and resistance respectively , the dimensional formula for R/L is same as that for

(a) frequency

(b) $(\text{frequency})^2$

(c) time period

(d) $(\text{time period})^2$.

75. The dimensional formula of velocity gradient is

(a) $[M^0L^0T^{-1}]$

(b) $[MLT^{-1}]$

(c) $[ML^0T^{-1}]$

(d) $[M^0LT^{-2}]$

76. What is the dimensional formula of gravitational field strength?

(a) $[M^0LT^{-2}]$

(b) $[MLT^{-2}]$

(c) $[ML^2T^{-2}]$

(d) $[M^2L^2T^{-2}]$

77. if g is the acceleration due to gravity and R is the radius of the earth, then the dimensional formula for gR is

(a) $[M^0L^0T^0]$

(b) $[M^0L^2T^{-2}]$

(c) $[ML^2T^{-2}]$

(d) $[M^2L^2T^{-2}]$

78. in the equation : $S_{nth} = u+(a/2)(2n-1)$, the letters have their usual meanings. The dimensional formula of Snth is

(a) $[M^1L^0T^1]$

(b) $[M^1L^{-1}T^{-1}]$

(c) $[M^0L^1T^{-1}]$

(d) $[M^0L^1T^0]$

79 The dimensional formula of capacitance in term of M, L,T and I is

(a) $[M^1L^0T^2I^2]$

(b) $[ML^{-2}T^4I^2]$

(c) $[M^{-1}L^3T^3I]$

(d) $[M^{-1}L^{-2}T^4I^2]$

80. SI unit of intensity of wave s

(a)$Jm^{-2}s^{-2}$.

(b) $Jm^{-1}s^{-2}$.

(c) Wm^{-2}

(d) Jm^{-2}

81. in a new system of units, unit of mass 10 kg, unit of length is 1 km and unit of time is 1 minute. The value of 1 joule in this new hypothetical system is

(a) 3.6×10^{-4} new units

(b 6×10^{7} new units

(c)10^{11} new units

(d) 1.67×10^{4} new units

82. The dependence of physical quantity P is given by $P = P_0 e^{-at2}$ .. The constant a will

(a) be dimensionless

(b) have dimensions T^{-2}.

(c) Have dimensions same as that of P

(d) have dimension equal to the dimension of P multiplied by T^{-2}.

83. An athletic coach told his team that ‘muscle time speed equals power’. What dimension does he view for muscle.

(a) $[MLT^{-2}]$

(b) $[ML^2T^{-2}]$

(c) $[MLT^2]$

(d) [MLT]

84. Two quantities A & B are related by the relation A/B = m where m is linear mass density and A is force . The dimension of B will be

(a) same as that o f latent heat

(b) same as that of pressure

© same as that of work

(d) same as that of momentum

85. The vernier of a circular scale is divided into 30 divisions which coincide against 29 main scale divisions . Each main scale division is $1^o/2$. The least count of the instrument is

(a) 30’

(b) 10’

(c)1’

(d) 0.1’

86. which of the following is the dimensional formula for the energy per unit are per second

(a) $[ML^0T^0]$

(b) $[ML^0T^{-3}]$

(c) $[ML^2T^{-1}]$

(d) $[ML^{-1}]$

87. $[ML^3T^{-1}Q^{-2}]$ is the dimensional formula of

(a) resistance

(b) resistivity

(c) conductance

(d) conductivity

88. To measure the radius of the curvature with a spherometer we use the formula

(a) $R = (h^2/6) + (1/l)$

(b) $R = (l^2/6h) + (h/2)$

(c) $R = (h^2/2l) + (1/h)$

(d) $R = (2l^2/h) + (6/l)$

89. if the work done W is represented by the formula kW = m, where m is the mass then the dimensional formula for k is

(a) $[L^2T^2]$

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

(c) $[M^0L^{-1}T^2]$

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

90. The dimensional formula of magnetic field H is

(a) $[M^0AL^2T^0]$

(b) $[M^0L^0 TA^0]$

(c) $[M^0ALT^0]$

(d) $[M^0AL^{-1}T^0]$

91. The dimensions formula of resistivity in terms of M,L,T and Q is

(a) $[ML^3T^{-1}Q^{-2}]$

(b) $[ML^3T^2Q^{-1}]$

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

(d) $[MLT^{-1}Q^{-1}]$

92. If L denotes the inductance of an inductor through which a current I is flowing , then the dimensional formula ofmLI^2 is

(a) $[MLT^{-2}]$

(b) $[ML^2T^{-2}]$

(c) $[M^2L^2T^{-2}]$

(d) don't expressible in term of M,L,T]

93. in a capacitor the energy stored between the plates is given as ½ CV^2 where C is the capacity and V is the potential difference The dimension formula of CV^2 is

(a) $[MLT^{-2}]$

(b) [MLTA]

(c) $[ML^{-1}T^{-2}]$

(d) $[ML^{2}T^{-2}]$

94. What is the S.I unit of physical quantity whose dimensional formula is $[M^{-1}L^{-2}T^{4}A^{2}]$

(a) farad

(b) Volt

(c)siemen

(d) ohm.

95. The physical quantity that has a ratio of 103 between its SI unit and cgs unit is

(a) Young's modulus

(b) Boltzmann constant

© Planck's constant

(d) Universal gravitational constant

96. μ_0 & ε_0 denote the permeability and permittivity respectively of free space. The dimension of $\mu_0\varepsilon_0$ is

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

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

(c) $[LT^{-1}]$

(d) $[L^{2}T^{2}]$

97. What is the dimensional formula for mc^2, where the letters have their usual meanings?

(a) $[MLT^{-1}]$

(b) $[ML^{0}L^{0}]$

(c) $[ML^{2}T^{-2}]$

(d) $[M^{-1}L^{3}T^{6}]$

98. The dimensions of CV^2 match with the dimensions of

(a) LI^2

(b) L^2I^2

(c) L^2I

(d) none of these.

99. Which of the following does not have the dimensions of frequency ?

(a) 1/CR

(b) R/L

(c) $1/\sqrt{LC}$

(d) C/L.

100. The dimensional formula of L/RCV is

(a) $[M^0L^0T^0]$

(b) [MLT]

(c) [MLTA]

(d) $[M^0L^0T^0A^{-1}]$

101. The dimensional formula for specific heat is

(a) $[M^0L^2T^{-2}K^{-1}]$

(b) $[M^0LT^{-1}K^{-1}]$

(c) $[M^0LTK]$

(d) $[M^0LT^{-2}K]$

102. The dimensional formula for Wien's constant is

(a) $[M^0LT^0K]$

(b) [ML]

(c) [LTK]

(d) [MK]

103. The dimension formula for gas constant is

(a) $[MT^{-2}K]$

(b) $[MLT^{-2}]$

(c) [LK]

(d) $[ML^2T^{-2}K^{-1}]$

104. The ampere –hour is the unit of

(a) energy

(b) power

(c) current strength

(d) quantitative measure of electricity

105. The number of particles given by

$$n = D\,[(n_2-n_1)/\,(x_2-x_1)]$$

are crossing a unit area perpendicular to x axis in unit time , where n_1 and n_2 are the number of particles per unit volume for the values x_1 & x_2 of x respectively.

Then the dimensional formula of diffusion constant D is

(a) $[M^0LT^2]$

(b) $[M^0L^2T^{-4}]$

(c) $[M^0LT^{-3}]$

(d) $[M^0L^2T^{-1}]$

106. The quantity having dimensions 1 I mass is

(a) gravitational constant

(b) gravitational potential.

© young's modulus

(d) Strain.

107. The dimensional formula for magnetic flux density is

(a) $[ML^0T^{-2}A^{-1}]$

(b) $[M^0L^1T^{-2}A^{-2}]$

(c) $[M^0L^2T^{-2}A^{-1}]$

(d) $[M^0L^0T^{-1}A^{-1}]$

108. The dimensional formula representation of impedance of AC circuit is

(a) $[M^0L^2T^{-3}]$

(b) $[ML^2T^{-3}A^{-2}]$

(c) $[ML^2T^{-2}A^1]$

(d) $[ML^1T^{-3}A^2]$

109. The dimensional formula for the mechanical equivalent of heat J is

(a) $[ML^2T^{-2}]$

(b) $[M^0L^0T^0K^0]$

(c) $[ML^2T^2A^{-1}]$

(d) $[K^{-1}]$

110. if S = 1/3 ft^3 ‘f’ has the dimension of

(a) $[M^0L^{-1}T^3]$

(b) $[M^1L^1T^{-3}]$

(c) $[M^0L^1T^{-3}]$

(d) $[M^0L^{-1}T^{-3}]$

111. $[ML^0T^{-3}]$ represents the dimensional formula of

(a) intensity

(b) power

(c) angular momentum

(d) torque per unit twist

112. The dimensional formula of $\sqrt{(I/BM)}$ is

(a) $[M^0L^0T^0A^0]$

(b) $[M^0L^0T^1A^0]$

(c) $[M^1L^2A^1T^1]$

(d) $[M^0L^2A^1T^1]$

113. The dimensional quantity

(a) does not exist

(b) always has a unit

© never has a unit

(d) may have a unit.

114. The damping force on an oscillating particle is observed to be proportional to velocity. The constant of proportionally can be measured in

(a) kgs^{-1}.

(b) kgs.

(c) $kgms^{-1}$.

(d) $kgm^{-1}s^{-1}$.

115. The damping force on a body is proportional to the velocity of the body. The proportionally constant has the dimensional formula.

(a) $[M^2T^{-1}]$

(b) $[M\,LT^{-2}]$

(c) $[ML^0\,T^{-1}]$

(d) it is a dimensionless constant.

116. The dimensional formula of $(1/\varepsilon_0)\,(e^2/hc)$ is

(a) $[M^0L^0T^0A^0]$

(b) $[M^{-1}L^3T^2A^0]$

(c) $[M\,L^3T^{-4}A^{-2}]$

(d) $[M^{-1}L^{-3}T^4]$

117. The dimensional formula of electrical conductivity is

(a) $[M^{-1}L^{-3}T^3A^2]$

(b) $[M L^3T^3A^2]$

(c) $[M^2L^3T^{-3}A^2]$

(d) $[M L^3T^{-3}A^2]$

118. The SI unit of electrical conductivity is

(a) S

(b) Sm

(c) Sm^{-1}

(d) $S^{-1}m^{-1}$.

119. if energy E, velocity A and time T are chosen as fundamental quantities , then the dimensional formula of surface etension is

(a) $[EV^{-2}T^{-2}]$

(b) $[EV^{-1}T^{-2}]$

(c) $[EV^{-2}T^{-1}]$

(d) $[E^2V^{-1}T^{-2}]$

120. if the units of M and L are increased three times, then the units of energy wull be increased by

(a) 3 times

(b) 6 times

(c) 27 times

(d) 81 times.

121. The radius of the proton is about 10^{-15} m. The radius of the observable universe is 10^{26} m identify the distance which is half way between these two extremes on a logarithmic scale.

(a) 10^{21} m.

(b) 10^{6}m.

(c) 10^{-6}m.

(d) 10^0 m.

122. What will be the unit of time in that system in which unit of length is m, unit of mass is kg and unit of force is kg wt.

(a) 9.8s.

(b) $\sqrt{(9.8)}$ s

(c) $(9.8)^2$s

(d) $1/\sqrt{(9.8)}$ s.

123. if the unit of time is taken as one second and the acceleration due to gravity is also taken as unity in a particular system , then the unit of length in that system is

(a) 9.8 m

(b) $(9.8)^{-1}$ m

(c) $(9.8)^{-2}$ m

(d) zero.

124. The velocity ν of water waves may depend on their wavelength (λ), the density of water (ρ) and the acceleration due to gravity (g). . The method of dimensions gives the relation between these quantities as

(a) $\nu^2 \propto \lambda^{-1}\rho^{-1}$.

(b) $\nu^2 \propto g\lambda$

(c) $\nu^2 \propto g\lambda\rho$..

(d) $g^{-1} \propto \lambda^3$.

125. The frequency of vibration of a mass m suspended from a spring of spring constant k is given by relation

of the type $f = cm^x k^y$, where c is a dimensionless constant. The values of x and y are

(a) (1/2), (1/2)

(b) (-1/2), (-1/2)

(c) (1/2) , (-1/2)

(d) (-1/2) , (1/2)

126. How many joule are contained in one watt hour.

(a) 3.6×10^3 J

(b) 3.3×10^9 J

(c) $0.4 \times 8 \times 10^{-3}$ J

(d) (1/8) J.

127. The surface area and volume of a cubical body are numerically equal. The side of such a cube is

(a) 12 units

(b) 10 units

(c) 8 units

(d) 6 units.

128. A cube has numerically equal volume and surface area. The volume of such a cube is

(a) 216 units

(b) 1000 units

(c) 2000 units

(d) 3000 units.

129. Given :$X = (Gh/c^3)^{1/2}$, where G, h and care gravitational constant , Planck's constant and the velocity if light respectively . Dimensions of x are the same a those of

(a) mass

(b) time

(c) length

(d) acceleration

130. if R is Rydberg constant, h is Planck's constant and c is the velocity o flight then Rhc has the same dimensional formula as that of

(a) force

(b) power

(c) energy

(d) angular momentum

131. The dimensional formula of coefficient of permittivity for free space (ε_0) in the equation

$$F = (1/4\pi\varepsilon_0)\ (q_1q_2/r^2)$$

Where symbol have their usual meanings, is

(a) $[M^1L^3A^{-2}T^{-4}]$

(b) $[M^{-1}L^{-3}A^4T^2]$

(c) $[M^{-1}L^{-3}A^{-2}T^{-4}]$

(d) $[M^1L^3A^2T^{-4}]$

132. The thrust developed by a rocket motor is given by $F = mv + A(P_1-P_2)$, where m is the mass of the gas ejected per unit time, $\nu$is the velocity of the gas, A is area of cross section of the nozzle, P_1,P_2rae the pressures of the exhaust gas and surrounding atmosphere. The formula is dimensionally

(a) correct

(b) wrong.

© sometimes wrong, sometimes correct.

(d) data is not adequate

133. What is the dimensional formula of

Planck's constant / Linear momentum

(a) $[M^0L^0T^0]$

(b) $[M^0L^0T]$

(c) $[M^0LT^0]$

(d) $[MLT^{-1}]$

134. Which of the following quantities can be written in the international system of units kg $m^2A^{-2}s^{-3}$.

(a) resistance

(b) inductance

(c) capacitance

(d) magnetic flux.

135. $[ML^2T^{-3}]$ is the dimensional formula of

(a) Electric resistance

(b) Capacity

© Electric potential

(d) Specific resistance.

136. The unit of inductance is

(a) VA^{-1}.

(b) JA^{-1}.

(c) VsA^{-1}.

(d) VAs^{-1}.

137. in the international system of units , the magnetic permeability μ_0 is measured in

(a) $Wbm^{-2}A^{-1}$.

(b) $Wbm^{-1}A^{-1}$.

(c) $Wbm^{-1}A$.

(d) $WbmA^{-1}$.

138. Dimensional formula of the Hall coefficient is

(a) $[M^0L^0A^{-2}T^{-1}]$

(b) $[M^0L^3AT]$

(c) $[M^0L^0AT]$

(d) $[M^0L^3A^{-1}T^{--1}]$

139. What is unit of k in the relation.

$$U = ky /(y^2+a^2)$$

Where U represents the potential energy , y represents

the displacement and represents

the maximum displacement i.e., amplitude

(a) ms^{-1}

(b) ms

(c) Jm

(d) Js^{-1}.

140. if the unit of mass. Length and time are doubled, then the unit of force is

(a) doubled

(b) trebled

(c) halved

(d) unchanged

141. if E, m ,J & G represent energy, mass , angular momentum & gravitational constant respectively, then the dimensional formula of EJ^2 /m^3G^2 is

(a) angle

(b) length

(c) mass

(d) time.

142. The unit of magnetic moment is

(a) Am^{-2}

(b) $NA^{-1}m^{-1}$.

(c) Nm

(d) Am^2.

143. in the van der wall equation :

$$[P+(a/V^2)\ ]\ (V-b) = RT.$$

P is Pressure, V is volume, T is absolute temperature ,

R is molar gas constant, a & b are van der Waal

constants. The dimensional formula of a is same as that

of

(a) P

(b) V

(c) PV

(d) PV^2.

144. in Q. 143 the dimensional formula for b is same as that of

(a) P

(b) V

(c) PV

(d) PV^2.

145. inQ. 144, the dimensional formula of RT is the same as that of

(a) Specific heat

(b) latent heat

(c) temperature

(d) energy

146. in Q. no. 145, the dimensional formula of ab/RT is

(a) $[ML^2T]$

(b) $[M^0L^2T^0]$

(c) $[ML^5T^{-1}]$

(d) $[M^0L^6T^0]$

147. The equation of stationary wave is

$$\xi = 2a \sin (2\pi ct /\lambda) \cos (2\pi x/\lambda)$$

which of the following is correct.

(a) the units of ct and λ are same.

(b) The units of x and λ are same

(c) The units of ξ is same as that of a .

(d) All of these.

148. The force F is given in terms of time t and distance x by F = a sin ct +b cos dx.

Then the dimensions of a/b and c/d are given by

(a) $[MLT^{-2}, M^0L^0T^{-1}]$

(b) $[MLT^{-2}, M^0L^{-1}T^0]$

©$[M^0L^0T^0, M^0L^1T^{-1}]$

(d) $[M^0L^1T^{-1}, M^0L^0T^0]$

149. in a vernier calipers, ten smallest division of the vernier scale are equal to the nine smallest divisions on the main scale. If the smallest division on the main scale is half millimeter , then he vernier constant is

(a) .5 mm

(b) 0.1 mm

(c) 0.05 mm

(d) 0.005 mm.

150. One centimeter on the main scale of vernier calipers is divided into ten equal parts. If 10 divisions of vernier

sale coincide with 8 small divisions of the main scale, the least count of the callipers is

(a) 0.005 cm

(b) 0.05 cm

(c) 0.02 cm

(d) 0.01 cm.

151. A vernier caliper has 20 divisions on the vernier scale , which coincide 19 on the main scale. The least count of the instrument is 0.1 mm. The main scale divisions are of

(a) 0.5 mm

(b) 1 mm

(c) 2 mm.

(d) ¼ mm

152. n divisions of vernier scale of a vernier calipers coincide with (n-1) divisions of main scale. What is the least count of the instrument if the length of one main scale divisions is 1 mn.

(a) 10n cm

(b) n cm

(c) 9/10n cm

(d) 1/100n cm

153. The pitch of a screw gauge is 0.5 mm, its head scale contains 50 divisions . The leat count of the screw gauge is

(a) 0.001 mm.

(b) 0.01 mm

(c) 0.02 mm

(d) 0.025.

154. Which of the following quantities is undetectable by physical means but is very important for the conceptual understanding of some branch of physics.

(a) wave frequency

(b) wave speed

(c) wave length

(d) wave function.

155. The dimensional formula of current density is

(a) $[M^0L^{-2}T^{-1}Q]$

(b) $[M^0L^2T^1Q^{-1}]$

(c) $[MLT^{-1}Q]$

(d) $[ML^{-2}T^{-1}Q^2]$

156. The order of magnitude of the number of nitrogen molecules in an air bubble of diameter 2 mm under ordinary conditions is.

(a) 10^5.

(b) 10^9.

(c) 10^{13}.

(d) 10^{17}.

157. Which of the following pairs have same dimensional formula for both the quantities ?

(i) kinetic energy & torque

(ii) resistance and inductance

(iii) young's modulus and pressure.

(a) (i) only

(b) (ii) only

(c) (i) & (iii) only

(d) all of the three.

158. The dimensional formula for hole mobility in a smei-conductor is

(a) $[M^{-1}L^{0}T^{2}A]$

(b) $[M^{-1}L^{2}T^{-2}A]$

(c) $[M^{0}L^{0}T^{0}A^{0}]$

(d) $[ML^{-2}T^{-2}A]$

159. The unit of electric field is not equivalent to

(a) NC^{-1}

(b) JC^{-1}

(c) Vm^{-1}.

(d) $JC^{-1}\ m^{-1}$

UNIFORM MOTION

1. If x denotes displacement in time t and x = a cos t,

then acceleration is

(A) a cos t

(B) a cos t

(C) - a sin t

(D) -a sin t

2. On applying brakes an automobile stops after 5

seconds covering 25 m with uniformly retarded motion.

The initial speed of the automobile in ms^{-1} is

(A) 5

(B) 10

(C) 15

(D) 20

3. A body sliding on a smooth inclined plane requires 4 seconds to reach the bottom, starting from rest at the top. How much time does it take to cover one fourth the distance starting from rest at the top?

(A) 1 second

(B) 2 second

(C) 4 seconds

(D) 16 seconds

4. The initial velocity of a body moving along a straight line is 7 m/s. It has a uniform acceleration of 4 m/s^2. The distance covered by the body in the 5th second of its motion is

(A) 25 m

(B) 35 m

(C) 50 m

(D) 85 m

5. A particle experiences constant acceleration for 20 seconds after starting from rest. If it travels a distance S_1 in the first 10 seconds and a distance S_2 in the next 10 seconds, then

(A) $S_2 = S_1$

(B) $S_2 = 2S_1$

(C) $S_2 = 3S_1$

(D) $S_2 = 4S_1$

6. An athlete moves on a quarter circle of radius r. The values of distance travelled and displacement are

(A) distance πr, displacement = r

(B) distance $\pi r(2)^{1/2}$, displacement = $\pi r/2$

(C) distance = $\pi r/2$, displacement = $r(2)^{1/2}$

(D) distance = $\pi r/2$, displacement = zero.

7. A particle oscillates along the x-axis according to the equation $x = 0.05 \sin (5t-\pi/6)$, where x is in metres and t in sec. Its velocity at t = 0 is

(A) 1/4 m/s

(B) $(3)^{1/2}$ / 8 m/s

(C) 2.5 m/s

(D) 1/8m/s

8. A point moves in a straight line so that its displacement x (metre) time t (seconds) is given by $x^2 = t^2 + 1$. Its acceleration in ms^{-2}, time t seconds is

(A) $1/x - 1/x^2$

(B) $-t / x^2$

(C) $-t^2 / x^3$

(D) $1/x^3$

9. A body starts from rest and moves with constant acceleration. The ratio of distance covered by the body in nth second to that covered in n second is

(A) 1: n

(B) 2n- 1 /n^2

(C) n^2 / 2n-l

(D) 2n -1 / $2n^2$

10. The displacement time graph for the two particles A and B are the straight lines inclined at angles of 30° and 60° with the time axis. The ratio of the velocity V_A : V_B will be

(A) 1:2

(B) 1 : $(3)^{1/2}$

(C) $(3)^{1/2}$: 1

(D) 1:3

11. The relation between time t and distance x is $t = \alpha x^2 + \beta x$ where α and β are constants. The retardation is (v represents the velocity of the particle.)

(A) $2\alpha v^3$

(B) $2\beta v^3$

(C) $2\alpha\beta v^3$

(D) $2\beta^2 v^3$

12. A body is moved along a straight line by a machine delivering constant power. The distance moved by the body in time t is proportional to

(A) $t^{1/2}$

(B) $t^{3/4}$

(C) $t^{3/2}$

(D) t^2

13. An electron starting from rest has a velocity V that increases linearly with time t; that is v = Kt where K = 2 m/sec^2. Then the distance covered in the first 3 seconds will be

(A) 9 m

(B) 18 m

(C) 27m

(D) 36m.

14. A bus is beginning to move with an acceleration of 1 ms^{-2}. A man who is 48 m behind the bus starts running at 10 ms^{-1} to catch the bus. The man will be able to catch the bus after

(A) 6 sec

(B) 16 sec

(C) 8 sec

(D) 10 sec.

15. The distance between a town and a factory is 30 km. A man started to walk from the factory to the town at 6 : 30 a.m. While a cyclist left the town for the factory at 6 : 40 a.m. riding at a speed of 18 km /hr, the man met the cyclist after walking 6 km. Find at what time they met ?

(A) 7 : 30 a.m.

(B) 8 a.m.

(C) 8 :10 a.m.

(D) 8 : 30 a.m.

16. In the above question, what is the speed with which man walked?

(A) 6 km/hr

(B) 4km/hr

(C) 5 km/hr

(D) 8km/hr

17. Two motor cars leave with a 1 minute gap and move with an acceleration of 0.2 ms^{-2}. How long after the departure of the second car does the distance between them become equal to three times its initial value?

(A) 1/2 min.

(B) l min.

(C) 3/2min.

(D) 2 min

18. The initial velocity of a particle is u (at, t = 0) and the acceleration f is given by at. Which of the following relations is valid?

(A) $V = u + at^2$

(B) $V = u+at^2/2$

(C) V= u + at

(D) V = u

19. A body covers 200 cm in the first 2 seconds and 220 cm in the next 4 seconds. The velocity at the end of 7th second is

(A) 20 cms^{-1}

(B) 10 cms^{-1}

(C) 115 cms^{-1}

(D) -10 cms^{-1}

20. The speed of the car is reduced to one third of its original value in travelling a distance S. Then the car is brought to rest in a minimum distance

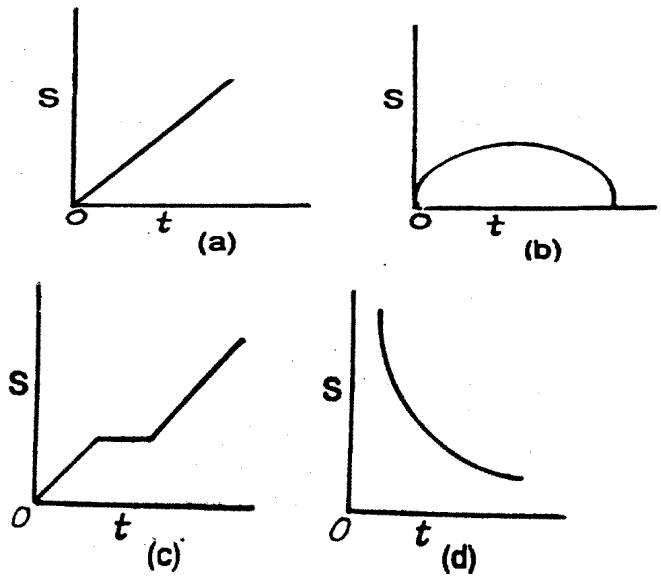
(A) 3 S

(B) 9 S

(C) 8/9 S

(D) 9/8 S

21. A ball is thrown vertically upwards. Which graph best represents the relationship between displacement and time for the motion of the ball ?



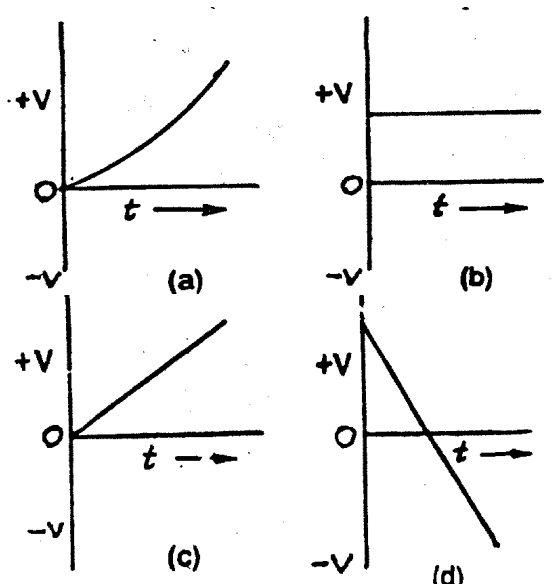
(A) (a)

(B) (b)

(C) (c)

(D) (d)

22. A ball is thrown vertically upwards. Which graph best represents the relationship between velocity and time for the motion of the ball?



(A) (a)

(B)(b)

(C) (c)

(D) (d)

23. On a displacement time graph, two straight lines make angles of 45° and 60° with the time axis, the ratio of the velocities represented by them is

(A) $1: (2)^{1/2}$

(B) $1: (3)^{1/2}$

(C) $(2)^{1/2} :1$

(D) $(3)^{1/2} : 1$

24. A boy sitting on the topmost berth in a compartment of a train which is just going to stop on a railway station, drops an apple aiming at the open hand of a brother situated vertically below the hands at a distance of 2 metre, the apple will fall

(A) straight in the hand of his brother

(B) slightly away from the hand of his brother in the direction of motion of the train

(C) slightly away from the hand of his brother in the direction opposite to the direction of motion of the train.

(D) None of the above.

25. Two cars A and B are travelling in the same direction with velocities V_A and V_B ($V_A > V_B$) When the car A is at a distance d behind the car B the driver of the car A applies brakes producing a uniform retardation a. There will be no collision when

(A) $d < (V_A - V_B)^2 / 2a$

(B) $d < (V_A^2 - V_B^2)/2a$

(C) $d > (V_A - V_B)^2 / 2a$

(D) $d > (V_A^2 - V_B^2)/2a$

26. The distance described by a falling body in the last second of its motion is to that described by it in its last

but one second as 7:5. The velocity with which the body strikes the ground is

(A) 19.6 m/s

(B) 39.2 m/s

(C) 29.4 m/s

(D) 49m/s

27. A tiger chases a deer 30 m ahead of it and gains 3 m in 5 s after the chase started. After 1.0 s, the distance between them is

(A) 6 m

(B) 14 m

(C) 18m

(D) 24 m

28. A steam boat goes across a lake and comes back (i) on a quiet day when the water is still and (ii) on a rough

day when there is a uniform current so as to help the journey on wards and to impede the journey back. If the speed of the launch on both days was same, the time required for complete journey on the rough day, as compared to the quiet day will be

(A) less

(B) same

(C) more

(D) none of these.

29. A drunkard is walking along a straight road. He takes 5 steps forward and 3 steps backward, followed by 5 steps forward and 3 steps backward and so on. Each step is one metre long and takes 1 second. There is a pit on the road 13 metre away from the starting point. The drunkard will fall into the pit after

(A) 13 sec

(B) 25 sec

(C) 19 sec

(D) 37 sec

30. In a race for 100 metre dash, the first and the second runners have a gap of half metre at the midway stage. Assuming the first runner goes steady, by what percent should the second runner increase his speed just to win the race.

(A) 0.1%

(B) 0.5%

(C) less than 2%

(D) more than 2%.

31. A railway train starts from a station A, moves for one minute with a uniform acceleration of 0.2 m/s^2, then

moves on for 10 minutes with uniform velocity, after which it retards uniformly at the rate of l m/s^2 and stops at station B. The distance between A and B is

(A) 4536 m

(B) 7284 m

(C) 7632 m

(D) 6408 m

32. A man sitting in a moving train is facing the engine, he throws a coin up, the coin falls behind him. The train is

(A) moving forward with uniform speed

(B) moving backward with uniform speed

(C) moving forward with decelaration

(D) moving forward with acceleration.

33. A car accelerates from rest at rate α for sometime after which it decelerates at rate β to come to rest. If the total time lapse is t seconds, then the maximum velocity reached by the car is

(A) $(\alpha + \beta)\, t/\alpha\beta$

(B) $\alpha\beta t/(\alpha + \beta)$

(C) $(\alpha - \beta)\, t/\alpha\beta$

(D) $\alpha\beta t/(\alpha - \beta)$

34. A car accelerates from rest at rate α for sometime after which it decelerates at rate β to come to rest. If the total time lapse is t seconds, then the total distance covered by the

(A) $(\alpha + \beta)\, t^2/2\alpha\beta$

(B) $\alpha\beta t^2/(\alpha - \beta)$

(C) $(\alpha - \beta)\, t^2/2\alpha\beta$

(D) $\alpha\beta t^2/2(\alpha - \beta)$

35. A car accelerates from rest at rate α for some time from a station A after which it retards at rate β to come to rest at station B. If distance between stations A and B is S, the maximum velocity of the car is:

(A) $[2\alpha\beta S/(\alpha - \beta)]^{1/2}$

(B) $[(\alpha - \beta)S/2\alpha\beta]^{1/2}$

(C) $[(\alpha + \beta)S/2\alpha\beta]^{1/2}$

(D) $[2\alpha\beta S/(\alpha + \beta)]^{1/2}$

MOTION UNDER GRAVITY

36. A stone released with zero velocity from the top of tower reaches the ground in 4 sec. If g = 10m/sec^2, then the height of the tower is

(A) 20 m

(B) 40 m

(C) 80 m

(D) 160 m

37. A ball thrown vertically upward returns to its starting point in 4 s. Its initial speed is

(A) 23.6 m/s

(B) 6 m/s

(C) 19.6 m/s

(D) zero

38. A stone is thrown down-vertically from the top of a tower with an initial velocity of 10 ms^{-1}. It strikes the ground after 2 sec. The velocity with which the stone strikes the ground is {g = 10 m/s^2)

(A) 20 m/s

(B) 30 ms^{-1}

(C) 40 m/s

(D)10 m/s

39. A ball is released from the top of a tower of height h metres. It takes T seconds to reach the ground. Where is the ball at the time T/2 seconds?

(A) At h/2 metres from the ground

(B) At h/4 metres from the ground

(C) At 3h/4 metres from the ground

(D) depends upon the mass and volume of the ball

40. A stone weighing 3 kg falls from top of tower 100m high and burries itself 2m deep in sand. The time of penetration is

(A) 0.09 second

(B) 0.9 second

(C) 2.1 second

(D) 1.3 second

41. Drops of water fall from the roof of a building 9m high at regular intervals of time; the first drop reaching the ground at the same instant fourth drop starts to fall. What are the distances of the second and third drops from the roof?

(A) 6m and 2m

(B) 6m and 3m

(C) 4m and lm

(D) 4m and 2m.

42. A stone thrown vertically upward flies past a window one second after it was thrown upward and after three seconds on its way downward, the initial velocity of the stone is

(A) 10 ms^{-1}

(B) 20 ms^{-1}

(C)15 m/s

(D) 5 m/s

43. What is maximum height of a stone thrown vertically upward if its velocity is halved in 1.5 second? (g = 10 ms^{-2})

(A) 20 m

(B) 25 m

(C) 30m

(D) 45m.

44. A stone thrown upward with a speed u from the top of the tower reaches the ground with a velocity 3u. The height of the tower is

(A) $3u^2/g$

(B) $4u^2/g$

(C) $6u^2 / g$

(D) $9 u^2/g$

45. A balloon is at a height of 81 meters and is ascending upwards with a velocity of 12 m/s. A body of 2 kg weight is dropped from it. If g = 10 m/s^2, the body will reach the surface of the earth in

(A) 1.5 s

(B) 4.025 s

(C) 5.4s

(D) 6.75 s

46. A body falls freely from the top of a tower and it falls 7/16 th of the total distance in its last second. The time taken by the body to complete motion is

(A) 3 seconds

(B) 4 seconds

(C) 5 seconds

(D) 6 seconds

47. A body of mass 2 kg is released at the top of a smooth inclined plane having inclination 30°. It takes 3 seconds to reach the bottom. If the angle of inclination is doubled (made 60°), what will be the time taken?

(A) 3 second

(B) $(3)^{1/2}$ second

(C) $1/ (3)^{1/2}$ second

(D) None of these.

49. A body is released from a great height and falls freely towards the earth. Another body is released from the same height exactly one second later. Then the separation between the two bodies, 2 seconds after the release of the second body is

(A) 4.9 m

(B) 9.8m

(C) 19.6 m

(D) 24.5 m

50. Two balls of the same masses are thrown upwards at an interval of 2 seconds, along the same vertical line with the same initial velocity of 39.2 ms^{-1}. They will collide at a height

(A) 44.1m

(B) 58.8 m

(C) 73.5 m

(D) 78.4 m

51. A balloon is going upwards with a velocity of 20 ms^{-1}. It releases a packet when it is at a height of 160 m from the ground. The time taken by the packet to reach the ground will be (g = 10 ms^{-2}).

(A) 6 s

(B) 8 s

(C) 10 s

(D) 12 s

52. A ball is projected vertical upwards from the surface of earth with an initial speed + 49 m/s. The ball reaches its maximum height in 5.0 seconds. Neglecting air resistances, what is the total displacement of the ball from

the lime it is thrown until it returns to the point from which it was thrown.

(A) 248 m

(B) 9.8 m

(C) 49 m

(D) 0 m.

53. A stone falls freely from rest and the total distance covered by it in the last second of 9 its motion equals 9/25 of its motion, the stone remains in air for

(A) 4 S

(B) 5 S

(C)6S

(D)7S

54. One body is dropped while a second body is thrown downward with an initial velocity of lm/sec

simultaneously. The separation between these is 18 metres after a time

(A) 18 seconds

(B) 9 seconds

(C) 4.5 seconds

(D) 36 seconds

55. A particle is projected vertically upwards with a velocity u. Then (A) when it returns to the point of projection

(A) when it returns to the point of projection its displacement is u^2/g

(B) when it returns to the point of projection total distance covered by it is zero.

(C) when it is at the maximum height its acceleration is zero.

(D) when it returns to the point its average velocity is zero.

56. A person throws up 4 balls in succession and maintains them in air. The maximum height to which he throws each ball is 19.6 m. He throws the fourth ball, when the first returns to his hand. What are the positions of the balls in motion?

(A) 4.9m, 9.8m, 19.7 m

(B) 9.8m, 19.6m, 9.8m

(C) 14.7m, 19.6m, 14.7m

(D) 4.9m, 9.8m, 19.6m

57. The distance moved by freely falling body (starting from rest) during 1st, 2nd, 3rd.....nth second of its motion are proportional to

(A) even numbers

(B) odd numbers

(C) all integral numbers

(D) square of integral numbers

VECTORS

58. If the resultant of two vectors having magnitude of 7 and 4 is 3, the magnitude of the cross product of the two vectors could be

(A) 28

(B) 3

(C) 11

(D) zero.

59. If the resultant of the two vectors having magnitude of 7 and 4 is 11, the dot product of the two vectors could be

(A) 28

(B) 3

(C) zero

(D) 7/4

60. The angle between $(\hat{A}+\hat{B})$ and $\hat{A}\times\hat{B}$ is

(A) 0

(B) $\pi/4$

(C) $\pi/2$

(D) π

61. Two forces of 100 N and 25 N act concurrently on an object. These two forces could have a resultant force of

(A) zero N

(B) 50 N

(C)100N

(D)150N.

62. Two forces P and Q acting at a point are such that if P is reversed, the direction of the resultant is turned through 90°, then

(A) P = Q

(B) P = 2Q

(C) P= Q/2

(D) No relation exists between P and Q.

63. A man walks 40 m North, then 70 m East and then 40 m South. What is his displacement from the starting point?

(A) 150 m East

(B) 150 m West

(C) 70 m East

(D) 70 m West.

64. If $\vec{A} = \vec{B} + \vec{C}$ and the magnitudes of A, B and C are 5,4 and 3 units respectively the angle between A and C is

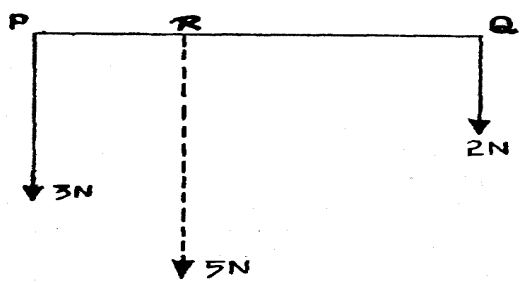
(A) $\sin^{-1}(3/4)$

(B) $\cos^{-1}(4/5)$

(C) $\cos^{-1}(3/5)$

(D) $\pi/2$

65. The resultant of the system shown in the figure is a force 5 N parallel to the given force through R where PR equals



(A) 3/5 RQ

(B) 2/3 RQ

(C) 2/5 RQ

(D) 1/2RQ

66. A proton in a cyclotron changes its velocity from 30 km/s north to 40 km/s east in 20 sees. What is the average acceleration during this time?

(A) 2.5km/s^2at 37°E of S

(B) 2.5km/s^2 at 37° S of E

(C) 2.5km/s^2at 37° N of E

(D) 2.5 km/s^2 at 37° E of N

67. In the arrangement shown in the figure, the ends P and Q of an unstretchable string move downwards with uniform speed u. Pulleys A and B are fixed. Mass M moves upwards with a speed

(A) u cos θ

(B) u/cosθ

(C) 2u cosθ

(D) $2u/\cos\theta$

68. A pendulum is suspended from the roof of a train moving with acceleration 'a. The inclination θ to the vertical is given by

(A) $\theta = 0$

(B) $\theta = \tan^{-1}(a/g)$

(C) $\theta = \tan^{-1}(g/a)$

(D) $\theta = \sin^{-1}(a/g)$

69. A particle is moving eastwards with a velocity of 5 m/sec. In 10 seconds the velocity changes to 5 m/sec north wards. The average acceleration in this time is

(A) 1/2 m/sec^2 towards north.

(B) $1/\sqrt{2}$ m/seq^2 towards north-east.

(C) 1/2 m/sec^2 towards north-west.

(D) $1/\sqrt{2}$ m/sec^2 towards north-west.

70. The resultant of two vectors A and B is perpendicular to the vector A and its magnitude is equal to half of the magnitude of vector B. The angle between A and B is

(A) 120°

(B) 150°

(C)135°

(D) None of these

71. The magnitude of two forces when acting at right angle give a resultant of √10 N and when acting at 60° produce a resultant of √13 N. The two forces are

(A) √5 N, √5 N

(B) √6 N, 2 N `

(C) 3N, 1N

(D) 2√2 N, 2N

72. The position vector of a particle is r = a cosωt i - a Sin ωt j. The velocity of the particle is

(A) parallel to position vector

(B) directed towards origin

(C) directed away from origin

(D) perpendicular to position vector

73. If two non-zero vectors A and B obey the relation A + B = - B the angle between them is

(A) 120°

(B) 90°

(C) 60°

(D) 0°

74. A body constrained to move in y direction is subjected to a force given by F = (-2 i + 15 j + 6 K) N.

What is the work done by this force, in moving the body through a distance of 10 m along the y-axis ?

(A) 190J

(B) 160J

(C) 150J

(D) 20J

75. Five equal forces of 10 N each are applied at one point and are lying in one plane. If the angles between them are equal, the resultant of these forces will be

(A) zero

(B)10N

(C) 20N

(D) $10\sqrt{2}$N

PROJECTILES

76. A shell is fired vertically upwards with a velocity u from the deck of a ship travelling at a speed of v. A person on the shore observes the motion of the shell as a parabola whose horizontal range is given by

(A) $2u^2v^2/g$

(B) $2u^2v^2/g^2$

(C) $2uv^2/g$

(D) $2uv/g$

77. It is possible to project a particle with a given velocity in two possible ways so as to make it pass through a point at a distance r from the point of projection. The product of times taken to reach this point in the two possible ways is then proportional to

(A) r

(B) r^2

(C) 1/r

(D) $1/r^2$

78. The greatest height attained by a projectile thrown with velocity u making an angle θ with horizontal is

(A) $u^2 \sin^2\theta/2g$

(B) $u^2 \sin\theta/2g$

(C) $u^2 \sin2\theta/2g$

(D) $u^2 \sin2\theta/g$

79. A projectile is thrown with velocity u making an angle θ with horizontal, the total time of flight is

(A) $u \sin\theta/2g$

(B) $2u \sin\theta/g$

(C) $2u \sin2\theta/g$

(D) $u \sin^2\theta/$

80. A cannon on a level plane is aimed at an angle θ above the horizontal and a shell is fired with a muzzle velocity v_0 towards a vertical cliff a distance D away. Then the height from the bottom at which the shell strikes the side walls of the cliff is

(A) D Sin θ - $gD^2/(2v_0^2\sin^2\theta)$

(B) D cos θ - $gD^2/(2v_0^2\cos^2\theta)$

(C) D tan θ - $gD^2/(2v_0^2\sin^2\theta)$

(D) D tan θ - $gD^2/(2v_0^2\cos^2\theta)$

81. Which of the following does not change when a projectile is fired at an angle with the horizontal?

(A) Momentum

(B) Kinetic energy

(C) Vertical component of velocity

(D) Horizontal component of velocity.

82. Two particles move in a uniform gravitational field with an acceleration g. At the initial moment the particles were located at one point and moved with velocities V_1 = 1 m/s and V_2 = 4 m/s horizontally in opposite directions. The distance between the particles at the moment when their velocity vectors become mutually perpendicular is ($g=10m/s^2$)

(A) 4 m

(B) 3 m

(C) 2 m

(D) 1 m

83. Two bodies were thrown simultaneously from the same point: one, straight up and the other, at an angle of θ = 30° to the horizontal. The initial velocity of each

body is equal to V_o = 20 m/s. Neglecting air resistance the distance between the bodies at t = 1.2 sec. later is

(A) 20 m

(B) 30m

(C) 24m

(D) 50 m

84. A particle of mass m is projected with a velocity v making an angle of 45° with horizontal. The magnitude of the angular momentum of the projectile about the point of projection when the particle is at its maximum height

(A) $m\sqrt{(2gh^3)}$

(B) $mv^3/\sqrt{2g}$

(C) $mv^3/ 4\sqrt{2g}$

(D) zero.

85. A projectile is thrown from a point in a horizontal plane such that the horizontal and vertical velocities are 9.8 m/s and 19.6 m/s. It will strike the plane after covering distance of

(A) 39.2 m

(B) 19.6 m

(C) 9.8 m

(D) 4.9 m.

86. A particle moves in a plane with constant acceleration in a direction, different from the initial velocity. The path of the particle is

(A) an ellipse

(B) an arc of a circle

(C) a straight line

(D) a parabola.

87. A person aims a gun at a bird from a point, at a horizontal distance of 100m. If the gun can impart a speed of 500 m/sec to the bullet, at what height above the bird must he aim his gun in order to hit it? (g =10m/sec^2)

(A) 10 cm

(B) 20 cm

(C) 50 cm

(D) 100 cm

88. A ball is thrown up from a horizontal ground level at 30 m/s and at an angle of 60° to the horizontal. When the ball just hits the ground the change in its total velocity is very nearly equal to

(A) 60m/s at an angle 60° below the horizontal

(B) 26m/s downward vertically

(C) 52 m/s downward vertically

(D) 52m/s upward vertically.

89. A baseball is thrown with an initial velocity of 100 m/s at an angle 30° above the horizontal. How far from the throwing point will it attain its original level?

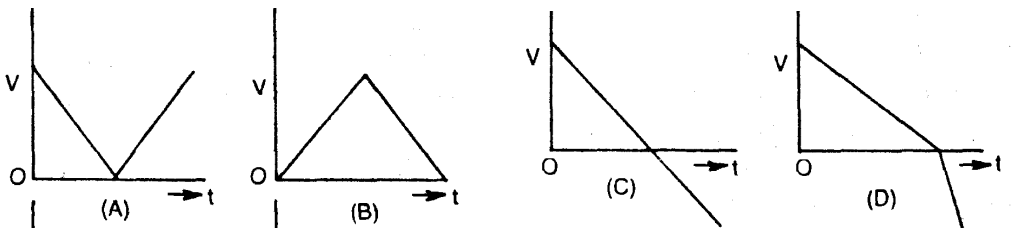
(A) 640 m

(B) 884m

(C) 89m

(D) 760m.

90. A ball is projected vertically upwards with a high velocity v. It returns to the ground in time t. Which v-t graph shows the motion correctly?



(A) (D)

(B) (C)

(C) (B)

(D) (A)

91. An aeroplane is travelling parallel to the ground at a height of 1960 m and at a speed of 540 km/hr. When it is vertically above a point A on the ground, an object is released from it. The object strikes the ground at point B. Neglecting air resistance, the distance AB is

(A) 180 m

(B) 0.3 km

(C) 3km

(D) 30km.

92. An aeroplane in a level flight at 144 km/hr, is at an altitude of 1000 m. How far from a given target should a bomb be released from it to hit the target?

(A) 571.43 m

(B) 671.43 m

(C) 371.43 m

(D) 471.43 m.

93. In the above question, the time taken to reach the target will be

(A)1000/7 secs

(B) 7 secs

(C) 10/7 sec

(D) 100/7 secs.

94. A stone is projected in air. Its time of flight is 3 seconds and range is 150 m. The horizontal component of velocity of projection of the stone is ($g=10m/s^2$)

(A) 22.5 m/s

(B) 15 m/s

(C) 50 m/s

(D) 30m/s

95. A stone is projected in air. Its time of flight is 3 seconds and range is 150 m. Maximum height reached by the stone is ($g = 10\ m/s^2$)

(A) 37.5 m

(B) 22.5 m

(C)90m

(D) 11.25 m.

96. A body is projected horizontally with speed of 19.6 m/s. After 2 sec its speed will be (take $g=9.8m/s^2$)

(A) $19.2/\sqrt{2}$ m/s

(B) $(19.6)\sqrt{2}$m/s

(C) 9.8 m/s

(D) 39.2 m/s

97. A body is projected horizontally from the top of a high tower with a speed of 20 m/s. After 4 sec the displacement of the body is (take $g=10m/s^2$)

(A) 40 m

(B) 80m

(C) $80\sqrt{2}$m

(D) $80/\sqrt{2}$ m

98. A body is projected horizontally with speed 20 m/s. nearly What will be its speed after 5 sec?

($g=10m/s^2$)

(A) 54 m/s

(B) 160 m/s

(C) 72 m/s

(D) 50 m/s

99. The velocity at the maximum height of a projectile is half of its initial velocity of projection u. Its range on horizontal plane is

(A) $3u^2/g$

(B) $3u^2/2g$

(C) $u^2/3g$

(D) $\sqrt{3}u^2/2g$

100. A projectile is thrown at an angle 0 with the horizontal. Its maximum height would be equal to horizontal range if the angle θ is

(A) $\tan^{-1} 1$

(B) $\tan^{-1} 2$

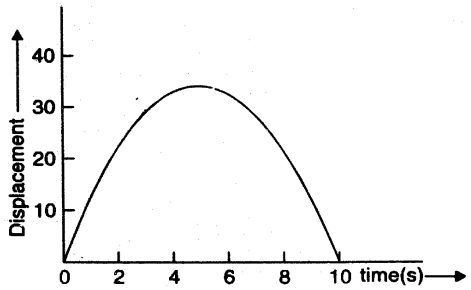
(C) $\tan^{-1} 4$

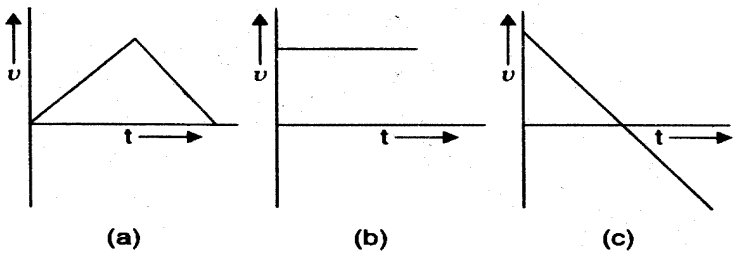
(D) $\tan^{-1} 1/4$

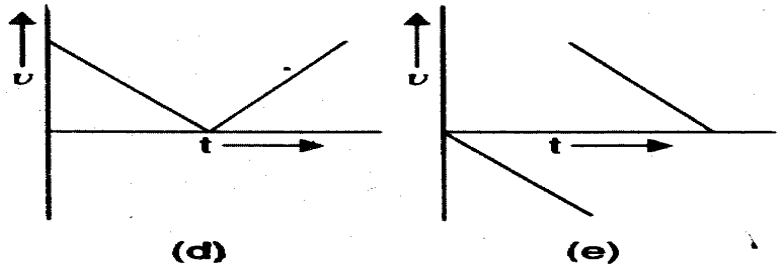
DISCRIPTION OF MOITON IN ONE DIMENSION

GRAPHICAL BANK

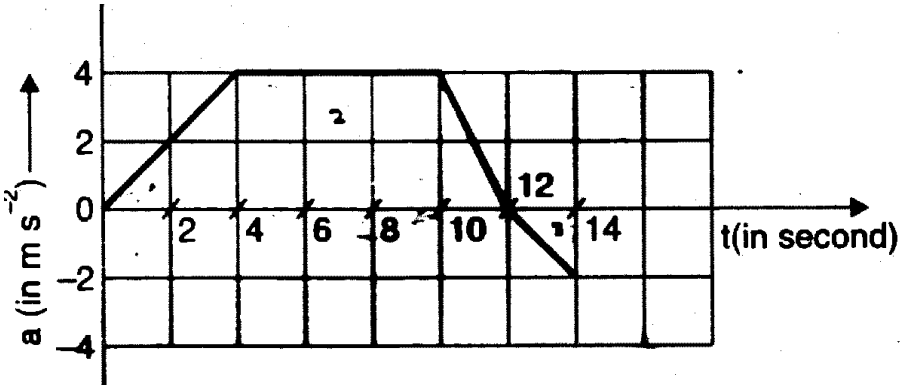
1. The Displacement time graph of a moving object is shown in fig. which of the velocity time graphs shown in fig. could represent th motion of the same body







2. A graph of acceleration versus time of a particle from rest at t = 0 is as shown n fig. the speed of the particle at t = 14 second is



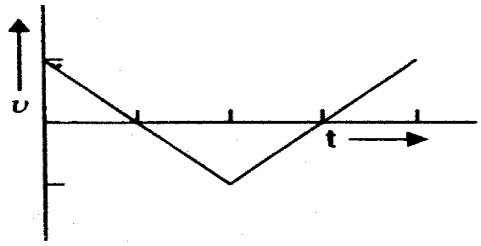
(a) $2ms^{-1}$.

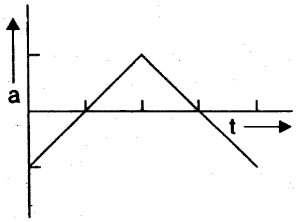
(b) $34\ ms^{-1}$.

(c) $20\ ms^{-1}$.

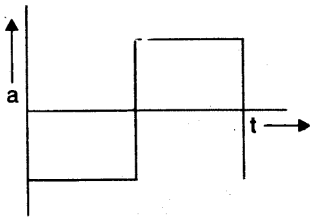
(d) $42\ ms^{-1}$.

3. The graph shown in the fig 21 shows the velocity ν versus time t for a body. Which of the following graphs shown in fig.22 represents the corresponding acceleration versus time graphs.

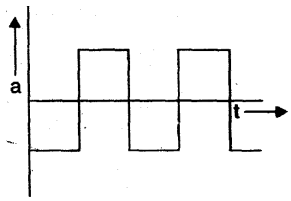




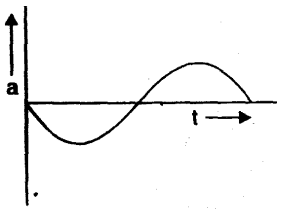
(a)



(b)

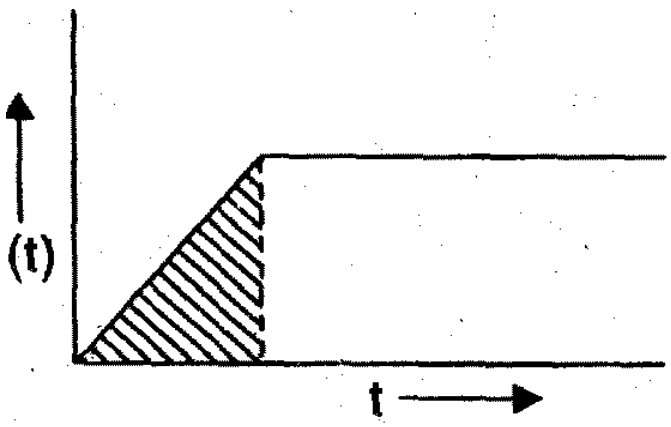


(c)



(d)

4. The graph depicts the velocity of an object at various times during its motion. The shaded portion of the graph has an area equal to



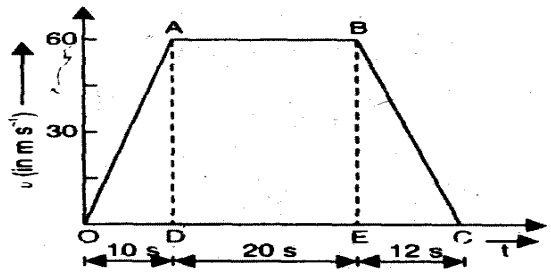
(a) the average acceleration

(b) distance moved during uniform motion.

(c) distance moved during accelerated motion.

(d) the average velocity

5. The velocity time graph of a moving train is depicted in the fig 24. the average velocity in time OD is



(A) 30 ms^{-1}.

(B) 60 ms^{-1}.

(C) 45 ms^{-1}.

(D) 23 ms^{-1}.

6. In Q. no. 5 distance traveled in time OD is

(A) 60m

(B) 600 m.

(C) 300 m.

(D) 450 m.

7. In Q. no. 5 , uniform acceleration during time OD is

(A) 2 ms^{-2}.

(B) 4 ms^{-2}.

(C) 6 ms^{-2}.

(D) 8 ms^{-2}.

8. In Q. 5 total distance covered is

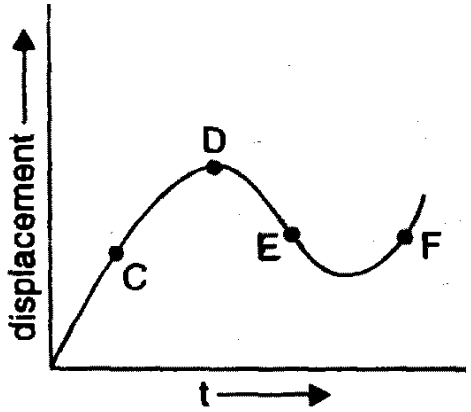
(A) 100m

(B) 1860 m

(C) 9m

(D) 73.5 m

9. The displacement time graph of a moving particle shown below. The instantaneous velocity of the particle is negative at the point.



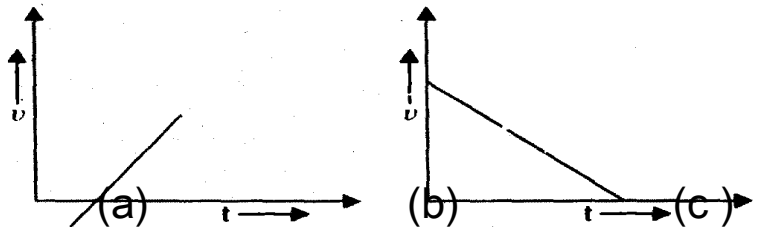
(A) C.

(B) D

(C) E.

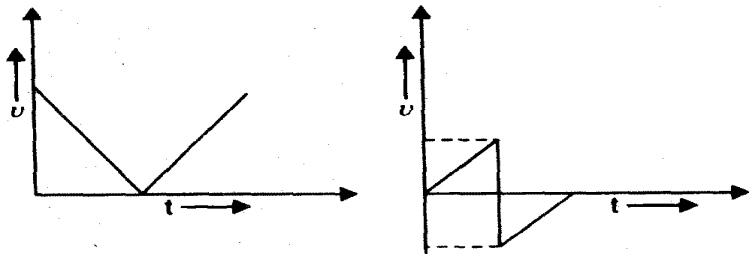
(D) F

10. Which of the following curves represent the ν - t graph of an objest falling on a metallic surface and bouncing back ?



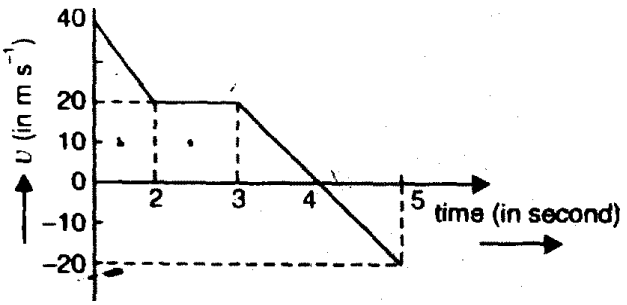
(d)

(a) (b)



(c) (d)

11. In the given ν - t graph, the distance traveled by the body in 5 seconds will be



(A) 20 m

(B) 40 m

(C) 80 m

(D) 100 m.

12. In Q. no. 11 the displacement of the body in 5 second will be

(A) 20m

(B) 40 m

(C) 80 m

(D) 100 m

13. In Q. no. 11 the average velocity of the body in 5 seconds is

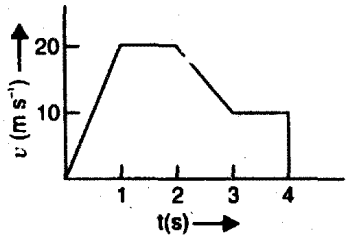
(A) 4 ms^{-1}.

(B) 8 ms^{-1}.

(C) 16 ms^{-1}.

(D) 20 ms^{-1}.

14. The variation of velocity of a particle moving along a straight line is shown in the fig . the distance traveled by the particle in 4 s is



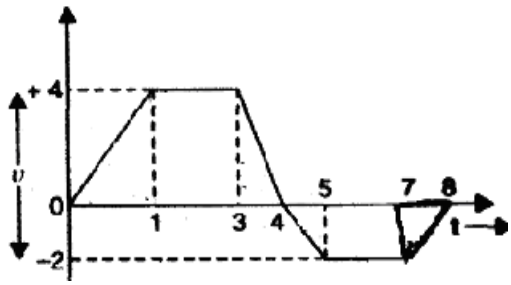
(A) 25 m

(B) 30 m

(C) 55 m

(D) 60m

15. The velocity time graph particle in linear motion is shown. Both ν and t are in SI units what is the displacement of the particle from the origin after 8 second ?



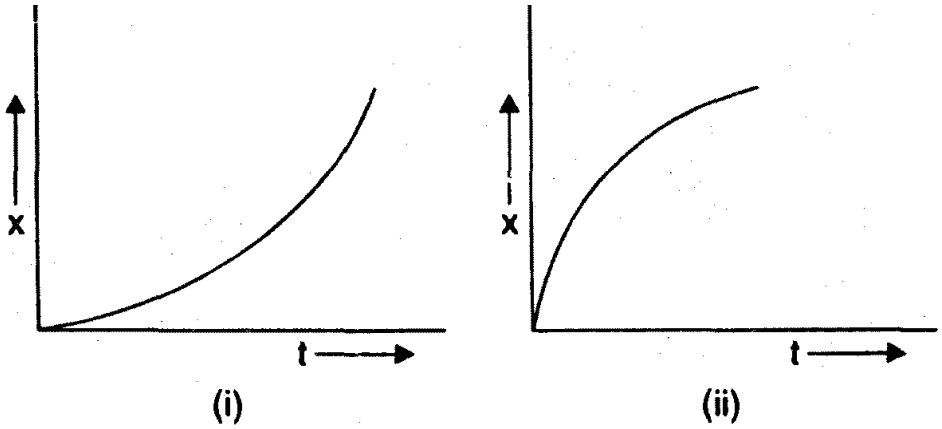
(A) 6 m

(B) 8

(C) 16 m

(D) 18m

16. Fig (i) and (ii) show the displacement time graphs of two particles moving along the x axis. We can say that



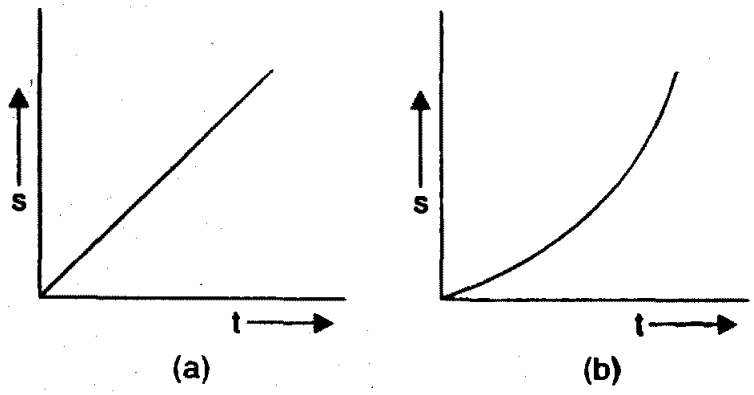
(A) both the particle are having a uniformly retarded motion.

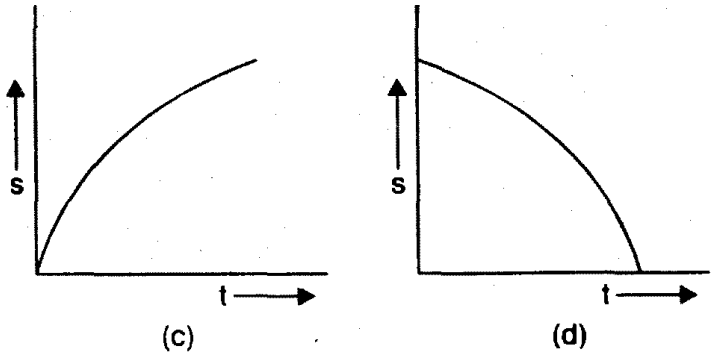
(B) Both the particle are having a uniformly accelerated motion.

(C) particle (i) is having a uniformly accelerated motion while particle (ii) is having a uniformly retarded motion.

(D) particle (i) is having a uniformly retarded motion while particles (ii) is having a uniformly accelerated motion.

17. Which of the following graphs represents the distance time variation of a body released from the top of a building





18. A rocket is fired upwards. Its engine explodes fully in 12 second. The height reached by the rocket as calculated from its velocity time graph is

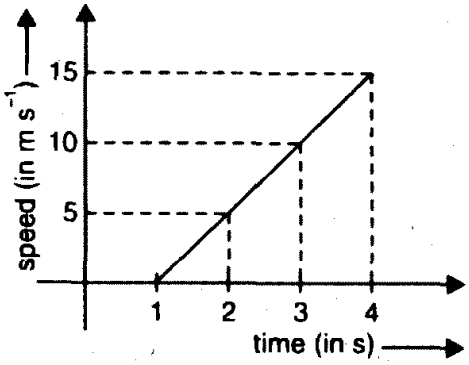
(A) 1200 x 66 m

(B) 1200 x 32 m.

(C) (1200/12)m

(D) 1200 x 12^2 m

19. The speed versus time graph of a body is shown in the fig. . which of the following statement is correct



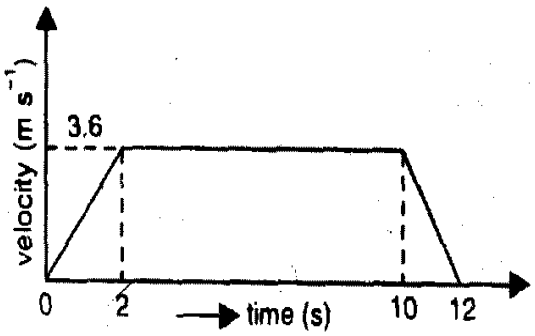
(A) the body is moving with uniform acceleration of 6.67 ms^{-2} at all times.

(B) The body is at rest for 1 s and has a uniform acceleration of 6.67 ms ms^{-2}.

(C) The body is at rest for one second and has a uniform acceleration of 5 ms^{-2} afterward.

(D) The body is at rest for 1 s and has a uniform retardation of 6. 67ms^{-2} afterwards.

20. An elevator is going up. The variation in the velocity of the elevator is as given in the graph . What is the height to which the elevator takes the passengers.



(A) 3.6 m

(B) 28.8 m

(C) 36.0 m

(D) 72. 0 m

21. In Q. no. 20 what will be the average velocity of the elevator.

(A) 1 ms^{-1}.

(B) 3 ms^{-1}.

(C) 28.8 ms^{-1}.

(D) 1.8 ms^{-1}.

22. In Q. 20 the average acceleration of the elevator is

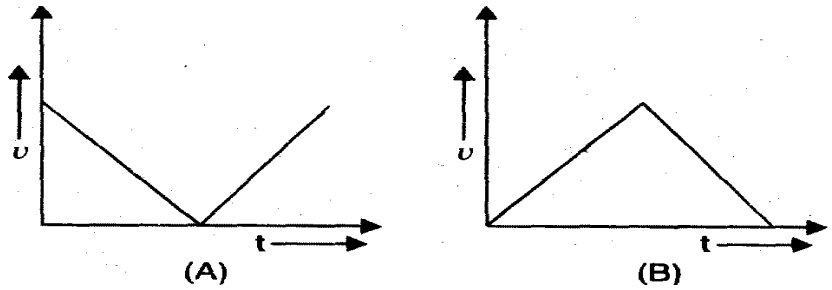
(A) zero

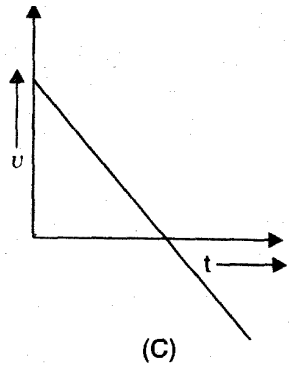
(B) 0.3 ms^{-2}.

(C) -1.8 ms^{-1}.

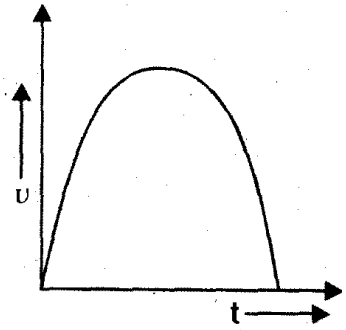
(D) 1.8 ms^{-2}.

23. A ball is projected vertically upwards, which graph in the figure represents the velocity of the ball during its flight when air resistance is ignored.





(C)



(D)

(A) A

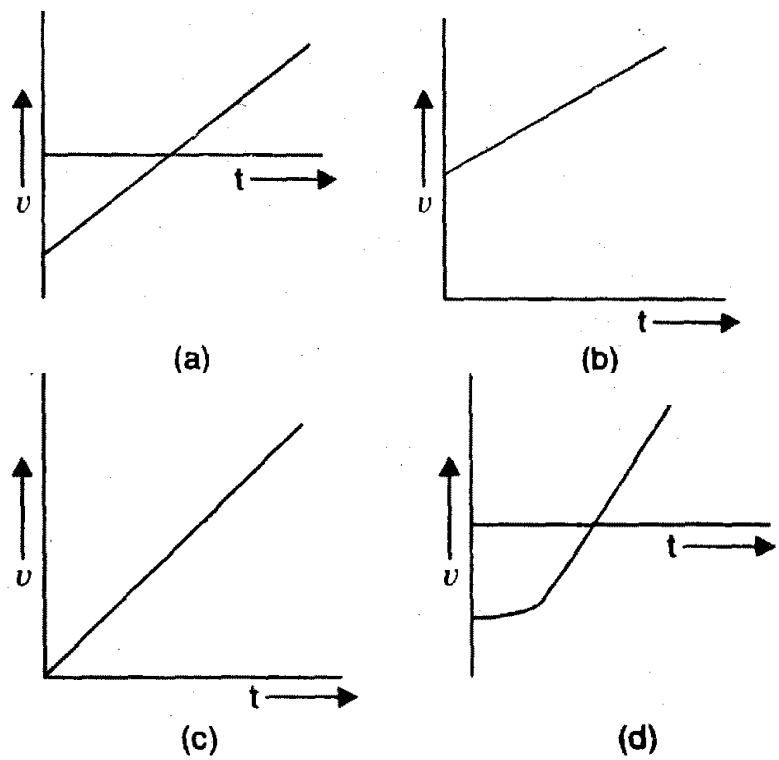
(B) B

(C) C

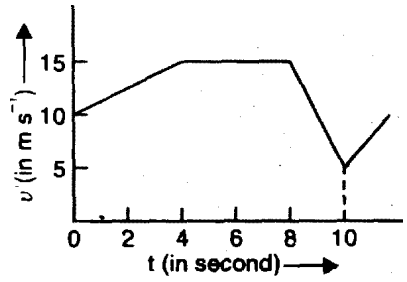
(D) D

24. A particle moves along X – axis in such a way that its x – coordinate varies with time t . according to the equation : $X = (6 - 4t + 6t^2)$ metre. The velocity of

the particle will vary with time according to the graph..



25. In the velocity time graph shown in fg. The distance traveled by the particle between 1.0 second and 4.0 second is nearly.



(A) 39 m

(B) 60 m

(C) 80 m

(D) 100m.

26. In the above question, the acceleration of the particle at t = 9 second is

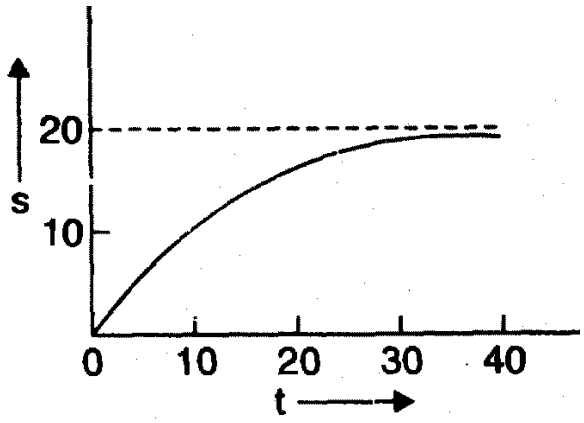
(A) zero.

(B) -2 ms^{-2}.

(C) -5 ms^{-2}.

(D) + 5 ms^{-2}.

27. The displacement of a particle as a function of time t is shown in fig. the figure indicates



(A) the velocity of the particle is constant

(B) the particle starts with certain velocity, but the motion is retarded and finally the particle stops.

(C) the particle starts with a constant velocity, the motion is accelerated ad finally the particle moves with

another constant velocity

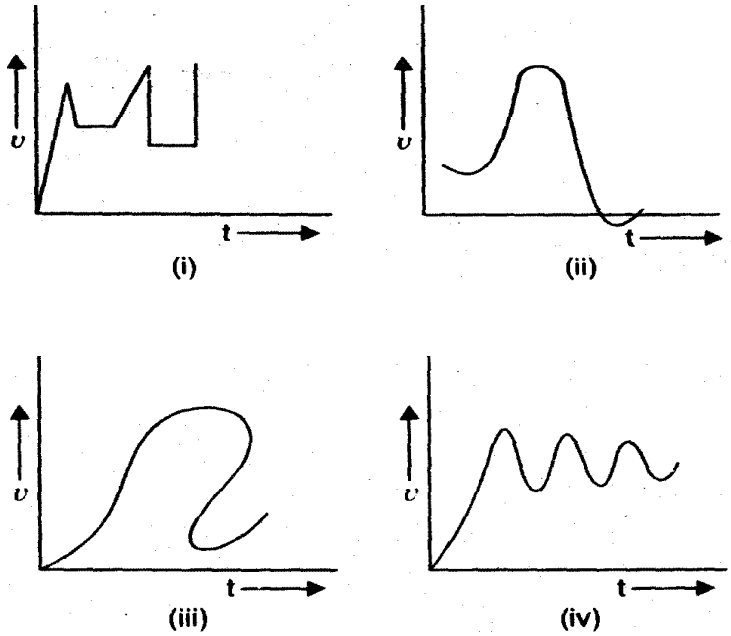
(D) the acceleration of the particle is constant

throughout.

28. The following figures show velocity v versus time t

curves . But only some of these can be realized in

practice. These are



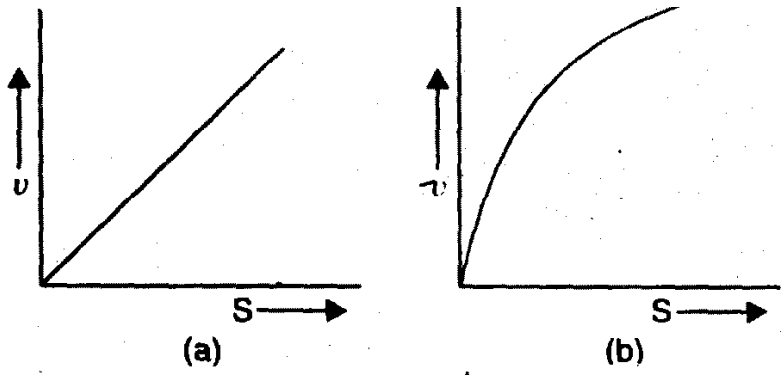
(A) (i) , (ii) & (iv) only

(B) (i), (ii) & (iii) only.

(C) (ii) & (iv) only.

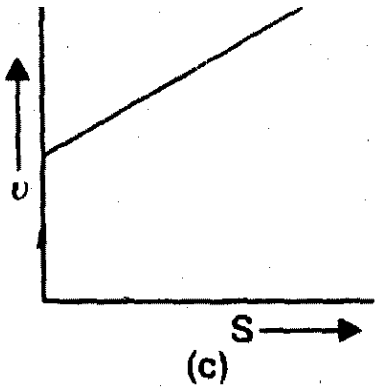
(D) all.

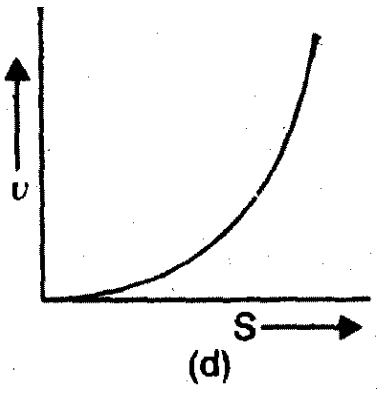
29. A particle starts from rest and moves along a



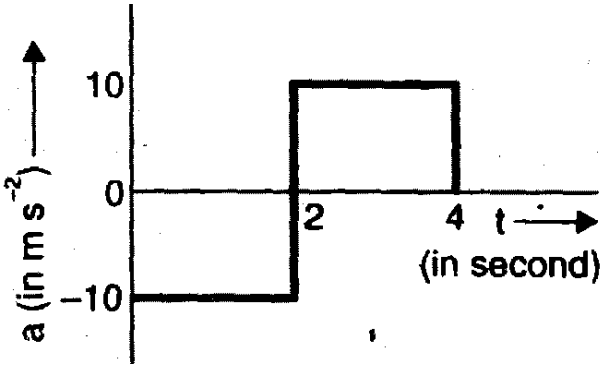
straight line with constant acceleration. The

variation velocity v with displacement S is





30. A particle starts from rest at time t = 0 and moves on a straight line with acceleration as plotted in fig 41. the speed of the particle sill be maximum after time .



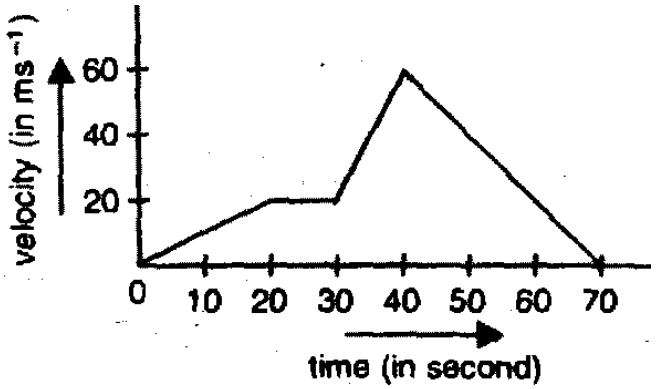
(A) 1 s.

(B) 2s.

(C) 3 s

(D) 4s.

31. The velocity versus time graph of a moving particle is shown in the fig. The maximum acceleration is



(A) 1 ms^{-2}.

(B) 2 ms^{-2}.

(C) 3 ms^{-2}.

(D) 4 ms^{-2}.

32. In the above question the retardation is

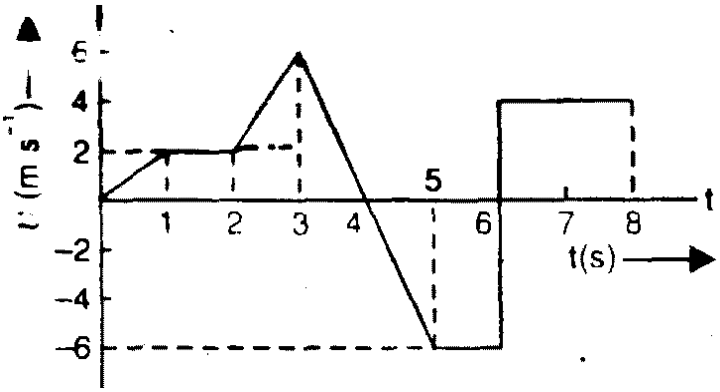
(A) 1 ms^{-2}.

(B) 2 ms^{-2}.

(C) 3 ms^{-2}.

(D) 4 ms^{-2}.

33. The velocity time graph of a body is shown in the figure. The displacement of the body in 8 seconds is



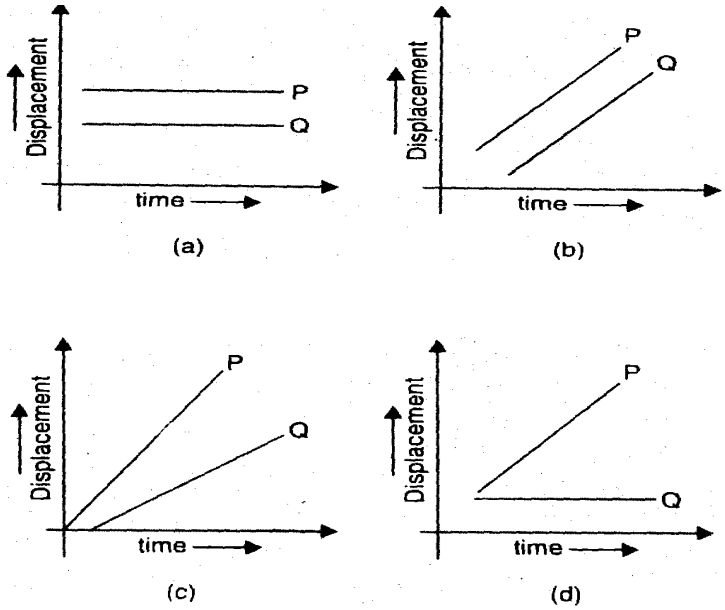
(A) 9m

(B) 10 m

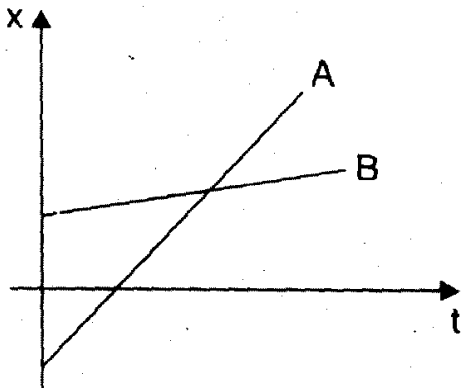
(C) 24 m

(D) 30 m

34. Which of the following represents the time displacement graph of two objects P and Q moving with zero relative speed ?



35. Fig shows the time displacement graph of the particles A and B which of the following statements is correct ?



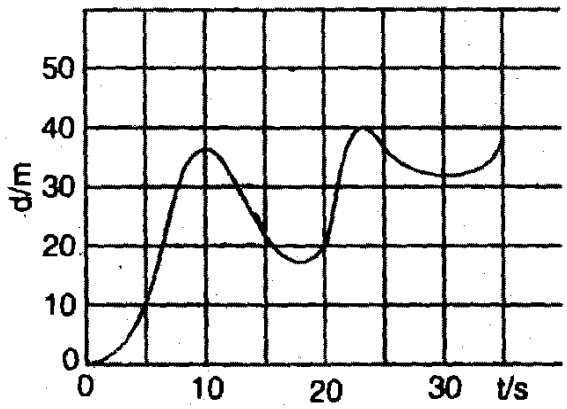
(A) Both A and B move with uniform equal speed.

(B) A is accelerated, B is retarded.

(C) Both A and B move with uniform speed. The speed of B is more than he speed of A.

(D) Both A and B move with uniform speed but the speed of A is more than the speed of B.

36. In the displacement d versus time t graph given below , the value of average velocity in the time interval 0 to 20 s in



(A) 1.5

(B) 4

(C) 1

(D) 2.

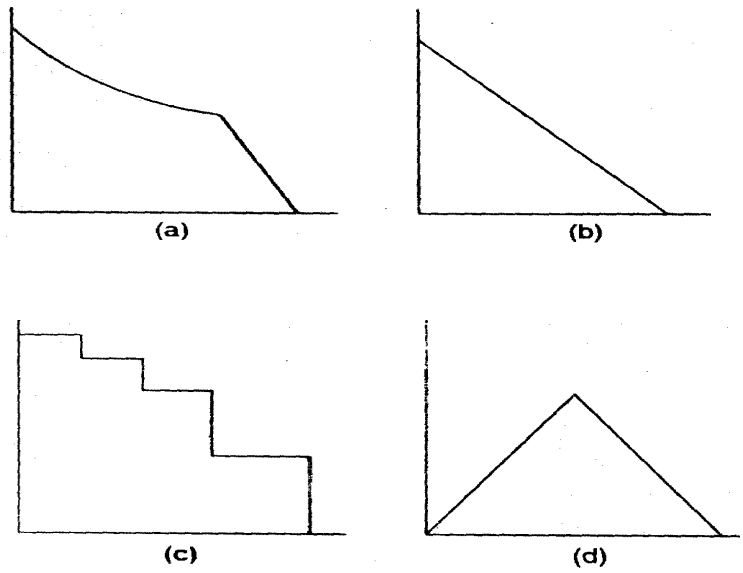
37. A football is rolling down a hill of unknown shape.

The speed of the football at different times is noted

as given

Time	Instantaneous speed .
0s	0 ms^{-1}.
1s	4 ms^{-1}.
2 s	8 ms^{-1}.
3s	12ms^{-1}.
4s	16 ms^{-1}.

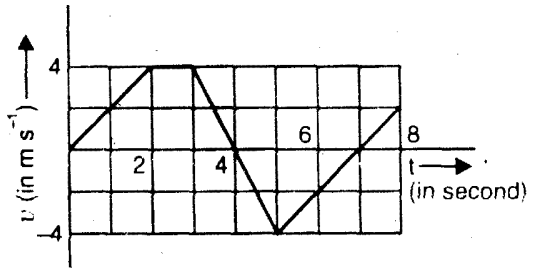
The correct shape of the hill is depicted in



38. Fig here gives the speed time graph for a body.

The distance traveled between t = 1. 0 second and

t = 7.0 second is nearest to



(A) 1.5 m

(B) 2

(C) 3

(D) 4

39. The velocity time graph of a body is shown in fig.

50 The ratio of the …… during the intervals OA and

OB is ……

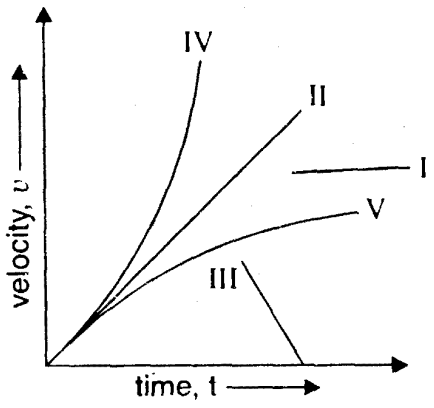
(A) average velocities ; 1

(B) OA/OB ; ¼

(C) average accelerates same as distance covered.

(D) distance covered. ; ½

40. Five velocity time graphs are shown in the fig in which case is the acceleration uniform and positive ?



(A) I

(B) II

(C) III

(D) IV

(E) V

41. In Q. no. 40 in which case is the acceleration increasing with time

(A) I

(B) II

(C) III

(D) IV

(E) V

42. In Q. no. 40 in which case the acceleration is decreasing with the passage of time

(A) I

(B) II

(C) III

(D) IV

(E) V

43. In Q. no. 40 in which case the acceleration is zero ?

(A) I

(B) II

(C) III

(D) IV

(E) V

44. In Q. no. 40 in which case the acceleration is uniform and negative

(A) I

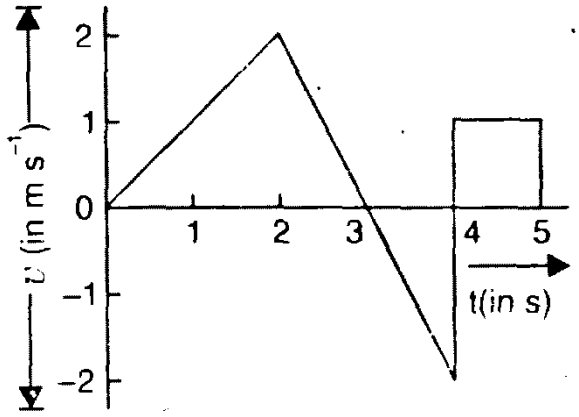
(B) II

(C) III

(D) IV

(E) V

45. The velocity time graph of a particle moving along a straight line is shown in the fig the displacement of the body in 5 seconds is



(A) 0.5 m

(B) 1m.

(C) 2m

(D) 3m

46. In the above question the distance covered by the body in 5 second is

(A) 1m

(B) 2m

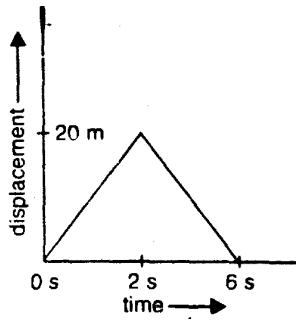
(C) 3m

(D) 5m

47. For the displacement time graph shown in the fig

the ratio of the magnitudes of the speeds during the

first two second and the next four second is



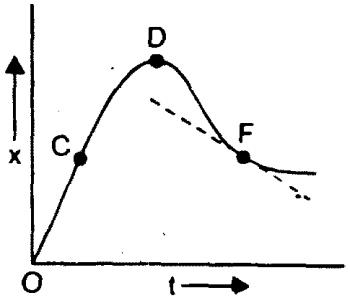
(A) 1 : 1

(B) 2 : 1

(C) 1 : 2

(D) 3 : 2

48. Refer to x – t graph . Which of the following is incorrect.



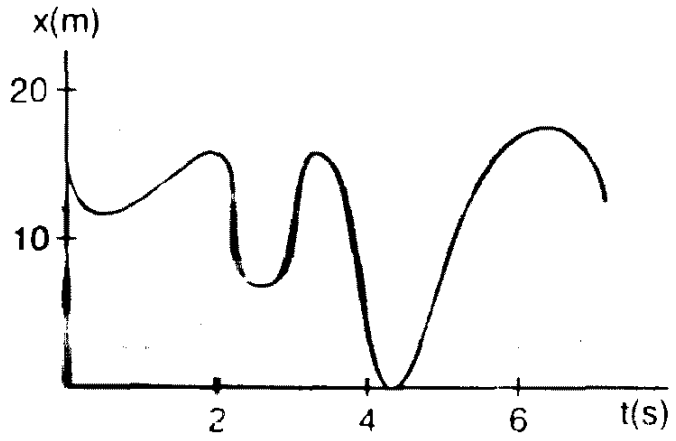
(A) At D, velocity is positive

(B) At F, motion is in the - x direction.

(C) at C, velocity is +ve

(D) All of these.

49. Fig shows the position of a particle moving along the X- axis as a function of time



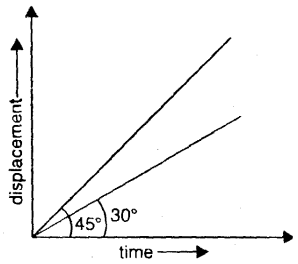
(A) The particle has come to rest 6 times.

(B) The maximum speed is at t =6s.

(C) The velocity remains positive for t = 0 and t = 6s.

(D) The average velocity for the total period shown is negative.

51. The displacement time graphs of two moving p articles make angles 30^0 and 45^0 with the x axis. The ratio of the two velocities is



(A) $\sqrt{3} : 1$

(B) 1 : 1

(C) 1 : 2

(D) 1 : √3.

54. What does the shaded portion in the fig represent

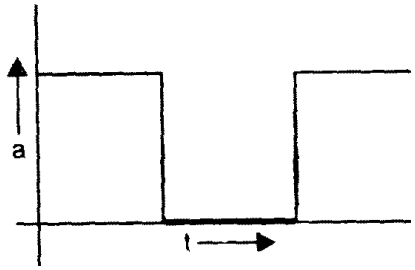
(A) momentum

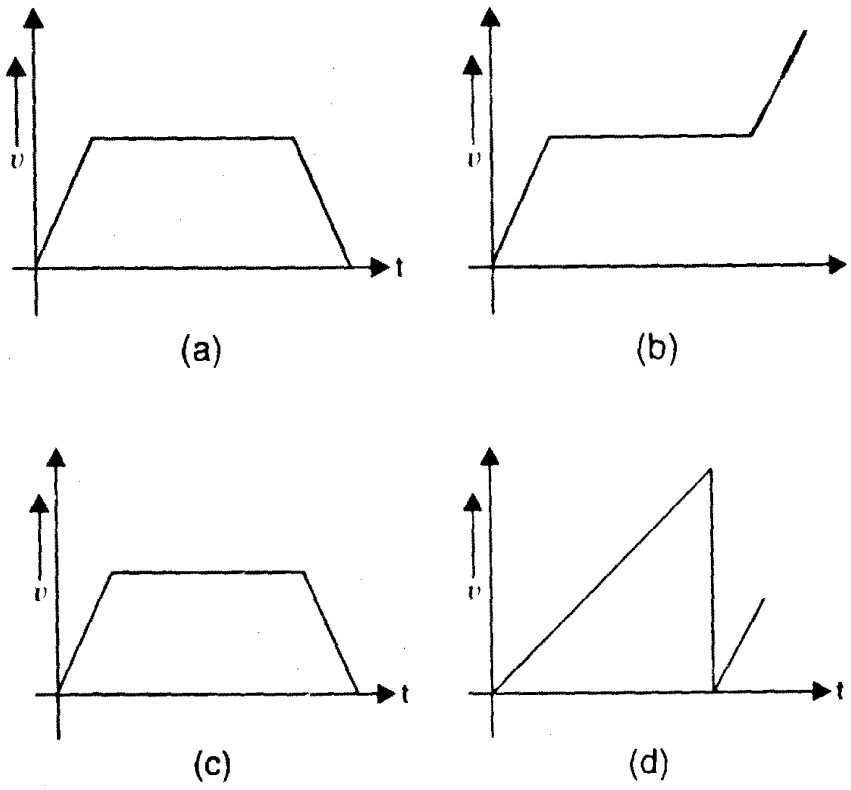
(B) acceleration

(C) distance

(d) velocity

55. Fig . 61shows the acceleration time graph of a particle. Which of the following the corresponding velocity time graph.

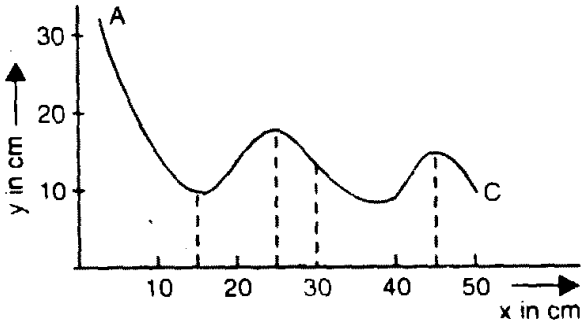




56. Fig shows the path A to C traced by a particle in xy plane . B is a point on the path between x = 10 cm and 50 cm such that the instantaneous particle velocity at B is the same in direction as the

average particle velocity during the path A to B.

The x co-ordinates of B is nearest to



(A) 16 cm

(B) 22 cm

(C) 30 cm

(D) 44 cm.

57. Fig gives the time t versus velocity ν relation for a vehicle moving in a straight path. The displacement between t = 0 and t= 12.5 s is

(A) 30 m

(B) 150 m

(C) 75 m

(D) 125 m

58. In the above question the magnitude | a | of highest acceleration retardation is

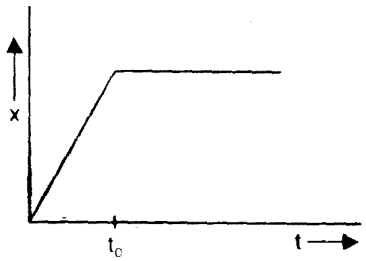
(A) 8 ms^{-2}.

(B) 4 ms^{-2}.

(C)2 ms^{-2}.

(D) 16 ms^{-2}.

59. Fig shows the x- t graph of a particle moving along x – axis Which of the following is correct ?



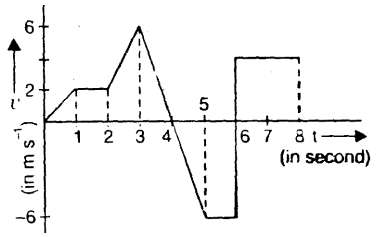
(A) The particle moves at a constant velocity up to a time t_0 and then stops

(B) The velocity increases up to a time t_0 and then become constant.

(C) The particle is continuously in motion along positive x direction.

(D) The particle is at rest.

60. The velocity time graph of a particle moving along a straight line is shown in fig. The displacement from the origin after 8 second is



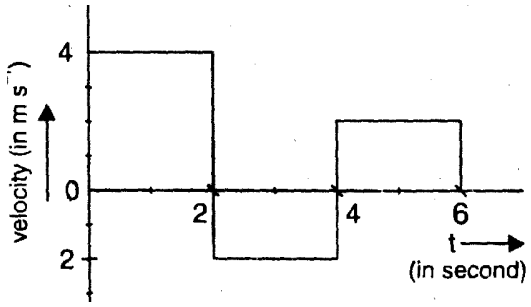
(A) 6 m

(B) 8 m

(C) 16 m

(D) 9 m.

61. In the velocity time graph , a straight line is normal to the time axis. The acceleration is



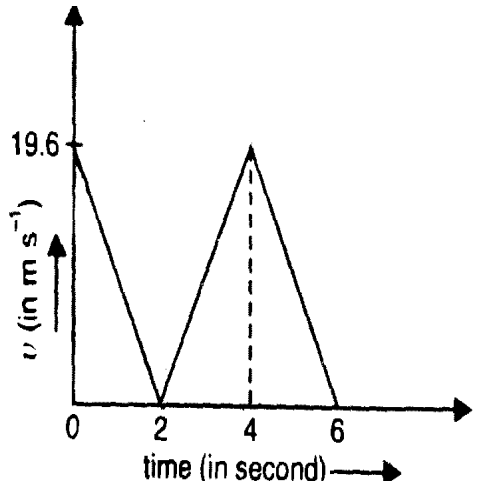
(A) zero.

(B) positive

(C) negative

(D) infinite.

62. The velocity time graph of a body moving in a straight line is shown in fig. The displacement and the distance traveled by the body in 6 seconds are respectively



(A) 8m, 16m

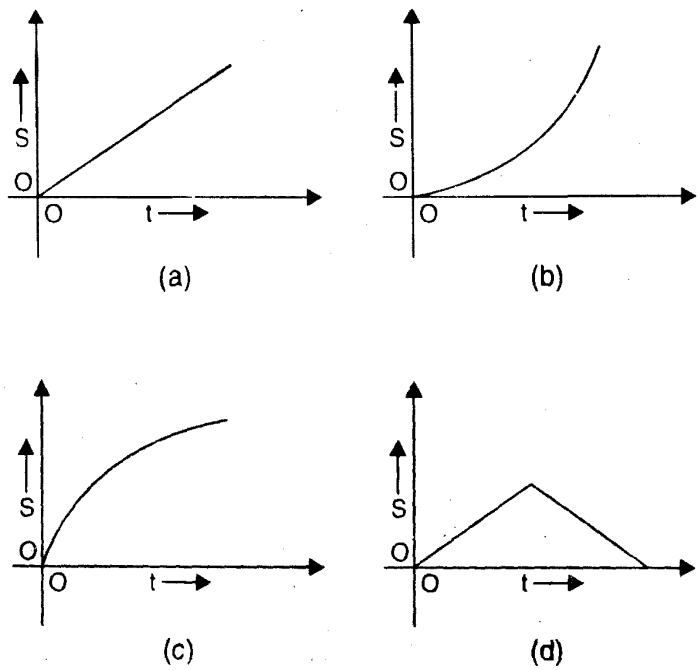
(B) 16m , 8m

`(C) 16 m ,16m

(D) 8m, 8m

63. From a high tower at time t = 0 , one stone is dropped from rest and simultaneously another stone is projected vertically up with an initial

velocity. The graph of the distance 'S' between the two stones, before either hits the ground , plotted against time 't' will be as



64. The velocity time graph of a particle is as shown in

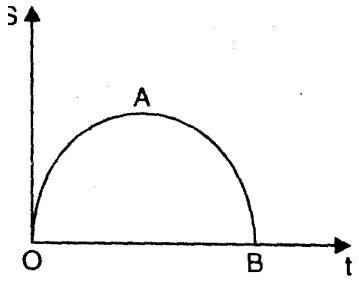
(a) it moves with constant acceleration throughout.

(B) it move with an acceleration of constant magnitude but changing direction at the end of every two second.

(C) The displacement of the particle is zero.

(D) The velocity becomes zeo at t = 4 second.

65. The graph displacement time for a body traveling in straight line is given. We can conclude that



(A) the velocity is constant

(B) the velocity increases uniformly

(C) the body is subjected to acceleration from O to A

(D) the velocity of the body at a is zero.

PROJECTILES

1. A shell is fired vertically upwards with a velocity u from the deck of a ship travelling at a speed of v. A person on the shore observes the motion of the shell as a parabola whose horizontal range is given by:

(A) $2u^2v^2/g$

(B) $2u^2v^2/g^2$

(C) $2uv^2/g$

(D) $2uv/g$

2. It is possible to project a particle with a given velocity in two possible ways so as to make it pass through a point at a distance r from the point of projection. The product of times taken to reach this point in the two possible ways is then proportional to

(A) r

(B) r^2

(C) 1/r

(D) $1/r^2$

3. The greatest height attained by a projectile thrown with velocity u making an angle θ with horizontal is :

(A) $u^2 \sin^2\theta/2g$

(B) $u^2 \sin\theta/2g$

(C) $u^2 \sin2\theta/2g$

(D) $u^2 \sin2\theta/g$

4. A projectile is thrown with velocity u making an angle θ with horizontal, the total time of flight is

(A) $u \sin\theta/2g$

(B) $2u \sin\theta/g$

(C) $2u \sin 2\theta/g$

(D) $u \sin^2\theta/$

5. A cannon on a level plane is aimed at an angle θ above the horizontal and a shell is fired with a muzzle velocity v_0 towards a vertical cliff a distance D away. Then the height from the bottom at which the shell strikes the side walls of the cliff is

(A) $D \text{ Sin } \theta - gD^2/ (2v_0^2\sin^2\theta)$

(B) $D \cos \theta - gD^2/ (2v_0^2\cos^2\theta)$

(C) $D \tan \theta - gD^2/ (2v_0^2\sin^2\theta)$

(D) $D \tan \theta - gD^2/ (2v_0^2\cos^2\theta)$

6. Which of the following does not change when a projectile is fired at an angle with the horizontal?

(A) Momentum

(B) Kinetic energy

(C) Vertical component of velocity

(D) Horizontal component of velocity.

7. Two particles move in a uniform gravitational field with an acceleration g. At the initial moment the particles were located at one point and moved with velocities V_1 = 1 m/s and V_2 = 4 m/s horizontally in opposite directions. The distance between the particles at the moment when their velocity vectors become mutually perpendicular is ($g=10m/s^2$)

(A) 4 m

(B) 3 m

(C) 2 m

(D) 1 m

8. Two bodies were thrown simultaneously from the same point: one, straight up and the other, at an angle of $\theta = 30°$ to the horizontal. The initial velocity of each body is equal to $V_o = 20$ m/s. Neglecting air resistance the distance between the bodies at t = 1.2 sec. later is

(A) 20 m

(B) 30m

(C) 24m

(D) 50 m

9. A particle of mass m is projected with a velocity v making an angle of 45° with horizontal. The magnitude of the angular momentum of the projectile about the point of projection when the particle is at its maximum height

(A) $m\sqrt{(2gh^3)}$

(B) $mv^3/\sqrt{2g}$

(C) $mv^3/ 4\sqrt{2g}$

(D) zero.

10. A projectile is thrown from a point in a horizontal plane such that the horizontal and vertical velocities are 9.8 m/s and 19.6 m/s. It will strike the plane after covering distance of

(A) 39.2 m

(B) 19.6 m

(C) 9.8 m

(D) 4.9 m.

11. A particle moves in a plane with constant acceleration in a direction, different from the initial velocity. The path of the particle is

(A) an ellipse

(B) an arc of a circle

(C) a straight line

(D) a parabola.

12. A person aims a gun at a bird from a point, at a horizontal distance of 100m. If the gun can impart a speed of 500 m/sec to the bullet, at what height above the bird must he aim his gun in order to hit it?

(A) 10 cm

(B) 20 cm

(C) 50 cm

(D) 100 cm

13. A ball is thrown up from a horizontal ground level at 30 m/s and at an angle of 60° to the horizontal. When the ball just hits the ground the change in its total velocity is very nearly equal to

(A) 60m/s at an angle 60° below the horizontal

(B) 26m/s downward vertically

(C) 52 m/s downward vertically

(D) 52m/s upward vertically.

14. A baseball is thrown with an initial velocity of 100 m/s at an angle 30° above the horizontal. How far from the throwing point will it attain its original level?

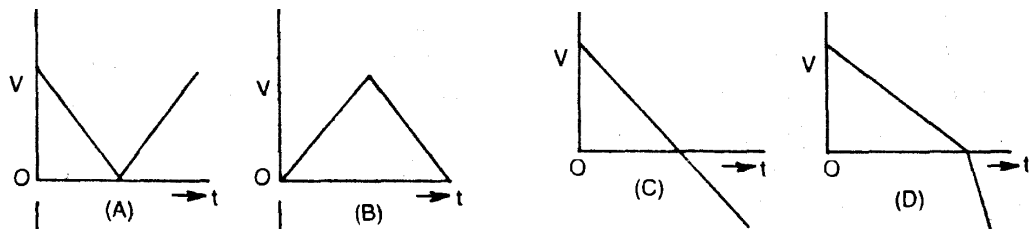
(A) 640 m

(B) 884m

(C) 89m

(D) 760m.

15. A ball is projected vertically upwards with a high velocity v. It returns to the ground in time t. Which v-t graph shows the motion correctly?



(A) (D)

(B) (C)

(C) (B)

(D) (A)

16. An aeroplane is travelling parallel to the ground at a height of 1960 m and at a speed of 540 km/hr. When it

is vertically above a point A on the ground, an object is released from it. The object strikes the ground at point B. Neglecting air resistance, the distance AB is

(A) 180 m

(B) 0.3 km

(C) 3km

(D) 30km.

17. An aeroplane in a level flight at 144 km/hr, is at an altitude of 1000 m. How far from a given target should a bomb be released from it to hit the target?

(A) 571.43 m

(B) 671.43 m

(C) 371.43 m

(D) 471.43 m.

18. In the above question, the time taken to reach the target will be

(A)1000/7 secs

(B) 7 secs

(C) 10/7 sec

(D) 100/7 secs.

19. A stone is projected in air. Its time of flight is 3 seconds and range is 150 m. The horizontal component of velocity of projection of the stone is ($g=10m/s^2$)

(A) 22.5 m/s

(B) 15 m/s

(C) 50 m/s

(D) 30m/s

20. A stone is projected in air. Its time of flight is 3 seconds and range is 150 m. Maximum height reached by the stone is

(A) 37.5 m

(B) 22.5 m

(C)90m

(D) 11.25 m.

21. A body is projected horizontally with speed of 19.6 m/s. After 2 sec its speed will be

(A) 19.2/√2 m/s

(B) (19.6)√2m/s

(C) 9.8 m/s

(D) 39.2 m/s

22. A body is projected horizontally from the top of a high tower with a speed of 20 m/s. After 4 sec the displacement of the body is (take $g=10m/s^2$)

(A) 40 m

(B) 80m

(C) $80\sqrt{2}$m

(D) $80/\sqrt{2}$ m

23. A body is projected horizontally with speed 20 m/s. nearly What will be its speed after 5 sec?

($g=10m/s^2$) :

(A) 54 m/s

(B) 160 m/s

(C) 72 m/s

(D) 50 m/s

24. The velocity at the maximum height of a projectile is half of its initial velocity of projection u. Its range on horizontal plane is :

(A) $3u^2/g$

(B) $3u^2/2g$

(C) $u^2/3g$

(D) $\sqrt{3}u^2/2g$

25. A projectile is thrown at an angle 0 with the horizontal. Its maximum height would be equal to horizontal range if the angle θ is :

(A) $\tan^{-1} 1$

(B) $\tan^{-1} 2$

(C) $\tan^{-1} 4$

(D) $\tan^{-1} 1/4$

26. A stone is projected in air. Its time of flight is 3 seconds and range is 150 *m.* The horizontal component of velocity of projection of the stone is ($g=10m/s^2$)

(A) 22.5 m/s

(B) 15 m/s

(C) 50 m/s

(D) 30m/s

27 Which of the following does not change when a projectile is fired at an angle with the horizontal?

(A) Momentum

(B) Kinetic energy

(C) Vertical component of velocity

(D) Horizontal component of velocity.

28. A projectile is thrown from a point in a horizontal plane such that the horizontal and vertical velocities are 9.8 m/s and 19.6 m/s. It will strike the plane after covering distance of

(A) 39.2 m

(B) 19.6 m

(C) 9.8 m

(D) 4.9 m.

29. A particle moves in a plane with constant acceleration in a direction, different from the initial velocity. The path of the particle is

(A) an ellipse

(B) an arc of a circle

(C) a straight line

(D) a parabola.

30. A person aims a gun at a bird from a point, at a horizontal distance of 100m. If the gun can impart a speed of 500 m/sec to the bullet, at what height above the bird must he aim his gun in order to hit it?

(A) 10 cm

(B) 20 cm

(C) 50 cm

(D) 100 cm

WORK, POWER & ENERGY

1. If the kinetic energy of a body increases by 0.1%, the percent increase of its momentum will be

   (a) 0.05%

   (b) 0.1%

   (c)1.0%

   (D) 10%

2. The linear momentum P of a body moving in one dimension varies with time according to the equation $P = a + bt^2$, where a and b are positive constants. The net force acting on the body is

   (a) Proportional to t^2.

   (b) a constant

   (C) Proportional to t

(d) inversely proportional to t.

3. The kinetic energy acquired by a body of Mass M after travelling a fixed distance from rest under the action a constant force is

(a) $\propto$ M

(b) $\propto\sqrt{}$ M

(c)1/$\sqrt{}$M.

(d) independent of M.

4. The ratio of the velocity of separation to the velocity of approach of two bodies is called

(a) coefficient of elasticity

(b) coefficient of contact

(C) coefficient if velocity

(d) coefficient of restitution

5. A ball of mass m collides with a wall with speed ν rebounds on the same line with the same speed. If mass of the wall is taken as infinite , then the work done by the ball on the wall is.

(a) $m\nu^2$.

(b) $\frac{1}{2} m\nu^2$.

(c) $2 m\nu$.

(d) zero

6. The temperature at the bottom of a high water fall higher than at the top because

(a) by itself heat flows from higher to lower temperature.

(b) the difference in height causes a difference in pressure.

(c) thermal energy is transformed into mechanical energy.

(d) mechanical energy is transformed into thermal energy.

7. A particle is displaced from a position 2i – j +k to another position 3i+2j-2k under the action of a force, 2i+j-k. The work done by the fore (in arbitrary units)

(a) 8

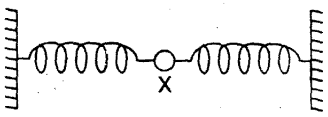
(b) 10

(c) 12

(d) 36.

8. A bead X resting on a smooth horizontal surface , is connected to two identical springs and is made to

oscillate to and fro along the line of the springs. When the bead passes through the central position its energy is



(a) zero (b) mostly potential energy (c) all potential energy

(d) half potential energy & half kinetic energy.

(e) all kinetic energy

9. A body of mass 2 kg is thrown vertically upwards with K.E 245 J. The acceleration due to gravity is 9.8 ms^{-2}. The K.E. of the body will become half at a height of

(a) 25m.

(b)12.5 m

(c) 6.25 m

(d) 5m.

10. A mass of 10 g moving with a velocity of 100 cm s^{-1} strikes a pendulum bob of mass 10g. The two masses stick together. The maximum height reached by the system now is (g= 10ms^{-2})

(a) zero

(b) 5cm

(c) 2.5 cm

(d) 1.25 cm.

11. Two springs have force constants K_1 & K_2 (K_1 > K_2).Each spring is extended by the same force F. if their elastic energies are E_1 & E_2 , then E_1/E_2 is equal to

(a) $K_1 : K_2$

(b) $K_2 : K_1$

(c) $\sqrt{K_1} : \sqrt{K_2}$

(d) $K_1^2 : K_2^2$

12. Mechanical advantage in a mechanical machine where a resistance W is overcome by applying an effort P is

(A) W-P

(b) P/W

(c) WxP

(d) W/P.

13. A compresses a liter of air from a pressure of one atmosphere to two atmosphere and does work W_A. But b compresses one liter of water from a pressure o

one atmosphere to two atmosphere and does work W_B. Then

(a) $W_A = W_B$.

(b) $W_A > W_B$.

(c) $W_A < W_B$.

(d) $W_A \geq W_B$.

14. A particle is moving in a horizontal circle with a constant speed, Which of the following remains constant

(a) kinetic energy of the body

(b) momentum of the body

(c) radial acceleration

(d) displacement of the body from the centre of the circle.

15. A body is displaced from $x = x_1$ to $x = x_2$ by a force $2x$. The work done is

(a) $(x_2 - x_1)^2$.

(b) $x_2^2 - x_1^2$.

(c) $2x_2 (x_2 - x_1)$

(d) $2x_1 (x_2 - x_1)$

16. A force 4 N acts through a distance of 11 m in the direction of the force. The work done is

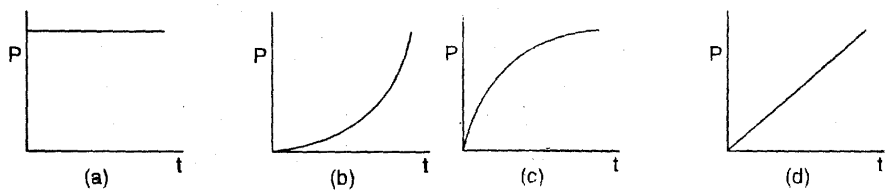
(A) 10J

(b) 11J

(c) 15 J

(d) 44 J

17. a motor drives a body along a straight line with a constant force. The power P developed by the Motor must vary with time t according to



18. When a 4 kg mass is hug vertically on a light spring that obeys Hooke's law, spring stretches by 2cm. The work required to be done by an external agent in stretching this spring by 5 cm will be

(A) 4.900 joule.

(b) 2.450 joule

(c) 0.495 joule.

(d) 0.245 joule.

19. A force F = (5i + 3j) Newton is applied over a particle which displaces it from its origin to the point r = (2i – Ij) meter. The work done on the particle is

(a) -7J

(b) + 13 J

(c) +7 J

(d) +11 J

20. A car is moving with a speed of 100 kmh^{-1} . if the mass of the car is 950 kg, then its kinetic energy is

(A) 0.367 MJ

(b) 3.7 J

(c) 3.67 MJ

(d) 367 J

21. A body is dropped from a height of 20 m and rebounds to a height of 10m. The loss of energy is

(A) 10%

(b) 45%

(c) 50%

(d) 75%

22. Tripling the velocity of your scooter multiplies the distance for stooping it by

(A) 3

(b) 6

(c) 9

(d) 12

23. For the same value of kinetic energy, the momentum shall be maximum for

(a) a proton

(b) an electron

(c) a deutron

(d) an α particle.

SET –II

24. A particle of mass m is moving in a horizontal circle of radius R under a centripetal force given by $(-k/R^2)$, where k is a constant. Then

(a) The kinetic energy of the particle is k/12R

(b) The total energy of the particle is (-k/2R)

(c) The kinetic energy of the particle is (-k/R)

(d) The potential energy of the particle is k/2R

25. A pendulum bob has a 3m s^{-1} at its lowest position. The pendulum is 0.5 m long. The speed of the bob ,

when the length makes an angle 60^0 to the vertical will be

(a) 3 m s^{-1}.

(b) 1/3 m s^{-1}.

(c) ½ m s^{-1}.

(d) 2 m s^{-1}.

26. A moving body with a mass m_1 strikes a stationary body of mass m_2 The masses m_1 & m_2 should be in ratio m_1/m_2 so as to decrease the velocity of the first body 1.5 times assuming a perfectly elastic impact. Then the ratio m_1/m_2 is

(a) 5

(b) 1/5

(c) 1/25

(d) 25

27. In a certain situation , F and S are not equal to zero but the work is zero. From this, we conclude that

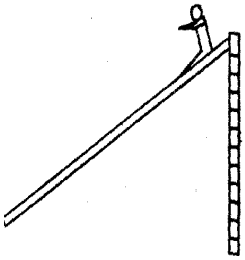
(a) $\vec{F}$ & $\vec{S}$ are in same direction

(b) $\vec{F}$ & $\vec{S}$ are in opposite direction

(c) $\vec{F}$ & $\vec{S}$ are at right angles

(d) $\vec{F} > \vec{S}$

28. In a children's park, there is a slide which has a total length of 10m and a height of 8.0 m. A vertical ladder is provided to reach the top. A boy weighing 200 N



climbs up the ladder to the top of the slide and slides down to the ground. The average friction offered by the slide is three tenth of his weight. The work done by the slide on the boy as he comes down is

(a) 0 J

(b) +600 J

(c) -600 J

(d) + 1600 J

29. A body of mass m is suspended from a mass less spring of natural length l. it stretches the spring through a vertical distance y. The potential energy of the stretched spring is

(a) mg (l + y)

(b) ½ mg (l + y)

(c) ½ mgy

(d) mgy.

30. A bomb of mass M at rest explodes into two fragments of masses m_1 & m_2. The total energy released in the explosion is E. if E_1 and E_2 represent the energies carried by masses m_1 and m_2 respectively , then which of the following is correct ?

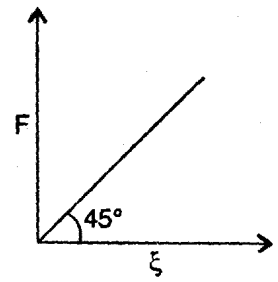
(a) $E_1 = (m_2/M)E$

(b) $E_1 = (m_1/m_2)E$

(c) $E_1 = (m_1/M)E$

(d) $E_1 = (m_2/m_1)E$

31. The F - ξ graph of a string is shown in the fig. if the same experiment is



performed with half length of the spring , ten F -ξ graph will make an angle θ with ξ-axis such that

(a) $\theta = 45^0$.

(b) $\theta < 45^0$.

(c) $\theta = 0^0$.

(d) $\theta > 45^0$.

32. A glass marble dropped from a certain height above the horizontal surface reaches the surface in time t and then continues to bounce up an down . The time in which the marble finally comes to rest is

(a) $e^n t$

(b) $e^2 t$

(c) t [(1+ e) / (1 -e)]

(d) t [(1- e) / (1 +e)]

33. A ball of mass 1 kg collides with a wall speed 8 ms^{-1}. and rebounds on the same line with the same speed if the mass of the ball is taken as infinite , the work done by the ball on the wall is

(a) 6J

(b) 8J

(c)9J

(d) zero.

34. A weight suspended from the free end of a vertically hanging spring produces an extension of 3 cm. The spring is cut into two parts so that the length of the longer pat is (2/3)th of the original length. If the same weight is now suspended from the longer part of the spring , the extension produced will be

(a) 0.1 cm

(b) 0.5 cm

(c) 1 cm

(d) 2 cm

35. Ten liter of water per second is lifter from a well through 20m and delivered with a velocity of 20 m s^{-1}. if g = 10 ms^{-2} , then the power of the motor is

(A) 1 kW

(b) 1.5 kW

(c) 2 kW

(d) 2.5 kW

36. The energy required to accelerate a car from rest to 10 ms^{-1} is E. What energy will be required to accelerate the car from 10 ms^{-1} to 20 ms^{-1}?

(a)E

(b) 3E

(c) 5E

(d) 7E.

37. In a molecule , the potential energy between two atoms is given by : $U(x) = a/x^{12} - b/x^{6}$. where a and b are positive constants and x is the distance between atoms . For stable equilibrium of atom, the value of x is

(a) zero.

(b) $[a/2b]^{1/6}$.

(c) $[2b/b]^{1/6}$.

(d) $[11a/5b]^{1/6}$.

38. If the force acting on a body is inversely proportional to its velocity, then the kinetic energy acquired by the body in time t is proportional to

(a)t^0.

(b) t^1.

(c) t^2.

(d) t^4.

39. A position dependent force $F = 3x^2 - 2x + 7$ acts on a body of mass 7 kg and displace it from x = 0m to x = 5m. The work done on the body is x joule. If both F and x are measured in SI units , the value of x is

(a) 135

(b) 235.

(c) 335.

(d) 935.

40. A nucleus ruptures into two nuclear parts which have their velocity ratio equal to 2 :1 . The ratio of their respective nuclear sizes is

(a) 1 : 2

(b) 1 : $\sqrt{2}$

(c) 1 : $2^{1/3}$.

(d) 1 : 8

41. A 10m long iron chain of linear mass density 0.8 kg m^{-1} is hanging freely from a rigid support . if g = 10m s^{-2} , then the power required to lift the chain up to the point of support in 10 seconds is

(a) 10W

(b) 20 W

(c) 30 W

(d) 40 W

42. A pump motor is used to deliver water at a certain rate from a given pipe . To obtain thrice as much water from the same pipe in the same time, power of the motor has to be increased

(a) 3 times

(b) 9 times.

(c) 27 times

(d) 81 times.

43. A bob of mass 9 kg at a rest explodes into two pieces of masses 3 kg and 6 kg . The velocity of mass 3 kg in 16 m s^{-1}. The kinetic energy of the mass 6 kg is

(a) 96J

(b) 192 J

(c) 384 J

(d) 768J

44. A child is swinging a swing. He is 0.5 m above the ground at the lowest position. The highest position is at 1.5m from the ground. If g = 10 ms^{-2}. then the velocity of the child at the lowest position of the swing is

(a) $\sqrt{10}$ ms^{-1}.

(b) $\sqrt{20}$ ms^{-1}.

(c) $\sqrt{30}$ ms^{-1}.

(d) $\sqrt{40}$ ms^{-1}.

45. Two bodies A and B having masses in the ratio 1 : 4 have kinetic energies in the ratio 4 : 1. the ratio of the linear momenta of A and B is

(a) 1 : 4

(b) 1 :2

(c) 1 :1

(d) 1 :15

46. A motor delivers water at the rate of 100 liter/minute from a certain pipe. If the power of the motor is increased x times , then the motor delivers water at the rate of 200 liter//minute through the same pipe . then, the value of x is

(a) 4

(b) 8

(c) 16

(d) 32

47. The momentum of a body having kinetic energy E is doubled. The new kinetic energy is

(a) E

(b) 4E

(c) 16E

(d) 32 E

48. if the momentum of a body decreases by 10%, then the percentages decrease in kinetic energy is

(a) 19

(b) 21

(c) 37

(d) 42

49. A moving car encounters air resistance which is proportional to the square of the speed of the car. The ratio of the power required at 40 km h^{-1} to that required at 80 kmh^{-1} to that requires 80 km h^{-1}, with the same breaking power, is

(a) 1 : 6

(b) 1:8

(c) 1:16

(d) 16 : 1

50. The automobile moving at a velocity of 30 km h^{-1} is stopped in 8 m by applying brakes. If the same automobile were travelling at 60 kmh^{-1} , then with the same breaking power, the automobile can be stopped with in a distance of

(a) 8m

(b) 16m

(c) 24 m

(d) 32 m

51. A body of mass 0.01 kg has a momentum of 103 g cm s-1 . its kinetic energy in cgs units is

(a) 5×10^4 erg.

(b) 10^3 erg.

(c) 0.01 erg

(d) 10 erg.

52. Water is pouring down from a waterfall at eh rate of 75 kg s^{-1} on the blades of turbine. If the height of the fall be 100m, then the power delivered to the turbine is nearly.

(a) 95 kW

(b) 75 kW

(c) 100 kW

(d) 0 kW

53. The engine of a truck moving along a straight road delivers constant power. The distance travelled by the truck in time t is proportional to

(a) t

(b) t^2

(c) $\sqrt{t}$

(d) $t^{3/2}$.

54. An electric motor of 100 W power drives a stirrer in a water bath. Only 80% of the energy supplied to the

motor is used up in stirring water. The work done on water in 1 second is

(a) 100 J

(b) 80J

(c) 180J

(d) 145 J

55. A person pushes a rock of 10^{10} kg mass by applying a force of only 10 N for just 4 second. The work done is

(a) 1000 joule

(b) 0 joule

(c) nearly zero.

(d) positive.

56,. A motor boat moving with a constant velocity of 10 ms^{-1} encounters water resistance of 1000N. the power of the motor boat is

(a) 10 kW

(b) 110 kW

(c) 1000 kW

(d) 10^6 kW

57. A body of weight of 10 N is lifted through a height of a m and held for 0.275 s. The work done against the force of gravity is

(a) zero

(b) 20 x 0.265 joule.

(c) 20 / 0.275 joule.

(d) 20 joule.

58. if distance is plotted against x –axis and kinetic energy against y –axis , then the slope of the graph so obtained is proportional to

(a) distance

(b) kinetic energy

(c) velocity

(d) acceleration

59. if speed is plotted against x-axis and kinetic energy against y –axis, then the graph obtained has a shape similar to that of

(a) circle

(b) ellipse

(c) hyperbola

(d) parabola

60. A person weighing 70 kg wt. lifts a mass of 30 kg to the roof of a building 10 m high. If he takes 50 seconds to do so, then the power spent is

(a) 19.6 W

(b) 196 W

(c) 300 W

(d) 50 W

61. if two electrons are forced to come closer to each other then the potential energy of the electrons

(a) becomes zero.

(b) increases,

(C) decreases.

(d) becomes infinite.

62. The force constant o a weightless spring is 16 N m^{-1}. The body of mass 1.0 kg suspended from it is pulled down through 5 cm and then released. The maximum kinetic energy of the system will be

(a) 2×10^{-2} J

(b) 4×10^{-2} J

(c) 8×10^{-2} J

(d) 16×10^{-2} J

63. A pendulum consisting of a steel ball of mass m tied to a string of length l is made to swing on a circular arc in a vertical plane. At the end of this arc, a wooden ball of mass 9 g is placed at rest. the fraction of the kinetic energy transferred to the stationary ball by the swinging ball is

(a) zero.

(b) ¼.

(c) 1/6

(d) 1/9.

64. Which of the following statements is incorrect

(a) The work done by sun in rotating planets around it is zero.

(b) Two vehicles having equal masses and equal speeds moving in opposite directions possess equal kinetic energy.

(c) Potential energy arising from the attractive forces is always positive.

(d) A particle is moving along the circumference of a circular track with variable speed. Some work is being done in this case.

65. An engine continuously pumps water through a pipe with speed ν. Tha rate at which kinetic energy is being delivered to water is proportional to

(a) υ

(b) υ^2.

(c) υ^3

(d) υ^4.

66. A man weighing 600 N climbs a stair carrying a load of 20 kg on his heat. The staircase has 20 steps each step has a height of 0.2m. if the man takes 10 second to climb, then te power expended is nearly

(a) 320W

(b) 20W

(c) 600W

(d) 800 W.

67. A load of mass M is moved up a smooth inclined plane of inclination θ, height h and lengt l. The work done is

(a) Mgl.

(b) Mgh

(c) Mg cos θ

(d) M tanθ/g.

68. A stone is falling freely in free space . its velocity is x when it has lost y units of the potential energy in the gravitational field of earth. Then the mass of the stone.

(a)xy

(b)$2y/x^2$.

(c) x + y

(d) (2y/x) + 9.8

69. A Crane can lift a body of mass 100 kg vertically upward with a constant speed of 5 ms^{-1}. if the value of acceleration due to gravity is 10 ms^{-2}. then the power of the crane is

(a) 100 x 10 x 5W

(b) 100 x 5W

(c) (100 / 5) W

(d) 100W

70. A ball is thrown from a height of h meter with an inclined downward velocity ν_0. it hits the ground ,

loses half of its kinetic energy and bounces back to the same height. The value of v_0 is

(a) $\sqrt{(2gh)}$

(b) $\sqrt{(gh)}$

(c) $\sqrt{(3gh)}$

(d) $\sqrt{(2.5\ gh)}$

71. Ordinarily , the value of coefficient of restitution varies from

(a) 0 to 1

(b) 0 to 0.5

(c) -1 to +1

(d) -0.5 to +0.5.

72. Which of the following collisions is an elastic collision

(a) Two bodies move towards each other, collide and then move away from each other. There is a rise in temperature.

(b) Two bodies collide and the sound of collision is heard by a blind man

(C) Two steel balls collide such that their kinetic energy is conserved.

(d) A man jumps on to a moving part.

73. Which of the following statements is incorrect ?

(a) kinetic energy may be zero.

(b) Potential energy may be zero, positive or negative.

(c) Power, Energy and work are all scalars

(d) Ballistic pendulum is a device for measuring the speed of the bullets.

74. An electric motor produces a tension of 4500 N in a lifting cable and moves it at the rate of 2 ms^{-1}. The power of the motor is

(a) 4500 W

(b) 2W

(c) 2 kW

(d) 9 kW

75. An engine of power 7500 W makes a train move on a horizontal surface with constant velocity of 20 ms^{-1}. The force involved in the problem is

(a) 375 N.

(b) 400 N.

(c) 500N

(d) 600 N

76. A stone of mass m is moved in a circle of radius r with constant speed υ. The work done by the force over half the circumference of the circle is

(a) zero.

(b) $(m\nu^2 / r)\ \pi r$.

(c) $(m\nu^2/r) \times 2\pi r$

(d) $mg \times 2\pi r$.

77. A ball is thrown vertically upwards in free space. Its total mechanical energy .

(a) remains constant throughout the motion

(b) increases during ascent and decrease during descent

(C) is zero at maximum height.

(d) is equal to kinetic energy at a point just below the maximum height.

78. A railway coolie carrying a load of 20 kg wt. on his head walls a distance of 10 m on a horizontal surface. The work done by the coolie against the force of gravity is

(a) zero.

(b) 200 joule

(c) 200 x 9.8 x 10 joule.

(d) a function of coefficient of friction.

79. The temperature of a steel ball is observed to increase after it has fallen through 10m. Which of the following conclusions can be drawn ?

(a) The value of acceleration due to gravity has become equal to the average velocity of the ball

(b) The ball has countered air resistance

(c) The mechanical energy of the ball is partly converted into heat energy.

(d) both b and c

80. A gas expands from 5 liter to 105 liter at a constant pressure 100 Nm^{-2}. The work done is

(a) 1 joule

(b) 4 joule

(c) 8 joule.

(d) 10 joule.

81. A force of 5N moves the particle through a distance of 10m. if 25 joule of work is performed, then the

angle between the force and the direction of motion is

(a) 0^0.

(b) 90^0.

(c) 30^0.

(d) 60^0.

82. A Cycle and a scooter having same kinetic energy are stopped by equal retarding force. The scooter shall cover a distance which is

(a) equal to the distance covered by the cycle.

(b) greater than the distance covered by the cycle.

(C) less then the distance covered by the cycle

(d) zero.

83. The amount of work done by a labourer who carries n bricks. Each of mass m, to roof of a house whose height is h is

(a) nmgh

(b) mgh/n

(c) zero.

(d) ghn/m

84. A 5kg brick of dimensions 20 cm x 10 cm x 8 cm is lying on the largest base. It is now made to understand with length vertical . if g = 10 ms^{-2}. then the amount of the work done is

(A) 3 J

(b) 5J

(c) 7J

(d) 9J

85. The displacement x of a body of mass 1 kg on horizontal smooth surface function of time t is given by : $x = t^3/3$. The wok done by the external agent for the first one second is

(a) 0.25 J

(b) 0.5 J

(c) 0-.75 J

(d) 1 J

86. A ball of mass m approaches moving wall of infinite mass with speed υ along the normal to the wall . The speed of the wall is u towards the ball. The speed of the ball after an elastic collision with the wall is

(a) υ -2u away from the wall.

(b) $2u + \upsilon$ away from the wall.

(c) $u-\upsilon$ away from the wall.

(d) $u+\upsilon$ away from the wall.

87. An automobile weighing 1200 kg climbs up a hill that rises 1 9n 20. Neglecting frictional effects , the minimum power developed by the engine is 9000 W. if $g = 10\ ms^{-2}$ then the velocity of the automobile.

(a) 36 km h^{-1}.

(b) 54 km h^{-1}.

(c) 72 km h^{-1}.

(d) 90 km h^{-1}.

88. A 500 kg car, moving with a velocity of 36 km h^{-1} on a straight road uni -directionally doubles its velocity in

one minute . The power delivered by the engine for doubling the velocity is

(a) 750 W.

(b) 1050 W.

(c) 1150 W

(d) 1250 W.

89. A 1 kg body is projected vertically upward with a speed of 200 ms^{-1}. it rises to a height of 1500 m. if gravitational field intensity is uniform and equal to N kg^{-1}, then the energy used up in overcoming air resistance is

(a) 2 kJ

(b) 4 kJ

(c) 5kJ

(d) 50 kJ

90. A moving neutron collides with a stationary α particle . The fraction of the kinetic energy lost by the neutron is

(a) 16/25

(b) 9/25

(c)3/5.

(d) 2/5.

91. At a given time , the momentum of a body of mass 5 kg is 10 kgm s^{-1} . Now a force of 0.2 N acts on the body in the direction of motion for 20 second. The increase in the kinetic energy is

(a) 2.2 J

(b) 3.3 J

(c) 4.4 J

(d) 5.5 J

92. 100 cm^3 of water is compressed from 0.5 atmosphere pressure The work done is x. The work done in compressing 100 cm^3 of air from 0.5 atmosphere to 5 atmosphere is y. Then :

(a) $x<y$.

(b) $x > y$

(c) $x = y$.

(d) $x \neq y$.

93. A ship weighing 0.3×10^8 kg wt is pulled by a force of 0.5×10^5 N through a distance of 3 m. if the ship were originally at rest and water resistance is negligibly small, then the ship will acquire a speed of

(a) 0.1 ms^{-1}.

(b) 1 ms^{-1}.

(c) 1.5 ms^{-1}.

(d)12 ms^{-1}.

94. Under the action of a force, a 2 kg body moves such that its position x as a function of time is given by $x = (t^3/3)$ where x is in meter and t in second. The work done by the force in first two seconds is

(a) 1.6 J

(b) 16 J

(c) 160 J

(d) 1600 J

95. If clouds are 1 km about the earth and rain fell sufficient to cover 1 km^2 at sea level, 1 cm deep, then the work done in raising water to the clouds

(a) 98 x 10^{16} erg.

(b) 98 erg.

(c) 10^6 erg.

(d) 69.73 erg.

96. A man, by working a hand pump fixed to a well, pumps out 10 cubic meter water in 1 second . if the water in the well is 10 m below the ground level, then the work done by the man is

(A) 10^8 J

(b) 10^4 J.

(c) 10^5J

(d) 10^6 J

97. Two spring sP and Q having stiffness constants k_1 and k_2 ($<k_1$) respectively are stretched equally. Then

(a) Work done is done on Q.

(b) more work is done on P.

(c) their force constants will become equal.

(d) equal work is done on both the springs.

98. In the above question if equal forces are applied on the two springs, then

(a) Work done is done on Q.

(b) more work is done on P.

(c) their force constants will become equal.

(d) equal work is done on both the springs.

99. A fat person weighing 75 kg falls on a concrete floor from 2m. if whole of the mechanical energy converted into heat energy, then heat produced in SI units will be nearly.

(a) 1500 joule.

(b) 1200 joule.

(c) 1500 kcal.

(d) 1200 k cal.

100. A one kilowatt motor is used to pump water from a well a0m deep The quantity of water pumped out per second is nearly.

(a) 1 kg.

(b) 10 kg.

(c) 100 kg.

(d) 1000 kg.

101. A 20 newton stone falls accidentally from a height of 4 m on to a spring of stiffness constant 1960 Nm^{-1}. The maximum distance to which the spring shall suffer compression is

(a) (2/7)m

(b) (3/7)m.

(c)(4/6)m.

(d) 0.3295

102. The power of water jet flowing through an orifice of radius r with velocity ν is

(a) zero.

(b) 500 $\pi r^2 \nu^2$.

(c) 500 $\pi r^2 \nu^3$.

(d) $\pi r^4 \nu$.

103. Two bodies of masses m and 2m have same momentum. Their respective kinetic energies k_1 and k_2 are in the ratio.

(a) 1 : 2

(b) 2 :1

(c) 1: $\sqrt{2}$

(d) 1:4

104. Under the action of a constant force, a particle experiencing a constant acceleration. The power is

(a) zero.

(b) positive

(c) negative.

(d) increasing uniformly with time.

105. The velocity of an oscillating simple pendulum of length 1 m is 2 ms^{-1} at the lowest position. When the bob is at the extreme position, the angle made by the string of the pendulum with the vertical is

(a) $\cos^{-1}(0.4)$

(b) $\cos^{-1}(0.6)$

(c) $\cos^{-1}(0.8)$

(d) 30^0.

106. A horse pulls a wagon with a force of 360 N at an angle of 60^0 E with the horizontal at a speed of 10 km h^{-1}. The power of the horse is

(a) 1000 W

(b) 2000 W

(c) 500 W

(d) 750 W.

107. A car manufacturer claims that his car can be accelerated from rest to a velocity of 10 ms^{-1} in 5 second if the total mass of the car and its occupants is 100 kg. then the average horse power developed by the engine is

(a) $10^3/746$.

(b) $10^4/746$.

(c) $10^5/746$.

(d) 8.

108. A ball is dropped from a height h on the ground . if the coefficient of restitution is e, the height to which the ball goes up after it rebounds for the nth time is

(a) he^{2n}.

(b) he^n.

(c) e^{2n}/h.

(d) h/e^{2n}.

109. A water pump driven by petrol raises water at a rate of 0.5 m^3 min^{-1} from a depth of 30m. if the pump is 70% efficient , what power is developed by the engine.

(a) 1750 W.

(b) 2450 W

(c) 3500W.

(d) 700 W

110. A 1 kg block moving with a velocity of 4 ms^{-1}. collides with a stationary 2 kg block. The lighter block comes to rest after the collision. The loss of kinetic energy of the system is

(a) 1 J

(b) 2J

(c) 3J

(d) 4J

111. An iron chain of length l and mass m is placed on a frictional less table with 1/nth part hanging over the edge. The work done in pulling the hanging chain to the table is

(a) mgl.

(b) mgl/2.

(c) mgl/ $2n^2$.

(d) mgl/$2n^4$.

112. A body falls on a ground from a height of 10 meter and resounds to a height of 2.5 m .The ratio of the

velocity of the body before collision to the velocity of the body after collision is

(a) 2 :1

(b) 1 : 2

(c) 4 : 1

(d) 3 : 1

113. In the above question the percentage loss of kinetic energy of the body during its collision with the ground is

(a) 25%

(b) 50%

(c) 75%

(d) 99%

114. The mechanical energy required to accelerate the body from 10 ms^{-1} to 20 ms^{-1} compared with that required to accelerate from 0 to 1 ms^{-1} in the same interval of time covering same distance

(a) two times

(b) three times.

(c) four times.

(d) five times.

115. Water is falling on the blades of turbine at a rate of 6000 kg min^{-1}. The height of the fall is 100m. What is the power gained by the turbine ?

(a) 10 kW.

(b) 6 kW.

(c) 100kW

(d) 600 kW.

116. A long spring is stretched by 2 cm. its potential energy is V. if the spring is stretched by 10 cm, its potential energy would be

(a) V/25

(b) V/5.

(c) 5V.

(d) 25V.

117. A car of mass m has an engine which can deliver power P. The minimum time in which the car can be accelerated from rest to a speed υ is

(a) $m\nu^2/2P$.

(b) $P\ m\nu^2$

(c) $2P\ m\nu^2$

(d) $m\nu^2P$. (e) $P\ m\nu^2/2$

118. A slab S of mass m is released from a height h_0 from the top of a spring of force constant k. The maximum compression x of the spring is given by the equation

(a) $mgh_0 = ½ kx^2$.

(b) $mg(h_0 –x) = ½ kx^2$.

(C) $mgh_0 = ½ k(h_0+x)^2$.

(d) $mg(h_0 + x) = ½ kx^2$.

119. Sound falls vertically at the rate of 2 kg s^{-1} on to a conveyor belt moving horizontally with a velocity of 0.2 ms-1 . The extra power required to keep the belt moving is

(a) 0.08 W

(b) 0.04 W.

(c) 4W

(d) 1 W

120. A body of mass 5 kg collides elastically with a stationary body of mass 2.5 kg. After the collision ,the 2.5 kg body begins to move with a kinetic energy of 8J. Assuming the collision to be one- dimensional , the kinetic energy of the 5 kg body before collision is

(a) 3 J

(b) 6 J

(c) 9J.

(d) 11J

121. A lift pump works at 200 V, 10 A. IT pumps water at $4^{o}C$ to an average height of 15mto fill a tank of

volume 3 m x 2m x 1m. ig g = 10 ms-2 and the efficiency of the pump is 75%, then the time required to fill the tank is

(a) 10 minute.

(b) 20 minute.

(c)24 minute.

(d) 28 minute.

122. What power must a sprinter , weighing 80 kg , develop from the start if he has to impart a velocity of 10 ms^{-1} to his body m 4 second.

(a) 1 kW.

(b) 2 kW.

(c) 3 kW.

(d) 4kW.

123. A 1 kg block is attached to the free end of a vertically hanging spring of force constant 10 N cm^{-1}. When the block is released , what maximum extension does it cause when it comes to rest instantaneously.

(a) 1 cm

(b) 2 cm.

(c)3 cm

(d) 4cm.

124. A block weighing 10 N travels down a smooth curved track AB joined to a rough horizontal surface. The rough surface has a friction coefficient of 0.20 with the block. If the block starts slipping on the track from a point 1.0 m above the horizontal surface . then

it would move a distance S on the rough surface . The value of S is

(a) m

(b) 2m.

(c) 3m.

(d) 5m.

125. The quantities remaining constant in an elastic collision are.

(a) momentum, kinetic energy and temperature.

(b) momentum and kinetic energy but not temperature.

(C) momentum and temperature but not kinetic energy.

(d) momentum but neither kinetic energy nor temperature.

126. A coolie 1.5 m tall raises a load of 8- kg in 2 second from the ground to his head and then walks a distance of 40 m in another 2 second. The power developed by the coolie is

(a) 0.2 kW

(b) 0.4 kW

(c) 0.6 kW.

(d) 0.8 kW.

127. A ball moving with a velocity of 10 ms^{-1} impinges on a vertical wall at an angle of 45° with the normal to the wall. After the collisions to the wall. After the collision , the ball moves on the other side of the normal at an angle of 45° with the normal . The coefficient of

restitution is 0.5 the velocity of the ball after the collision will be

(a) $2ms^{-1}$

(b) $3\ ms^{-1}$

(c) $5\ ms^{-2}$

(d) $50\ ms^{-2}$.

128. A uniform chain of length L and mass M over changes a horizontal table with its two third part on the table. Te friction coefficient between the table and the chain is μ. The work done by the friction during the period the chain slips off the table is :

(a) -1/4 μMgl

(b) -2/9 μMgl

(c) -4/9 μMgl

(d) -6/7 μMgl

129. A boy whose mass is 30 kg climbs, with a constant speed, a vertical rope 6 m long in 10s. The power of the boy during the climb is

(a) 60 W.

(b) 3000 W.

(c) 180 W.

(d) 5W

130. Two springs A and B are stretched by applying force of equal magnitudes at the four ends. If the energy stored in A is E, that in B is

(a) E/2.

(b) 2E.

(c) E.

(d) E/4.

131. Two carts on horizontal straight rails are pushed apart by an explosion of a gun power placed between the carts. Suppose the coefficient of friction between the carts and the rails are identical if the 200 kg cart travels a distance of 36m and stops, then the distance covered by the cart weighing 300 kg is

(a) 32 m.

(b) 24 m

(c) 16m.

(d) 12 m.

132. A man throws a piece of stone to a height of 12 m where it reached with a speed of 12 ms^{-1}. If he

throws the same stone such that it just reached this height, the percentage of energy saved is nearly.

(a) 19%.

(b) 38%.

(c) 57%

(d) 76%

133. A pendulum bob has been pulled aside from its equilibrium position through an angle α and then released. If l is the length of the pendulum then the bob will reach the equilibrium position with speed of

(a) $\sqrt{2gl}$.

(b) $\sqrt{(2gl \cos\alpha)}$

(c) $\sqrt{[2gl (1-\cos \alpha)]}$

(d) $\sqrt{[2gl (1-\sin\alpha)]}$

134. The potential energy of a certain spring when stretched through a distance S is 10 joule. The amount of work in joule that must be done on this spring to stretch it through an additional distance S will be

(a) 30

(b) 40

(c) 10

(d) 20.

135. The potential energy of a particle in a certain field has the form, $U = (a/r^2) - (b/r)$ where a and b are positive constants, r is the distance from the centre of the field . The distance of the particle in the stable equilibrium position is

(a) a/b.

(b) – a/b

(c) 2a/b.

(d) -2a/b.

136. A 30 g bullet initially travelling horizontally at 50 ms^{-1} penetrates 10 cm into a wooden block. The average force it exerts is

(a) 4000 N

(b) 375 N.

(c) 2500 N.

(d) 4500 N.

137. The Fx graph of a particle of mass 100 g is shown in the fig. if the particle begins to move from rest at x = 0 its velocity at x = 12 m is .

(a) 10 ms^{-1}.

(b) 20 ms^{-1}.

(c) 30 ms^{-1}.

(d) 40 ms^{-1}.

138. A 5 kg stone of relative density 3 in resting at the bed of a lake . it is lifted through a height of 5 meter in the lake. If g = 10 ms^{-2}, then the work done is

(a) 500/3 J

(b) 350/3 J

(c) 750/3 J

(d) zero.

139. A block of mass m is suspended by a light thread from an elevator The elevator is accelerating upward

with uniform acceleration a. The work done during t second by the tension in the thread is

(a) zero.

(b) m/2 (g-a) at^2.

(c) m/2 (g+a) at^2.

(d) m/2 g at^2.

140. it is observed that the force required to tow a boat at constant velocity is proportional to the velocity . it takes 16 hp to tow a boat at a velocity of 2 km h^{-1}. The horse power required to tow this boat at a velocity of 3 kmh^{-1} is

(a)9

(b) 18.

(c) 36.

(d) 72.

141 The velocity of a 2 kg body changed from (4 i+ 3j) ms^{-1} to 6 k ms^{-1}. The work done on the body is

(a) 9 J

(b) 11J

(c) 1 J

(d) 0 J

142. A ball is allowed to fall from a height of 10m. There is 40% loss of energy every time it hits the ground. After second impact with the ground, the ball will rise upto

(a) 10m.

(b) 6m.

(c) 3.6m

(d) 2.4 m

143. A force of 1 N acts on a body of mass 0.5 kg initially at rest. The ratio of the works done by the force in the first , second and third second is

(a) 1 : 2 : 3

(b) 1 : 3 : 4

(c) 1 : 3 : 5

(d) 1 ;5 :9

144. A body of density r and volume V is lifted through height h in a liquid of density σ ($<\rho$). The increase in potential energy of the body is

(a) V (ρ-σ)gh.

(b) Vρgh.

(c) Vσgh

(d) zero.

145. A plate of ass m, length b and breadth a is initially lying on a horizontal floor with length parallel to the floor and breadth perpendicular to the floor. The work done to erect it on its breadth is

(a) mg [b/2]

(b) mg [a + b/2]

(c) mg [(b-a) / 2]

(d) mg [(b + a) /2]

146. A machine which is 75% efficient uses 12 J of energy lifting up a 1 kg mass through a certain distance. The mass is then allowed to fall through that distance. The velocity of the ball at the end of its fall is

(a) $\sqrt{24}$ ms^{-1}.

(b) $\sqrt{32}$ ms^{-1}.

(c) $\sqrt{18}$ ms^{-1}.

(d) 3 ms^{-1}.

147. A metallic wire of length L meter extends by 1 meter when stretched by suspending a weight mg to it. The mechanical energy stored in the wore is

(a) mg (L+ l)

(b) mgl.

(c) mgl/2.

(d) mg (L + l) / 2

148. A body of mass 2 kg slides down a curved track which is quadrant of a circle of radius 1m. All the surfaces are frictionless. If the body starts from rest , its speed at the bottom of the track is :

(a) 4.43 ms^{-1}.

(b) 2 ms^{-1}.

(c) 0.5 ms^{-1}.

(d) 19.6 ms^{-1}.

149. A sphere of mass 2 kg is moving on a frictionless horizontal table with velocity ν. It strikes against a spring and compresses it by 4m. The velocity of the sphere is :

(a) 4 ms^{-1}.

(b) $2\sqrt{2}$ ms^{-1}.

(c) 2 ms^{-1}.

(d) $\sqrt{2}$ ms^{-1}.

150. A dam is situated at a height of 550m above sea level and supplies water to a power house which is

at a height of 50 m above sea level. 200 kg of water passes through the turbines per second. What would be the maximum electric power output of the power house if the whole system were 80% efficient ?

(a) 8 MW.

(b) 10 MW

(c) 12.5 MW

(d) 16 MW.

GRAVITATION

Conceptual plus ;

level 1

1. Ballpen is based on the principle of

   (1) Gravitational force

   (2) Surface tension

   (3) Viscosity

   (4) Capillary

2. The planet closet to sun is

   (1) Venus

   (2)Saturn

   (3) Mars

   (4) Mercury

3. Balls of iron and woods of same radius are released freely from same height h. times taken by them to reach the earth are

(1) approximately same

(2) unequal

(3) zero

(4)identical

4. g_e and g_p are acceleration due togravity on the surface of earth and a planet respectively. The radius and the mass of the planet are double the radius and mass of the earth.

(1) $g_e = g_p$.

(2) $g_e = 2g_p$.

(3) $g_p = 2g_e$.

(4) $g_e = \sqrt{g_p}$.

5. Atmosphere is present on earth due to

(1) gravitational attraction

(2) air.

(3)inertia

(4) center of gravity

6. Where is the minimumm mass of two bodies of equalweight

(1) at moon

(2) at equator

(3)at artificial satellite

(4) at poles.

level 2

7. A bottle full of water at 30^oC is carried on moon in a space ship . if the bottle is opened on the surface of moon ,then the water will

(1) start boiling

(2) freeze

(3) remain as such

(4) Split into H_2 and O_2.

8. A satellite is launched in a cirular orbit of radius R and another satellite is launched in ciruclar orbit of radius 1.01 R. The time period of second satellite is different from that of the first satellite by

(1) 1.5% increased

(2) 1% decreased

(3) 1% increased

(4) 1.5% decreased

9. As satellite is revolving around a planet of mass M in an elliptical orbit of semi major axis a. The orbital velocity of the satellite at a distance r from the focus will be

(1) $[GM (2/r)-(1/a)]^{1/2}$.

(2) $[GM (1/r)-(2/a)]^{1/2}$.

(3) $[GM (2/r^2)-(1/a^2)]^{1/2}$.

(4) $[GM (1/r^2)-(2/a^2)]^{1/2}$.

10. Two identical trains A and B move with equal speeds on parallel tracks along the equator. A moves from east towest and b from west to east. Which train will exert grather pressure on the tracks?

(1) Train A

(2) Train B

(3) They will exert same force

(4) none of the above.

11. A body is suspended from a spring balance kept in a satellite . when the satellites revolves in a orbit of radius R1 then the reading of the balance is W_1 and when it revolves in orbit of radius R_2 ,its reading is W_2.

(1) $W_1>W_2$.

(2) $W_1=W_2$.

(3) $W_1<W_2$.

(4) $W_1=W_2.=0$

Numericals bank.

Level 1

1. A satellite is revolving around the earth with velocity v. The minimum percentage increase in its velocity necessary for the escape of satellite will be

   (1) 100%

   (2) 50%

   (3) 82.3%

   (4) 41.4%

2. The time period of a satellite in an orbit of radius Ris T. the time period in an orbit of radius 4R will be

   (1) 4T

   (2) 2T

   (3) $2\sqrt{2}$ T

   (4) 8T

3. The potential energy of a rocket of mass 100 kg at height 10^7m from earth's center is 4 x 10^9 joule.The weight of the rocket at height 10^9 will be

(1) 4 x 10^{-2} N

(2) 4 x 10^{-3} N

(3) 8 x 10^{-2} N

(4) 8 x 10^{-3} N

4. The mass of earth is 80 times that of moon. their diameters are 12800 km and 3200 km respecively the value of g on moon will be , if its value on earth is 980 cm/s^2.

(1) 98 cm/s^2.

(2) 196 cm/s^2.

(3)100 cm/s^2.

(4) 294 cm/s^2.

5. The force 75 newon acts on a body of mass 2.5 kg at a certain point. the intensity of gravitational field at that point will

(1) 20 N/kg

(2) 30 N/kg

(3) 40 N/kg

(4) 3 NK/g

6. The gravitational potential at a point above the earth surface is -51.2×10^7 joule/kg and acceleration due to gravity is 64 m/s^2. The distance of this point from centre ofearth is

(1) 4×10^3 km

(2) 4×10^3 km

(3) 8 x10^3 km

(4) 36x10^3 km

7. A space ship is released in a circular orbit near earth surface. how much additional velocity will have to given to the ship in order to escape it out of the orbit.

(1) 3.28m/s.

(2) 3.28 x 10^3 m/s.

(3) 3.28 x 10^7 m/s.

(4) 3.28 x 10^{-3}.

8. The change in the value of accleration of earth towards sun, when the moon comes from the position of solar eclipse to the position on the other side of

earth in line with sun is (mass of the moon = 7.36 x 10^{22} kg, the orbital radius of the moon 3.82 x 10^{8} m)

(1) 6.73 x 10^{-2} m/s^2.

(2) 6.73 x 10^{-3} m/s^2.

(3) 6.73 x 10^{-4} m/s^2.

(4) 6.73 x 10^{-5} m/s^2.

9. the gravitational potential difference between the surface of a planet and a point 20m above the surface is 2 joule/kg. if the gravitational field is uniform then the work done in carrying a 5 kg body to a height of4m above the surface is

(1) 2 joule

(2) 20 joule

(3) 40 joule

(4) 10 joule

10. The angulr velocity of the earth aout its axis is (m = milli)

(1) 0.073 m rad/s

(2) 0.004m rad/s.

(3) 4.36m rad/s

(4) 1.74 m rad /s.

11. if the gravtitational force were to vary inversely as the mth power of the distance,then the time period of planet in circular orbit of radius r around the sun will be proproional to

(1) $r^{-3m/2}$.

(2) $r^{3m/2}$.

(3) $r^{m + (1/2)}$.

(4) $r^{(m+1)/2}$.

Level 2

12. Takethe radius of the earth as 6400km,and acceleration due togravity 10m/S^2, if theradius of the mars is 1/10 th the mass of the earth,then the weight of a 60kg object , on the mars will be

    (1) 600N

    (2)300N

    (3) 240 N

    (4) 120 N.

13. A spaceship of mass 2500 kg is to be projected so that it can escape the gravitational field of earth is 6400 km, then the minimum initial velocity should be

    (1) 3.5km/s.

(2)5.6km/s.

(3) 7.9km/s.

(4) 11.2 km/s.

14. A planet has 1/10 of that of earth and radius 1/3th that of earth. if a person can throw a stone on the surface to height of 90m, then he will be able to throw the stone on that planet height.

(1) 81m.

(2) 90m

(3) 100m

(4) 45m

15. The ratio of the masses of mars and earth is 1:11 and ratio fotheir radii is 0.53 :1 .then ,the ratio of the time period of their satellites near their surfaces is

(1) 1.3

(2) 0.8

(3) 2.4

(4)0.4

16. A satellite is moving round the earth with the velocity v. To makethe sattelite escape , the minimum percentage increase in its velocity is nearly.

(1) 41.4%

(2) 82.8%

(3) 100%

(4) none of the above

17. Imagine a light planet revolving around a very masive star in a ciruclar orbit of radius Rwith a period of revolution T.if the gravitational force of the

attraction between the planet and the star is proportional to $R^{-5/2}$, then T^2 is proportional to

(1) R^3.

(2) $R^{7/2}$.

(3) $R^{3/2}$.

(4) $R^{3.75}$

18. Two satellites S1 and S2 revolve around the earth at a distance 3R ansd 6R from the centre fo the earth . then their periods of revolutions are in the ratio

(1) 1:2

(2) $1:2^{1.5}$.

(3) 2:1

(4) $1:2^{0.67}$.

19. The work in taking a body of mass to a height nR abovve earth's surface (where R is the radius of the earth) is

(1) nmgR

(2)(n/n+1)mgR (3)(n/n-1)mgR

(4) Zero

20. The radius of the moon is one fourth of the radius of the earth. if the moon is stopped for amoment and then released ,it will fall towards the earth. The acceleration of the moon just before it strikes the earth is

(1) 9.8 m/s^2.

(2) 6.3 m/s^2.

(3)0.0027 m/s^2.

(4) Zero.

21. The gravitational potenital difference between the surface of the planet and a point 20m above it is 16J/kg. then the work done in moivng a 2 kg mass by 8m on a slope of 60^0 from the horizontal is

(1) 11.1 J

(2)5.55 J

(3) 16.0 J

(4) 27.7 J

22. If masses m_1 and m_2 are at distances a_1 and a_2 from their center of mass , then

(1) $m_1/m_2 = \sqrt{(a_1/a_2)}$

(2) $m_1/m_2 = (a_1/a_2)^2$.

(3) $m_1/m_2 = (a_2/a_1)$

(4) $m_1/m_2 = \sqrt{(a_1/a_2)}$

23. A planet of mass m is revolving round the sun of mass m_s in an elliptical orbit. The maximum and the minimum distances of the planet from sun are r_1 and r_2 respectively. The time period of the planet is proportional to

(1) $(r_1+r_2)^{3/2}$.

(2) $(r_1+r_2^{1/2})$

(3) $(r_1- r_2)^{3/2}$.

(4) $(r_1- r_2)^{1/2}$.

24. The tail of a comet is farther from the sun because -

(1) its tail always remains in one position.

(2) the radiations from sun exert pressure on it so that the tail is formed farther from the sun.

(3) as the comet revolves round the sun , then due to centrifugal force some of its mass is thrown outwards.

(4) as the comet revolves then some of its mass is rawn in the direction of tail due to the presence of another star is that direction.

25. A bomb blasts on moon , its sound will be heard on earth after

(1) 3.7 minutes (2) 10 minutes

(3) 138 minutes

(4) sound will never be heard

26. The orbital velocity ofa satellite revolving close to earth's surface is

(1) 2.4km/s

(2) 11.2 km/s

(3) 8 km/s.

(4) 3.1 km/s.

27. if a satellite follows nearly circular path,but encounters air resistance so that there occurs conversion of mechanicalenergy into internal energy. This results in

(1) increase in kinetic energy of satellite

(2) increase in potentialc energy of satellite

(3) increase in the earth satellite distance

(4) the circular path of the satellite

28. The mass of moon can be determined by

(1) presuming moon to be an earh satellite

(2) releasing a satellite around sun.

(3) using a spring balance

(4)using a pendulum balance

Questions from the competitive exams:

1. At surface of earth weight of a person is 72N then his weight at height R/2 from surface of earth is (R = radius of earth)

   (1) 28 N

   (2) 16 N

   (3)32 N

   (4) 72 N

2. The depth d, at which the value of acceleration due to gravity becomes 1/n times the value at the surface , is (R= radius of the earth)

(1) R/n

(2) R[(n-1)/n]

(3) R/n^2.

(4) R[n/(n+1)]

3. the escape velocity for the earth is 11.2 km/sec. the mass of another planet is 10 times that of earth and its radius is four times that of earh. the escape velocity for this planet will be

(1) 11.2. km/s.

(2) 5.6 km/s.

(3) 280.0 km/s.

(4) 56.0 km/s.

4. the radius of the earth 4 times that of the moon and its mass is 80 times that of moon. if the acceleration

due to gravity on the surface of the earth is $10 m/s^2$.

that on the surface of the moon willbe

(1) $1 m/s^2$.

(2) $2 m/s^2$.

(3) $3 m/s^2$.

(4) $4 m/s^2$.

5. the escape velocity from the earth's surface is 11.2 km/s if a planet has a radius twice that of earth and on which the acceleration due to gravity is twice that on the earth. , then the escape velocity on this planet willbe

(1) 11.2 km/s

(2) 5.6 km/s.

(3) 22.4 km/s.

(4) 33.6 km/h.

6. if a particle moves under inverse square law then its orbital radius (r) and time for one revoluition (T) are related as

(1) $T^2 \propto r^3$.

(2) $T \propto r^3$.

(3) $T \propto r$.

(4) $T \propto r^4$.

7. if the radius of earth is reduced by 2% keeping its mass constant, theni weight of the body on its surface will

(1) decrease

(2) increase

(3) remain same

(4) more than at pole.

8. An earth satellite moves from an orbit ato another stable lowwer orbit B. In this process.

(1) gravitatonal P.E. increases.

(2) gravitational P.E decrease

(3) angular speed incrteasses

(4) none of these.

9. The mass and diameter of a planet are twice that of earth . the time period of pendulum on this planet is.

(1) $\sqrt{2}$ time that of earth

(2) The same

(3) $(1/\sqrt{2})$ times on earth

(4) none of these.

10. A satellite is an orbital aorund earth ; if its kineitc energy iss douled ,then

(1) it will fall on the earth

(2) it will rotate with a greater speed.

(3) it will maintain its path

(4) it will escape out of earth's gravitational field.

11. A man waves his arms while walking,this is

(1) to keep constant velocity

(2) to case the tension

(3) to increase the velocity

(4) to balance the effect of earth's gravity

12. If radius of earth were decreased by 1% it mass remaining he same the acceleration due to gravity on the surfaceof earth willbe

(1) increased by 1%

(2) decreased by 2%

(3) decreased by 1%

(4) decreased by 2%

13. Mass of the moon is 1/81th of the mass of the earth and its diameter is 1/3.7 of that of earth. if acceleration ue to gravity on the surfaceon earth is 9.8m/s^2 then acceleraiton due to gravity on the surface of the moon is

(1) 9.8 x 6m/s^2.

(2)(9.8/6)m/s^2.

(3) (9.8/3)m/s^2.

(4) 9.8 x 3m/s^2.

14. With what velocity should a particle be projected so that its height becomes equal to radius of earth

(1) $(GM/R)^{1/2}$.

(2) $(8GM/R)^{1/2}$.

(3) $(2GM/R)^{1/2}$.

(4) $(4GM/R)^{1/2}$.

15. Distance of geostationary satellite from the surface of earth is

(1) 6R

(2) 7R

(3) 5R

(4) 3R

16. Unit of gravitational potential is

(1) joule

(2) joule/kilogram

(3) joule kilogram

(4) kilogram

17. Radius of the earth R. if a body is taken to a height 3R from the surface of the earth then change in potential energy will be

(1) 3mgR

(2) 3/2 mgR

(3) mgR

(4) 3/4mgR

18. Who disproved the geocentric theory of universe

(1) Aristotle

(2) Charles Darwin.

(3) Issac Newton

(4) Copernicus.

19. The ratio of energy required to raise a satellite toa height h above the earth's surface to heat required to put it into he orbit is :

(1) h :R

(2) h : 2R

(3) 2h : R

(4) R ; h

20. if the radius of earth is reduced by 1% without changing the mass, then change in acceleration due to gravity will be

(1) 1% decrease

(2) 2 % increase

(3) 2% increase

(4) 1%increase

21. A spinning speed of earth is increased, then weight of the body at the equator

(1) increases

(2) does not change

(3) doubles

(4) decreases

22. If suddenly the gravitational force of attraction between the earth and a satellite revolving around it becomes zero,then the satellite will

(1) continue tomove its orbit with same velocity

(2) move tangentially to the original orbit with the same velocity

(3) become stationary in its orbit.

(4) move towards the earth.

23. Energy required tomove a body of mass m from an orbit of radius 2R to 3Ris

(1) $(GMm/12R^2)$

(2) $(GMm/3R^2)$

(3) (GMm/8R)

(4) (GMm/6R)

24. The kinetic energy needed toproject a body of mass m from the earth surface to infinity is

(1) mgR/2

(2) 2mgR

(3) mgR

(4) mgR/4

25. The time period of satellite of earth is 5 hours. if the separation between the earth and the satellite is increased to 4 times the previous value, the new time period will become.

(1) 10 hours.

(2) 80 hours.

(3) 40 hours.

(4) 20 hours

26. Two spherical bodies of mass M and 5M and radii R and 2R respectively are releasedin free space wth intial separation between their centres equal to 12R. if they attract each other due to gravitational force only, then the distance covered by the smaller body just before collision is

(1)2.5 R

(2)4.5 R

(3)7.5 R

(4) 1.5 R

27. The escape velocity for a body projected vertically upwards from the surface of earth is 11km/s. if the body is projected at an angleof 45^0 with the vertical,the escape velocity will be

(1) $11\sqrt{2}$ km/s.

(2) 22 km/s

(3) 11km/s

(4) $11/\sqrt{2}$ m/s.

28. The motion of planet in the solar system in an example of the conservation of

(1) mass

(2) linear momentum

(3) angular momentum

(4) energy

29. The velocity with which a projectile must be fired so that it escapes earth's gravitation does not depend on

(1) mass of the earth

(2) mass of the projectile

(3) radius of the projectile moiton

(4) gravitational constant.

30. The time of an earth satellite in circular orbit is independent of

(1) neither mass of the satellite nor radius of the orbit

(2) radius of its orbit

(3) both the mass and radius of the orbit

(4) the mass of the satellite

31. if ‘g’ is the acceleration due to gravity on the earth’s surface, the gain in the potential energy of an object of mass m raised from the surface of the earth to a heght equal to the radius of ‘R’ of th earth is

(1) mgR

(2) ½ mgR

(3) ¼ mgR

(4) 2mgR.

WAVE OPTICS

1. A beam of monochromatic blue light of wavelength 4200 A° in air travels in water with refractive index 4/3. wave length of light in water will be

   (a) 4000 A°.

   (b) 5500 A°.

   (c) 3000 A°.

   (d) 3150 A°.

2. Two coherent monochromatic light beams of intensities I & I are superimposed/ the maximum and minimum possible intensities in the resulting beam are

   (a) 5I,I

   (b) 9I,I

   (c) 5I, 3I

(d) 4I, I

3. In young's double slit experiment, fringe width is found to be 0.4 mm. if the whole apparatus is immersed in water of refractive index 4/3 without distributing the geometrical arrangement, new fringe width will be

(a) 0.30 mm.

(b) 0.40 mm

(c) 0.50mm

(d) 0.45 mm.

4. A decimeter length of solution with concentration 50 kg/m^3. rotates the plane of polarization by 24^0. specific rotation of the solution is

(a) 12^0.

(b) 30^0.

(c) 48^0

(d) 55^0.

5. A beam of light is partially refracted and partially reflected from a surface. If angle of refraction of light is 30^0., then angle of incidence is

(a) 50^0.

(b) 60^0.

(c) 75^0

(d) 87^0.

6. A parallel of monochromatic light of wave length 5000 A^o.is incident normally on a single narrow slit of width 0.001 mm. Light is focused by a convex lens on the screen placed on the focal plane. First minimum will be formed for the angle of diffraction.

(a) 15^0.

(b) 30^0.

(c) 45^0

(d) 60^0.

7. Light is incident normally on a diffraction grating through which first order diffraction is seen at 32^0.the second order diffraction will be seen at

(a) 84^0.

(b) 48^0.

(c) 64^0

(d) none of these.

8. A star is moving away from earth with velocity of 100 km/sec. if the velocity of light is 3×10^8 ms^{-1}.then shift of

the spectral line of λ = 5700 A^o. due to Doppler effect will be

(a) 1.90 A^o.

(b) 3.80 A^o.

(c) 5.70 A^o.

(d) 3150 A^o.

9. A star emitting radiations of wavelength 500 A^o.is approaching earth with a velocity of 1.5 x 10^6 ms^{-1}. change in wave length of radiations are received on the earth is

(a) zero

(b) 2.5 A^o.

(c) 25 A^o.

(d) 100 A^o.

10. in young's double slit experiment , if the widths of the slit are in ration 4:9 ratio of intensity of maxima to intensity of minima will be

(a) 25:1

(b) 9:4

(c) 3:2

(d) 81:16

11. in young's double slit experiment the distance between two slits is 0.1 mm and the wavelength of light used is 4 x 10^{-7} m. if the width of the fringe on the screen is 4mm, then distance between screen and slit will be

(a) 1m

(b 10m

(c) 50m

(d) 5m.

12. in young's double slit experiment, using monochromatic light, interference fringes are obtained. In the path of wave from one slit, a mica sheet of thickness 1.964 μm and refractive index 1.6 is kept. Fringe pattern is displaced by some distance. Then mica sheet is removed and distance between slit and screen is doubled.. it is found that distance between successive maxima & minima is same by which fringe pattern was displaced by keeping the mica sheet. Wave length of monochromatic light which was used will be

(a) 5800 A^o.

(b) 5892 A^o.

(c) 6800 A^o.

(d) 6900 A^{o}.

13. distance between two slits is 0.03 cm. A screen is placed at a distance of 1.5 m. interference pattern shows that fourth bright fringe is at 1 cm from the central maximum . wavelength of light used is

(a) 5000 A^{o}.

(b) 6000 A^{o}.

(c) 7000 A^{o}.

(d) 7500 A^{o}.

14. in a Fresnel biprism experiment , two positions of the lens give separation between the slit as 16 cm and 9 cm respectively. Actual distance of separation is

(a0 12.0 cm

(b) 12.5 cm

(c) 13.0 cm

(d) 13.5 cm

15. A light source approaches to the observer with velocity 0.5 cm. Doppler shift for light wavelength 5500 A^0. is

(a) 616 A^o.

(b) 1833 A^o.

(c) 5500 A^o.

(d) 6160 A^o.

16 In Young's double slit experiment , distance between sources is 1mm and the distance between source and screen is 1 m. if the fringe width is 6mm, hen wave length of the emitted from the source is

(a) 4000 A^o.

(b) 5000 A^o.

(c) 6000 A^o.

(d) 6400 A^o.

17. in young's experiment , 3rd bright fringe of light of wavelength λ_1 coincides with 4th bright fringe of light of wavelength λ_2, then

(a) $\lambda_1 = \lambda_2$.

(b) $3\lambda_2 = 4\lambda_1$.

(c) $3\lambda_1 = 4\lambda_2$.

(d) none of these

18. in young's experiment , wavelength of red light is 7.8 x 10^{-8} cm and that of blue light is 5.2 x 10^{-8} cm. value of n for which (n+1)th blue bright line coincides with nth red fringe is

(a) 1

(b)2

(c) 3

(d) 4.

19. in the Biprism experiment , distance between source and screen is 1.0m . fringe of widths 5 mm are obtained wavelength of light is 5000 A^o. separation of two coherent is

(a) 0.1 mm

(b) 0.01 mm

(c) 10 mm

(d) 0.05 mm.

20. What should be the order of magnitude of thickness of oil layer so that this layer appears colored due to interference of light.

(a) 1μm.

(b) 1 cm

(c) 10A^o.

d) 100 A^o.

21. in a spectrum of light of a luminous heavenly body wavelength of a spectral line is found ot be 4747 A^o. relative velocity of heavenly body w.r.t. to earth. Is

(a) 3×10^5 ms^{-1}.

(b) 3×10^6 ms^{-1}.

© 3×10^7 ms^{-1}.

(d) 3×10^4 ms^{-1}.

22. wavelength of light from moving star observed on the earth is found to decrease by 0.05%. relative to earth, star is

(a) moving away with velocity 1.5×10^4 ms^{-1}.

(b) moving away with velocity 1.5×10^5 ms^{-1}.

(c) moving towards earth with velocity 1.5×10^4 ms^{-1}.

(d) moving towards earth with velocity 1.5×10^5 ms^{-1}.

23. Wave length of H_α line in hydrogen spectrum is 656×10^{-9}m whereas wavelength of H_α. line in the spectrum of a distance galaxy is 706 nm. Speed of galaxy w.r.t. length is

(a) 2×10^5 ms^{-1}.

(b) 2×10^6 ms^{-1}.

(c) 2×10^7 ms^{-1}.

(d) 2×10^8 ms^{-1}.

24. Central fringe shifts to the position of fifth bright fringe if a thin film of refractive index 1.5 is introduced in the

path of light of wavelength 5000 A°. thickness of the glass plate is

(a) 1 μm

(b) 5 μm

(c) 3μm

(d) 4μm.

25. if the fringe width obtained in young's double slit experiment is 1.33 mm, then on immersing the whole set up in water with refractive index 1.33 , new fringe width will be

(a) dose not change

(b) 1.0 mm

(c) 2.0 mm

(d) 2.69 mm

26. I young's double slit experiment , distance between slit and screen D is 50 cm. if wavelength of the light being emitted from the source is 6000 A^o. and the fringe width is 0.048 cm, then fringe width for same D but for λ = 5000 A^0 will be.

(a) 0.58 mm

(b) 0.4 cm

(c) 1.14 cm

(d) 0.48 cm

27. if in young's double slit experiment , d= 0.1 mm, D = 20 cm, and λ = 5460 A^o., then angular position of first dark fringe will be

(a) 0.08^0.

(b) 0.24^0.

(c) 0.32^0.

(d) 0.16^0.

28. in young's double slit experiment , phase difference between two equally bright slits which are coherent also is $\pi/3$. Maximum intensity of the screen in I_0. then intensity at a point equidistant from the slits is

(a) $I_0/4$

(b) $I_0/2$

(c) $3I_0/4$

(d) I_0

29. in young's double slit experiment , a thin glass sheet of refractive index 1.5 is introduced in path of one of the interfering beams. By doing so , central fringe shifts to

a position occupied by fifth bright fringe. Wavelength of light used is

(a) 4000 A^o .

(b) 5000 A^o .

(c) 6000 A^o .

(d) 7000 A^o .

30. in the young's double slit experiment distance between screen and slits are 2m and the distance between the slits is 0.5 mm. . if the wavelength of the monochromatic source of light being used is 6000 A^o. then distances between the fringes will be

(a) 0.12 cm

(b) 0.24 cm

(c) 0.36 cm

(d) 0.48 cm

31. if wavelength of light used in young's double slit experiment is 5000A^{o} them phase difference between the waves reaching third bright fringe and central fringe will be

(a) zero

(b) 2π

(c) 3π

(d) 6π.

32. Width of a slit is 0.2 mm. light of wavelength 6328 A^{o}. Is incident on it normally . Screen at a distance of 9.0 meter from the slit. Then angular width of central maximum will be about

(a) 18"

(b) 36”

(c) 0.36^0.

(d) 0.91^0.

33. Light of wavelength 6500 A^o. is incident on a slit , it first minima for red light is at 30^0, then slit width will be about

(a) 1×10^{-6} m.

(b) 5.2×10^{-6} m.

(c)1.3×10^{-6} m.

(d) 2.6×10^{-6} m.

34. Refractive index of air is 1.0003 . required thickness of air column to have one more wavelength of yellow light than for th same thickness of vaccum is about

(a) 1 mm

(b) 2mm.

(c) 3mm

(d) 3.6 mm

35. Angular width of a central max. is 30^0 when the slit is illuminated by light of wavelength 6000A^o. then width of the slit will be approx.

(a)12 x 10^{-6} m.

(b) 12 x 10^{-7} m.

(c) 12 x 10^{-8} m.

(d)) 1 x 10^{-9} m.

36. width of a principal maximum on a screen at a distance of 50 cm from the slit having width 0.02 cm is 312.5 x 10^{-3} cm.. if waves were incident normally on the slit, then wavelength of the light from the source will be

(a) 6000A^{o}.

(b) 6250A^{o}.

(c) 6400A^{o}.

(d) 6525A^{o}.

37. light of wavelength 6000 A^{0}. is incident on a single slit first minimum is obtained at a distance of 0.4 cm from the centre. If width of the slit is 0.3 mm, then distance between slit and screen will be

(a) 1.0 m

(b) .15m

(c) 2.0 m

(d) 2.3 m

38. Fraunhoffer diffraction pattern of a single slit is obtained in the focal plane of lens of focal length 1m/ if

third maximum is formed at a distance of 5 mm from the central maximum and wavelength of light used is 5000 A^0. then width of the slit will be

(a) 0.02 cm

(b) 0.03 cm

(c) 0.04 cm

(d) 1 cm.

39. Distance between first and sixth minima in the diffraction pattern of a single slit is 0.5 mm. screen is 50 cm away from the slit. If slit width is 2.5 mm then wavelength of light used is

(a) 5000 A^o.

(b) 6000 A^o.

(c) 6500 A^o.

(d) 8000 A^o.

40. Two points separated by a distance of 0.1 mm can just be inspected in a microscope when light of wavelength 6000 A^o is used. If the points separated by 0.08 mm are to be seen, then wavelength of light used will be

(a) 1600 A^o.

(b) 3200 A^o.

(c) 4800 A^o.

(d) 6800 A^o.

41. First diffraction minima due to a single slit of width 10^{-4} cm is at $\theta = 30^0$. then wavelength of th light used is

(a) 4000 A^o.

(b) 5000 A^o.

(c) 6000 A^o.

(d) 6250 A^o.

42. if a ray of light strikes a glass plate of refractive index $\sqrt{3}$ and we get reflected and reflected ray at right angle to each other. Then angle of incidence is

(a) 30^0.

(b) 40^0.

(c) 53^0.

(d) 60^0.

43. Unpolarised light of intensity 32 W/m2 passes through three polarisers such that the transmission axis of last one is crossed with the first . if intensity of light transmitted by first polarized is 16 W/m^2, then intensity of finally emerging light will be

(a) $4W/m^2$.

(b)14W/m^2.

(c) 5W/m^2.

(d) 6W/m^2.

44. Percentage of the incident unpolarised light passing through the two Nicol prisms oriented with their principal planes making angle os θ is 12.5 , then θ is

(a) 45^0.

(b) 60^0.

(c) 65^0.

(d) 75^0

45. A parallel beam of monochromatic unpolarised light is incident on a transparent dielectric plate of refractive index μ. Reflected beam is completely polarized, if angle of incidence is 30^0 then μ will be.

(a) 1/3

(b) 1.5

(c) $\sqrt{1/3}$

(d) $\sqrt{(4/3)}$

46. if there is zero absorption in the Polaroid , and intensity of plane polarized light coming out of Polaroid is A^2. then intensity of incident beam will be

(a) A^2.

(b) $A^2/2$.

(c) $2A^2$.

(d) none of these.

47. frequency of the signal emitted by a rocket is 4×10^7 Hz. If apparent frequency observed on earth is 3.2 x

10^7 Hz. Then velocity with which rocket is moving away is

(a) 0.5 c

(b) 0.4 c.

(c) 0.3 c

(d) 0.2 c.

48. if velocity of a galaxy relative to earth is 1.2×10^6 ms^{-2}. then % increase in wavelength of light from galaxy as compared to the similar source on earth will be

a) 0.3%

(b) 0.4%

(c) 0.5%

(d) 0.6%

49. if an aeroplane is moving with velocity 1..87 x 10^3.km hr^{-1}.. and waves of frequency 7.8 x 10^9 Hz. Are sent toward the aeroplane from the radar station . then observed frequency of the waves reflected from the aeroplane will be

(a) 2.7 x 10^4. Hz.

(b) 7.2 x 10^4Hz.

(c) 8.7 x 10^9 Hz

(d) 7.8 x 10^9Hz.

50. Doppler shift for the light of wavelength 6000A^0 emitted from the sun is 0.04 A^o. if radius of the sun is 7 x 10^8 m then time period of rotation of the sun will be

(a) 30 days

(b) 365 days.

(c) 24 hours.

(d) 25 days.

51. frequency of radio waves corresponding to 10 meter wavelength is

(a) 3×10^{7} Hz.

(b) 3×10^{10} Hz

(c) 1×10^{9} Hz

(d) 2×10^{9} Hz

52. on introducing a thin mica sheet of thickness 2×10^{-6} m and refractive index 1.5 in the path of one of the waves , central bright maxima shifts by n fringe. Wavelength of the wave used is 5000 A^{0}, then n is.

(a) 1

(b) 2

(c) 5

(d) 10

53. two waves having intensities in the ratio 25:4 produce interference . then ratio of maximum to minimum intensity is

(a) 49:9

(b) 9 : 49

(c) 5:2

(d) 2: 5

54. in young's double slit experiment , ratio of intensities of a bright band and a dark band is 16 : 1 Ratio of amplitude of interfering waves will be

(a) 16:1

(b) 4:1

(c) 1 : 4

(d) 5 : 3

55. in young's double slit experiment , a amplitude of the coherent sources are in ratio 3 : 1, then ratio of maximum to minimum intensity of the fringe system will be

(a) 3:1

(b) 1 : 3

(c) 9 : 1

(d) 4 : 1

56. Two slits 4 mm apart are illuminated by light of wavelength 6000A^{o}. if fringe width is 0.3 mm then distance between source and screen will be

(a) 1m

(b) 1.5 m

(c) 2.0 m

(d) 2.5 m

57. Ratio of intensities of two waves is 25 : 4 then ration of maximum to minimum intensity will be

(a) 5 : 2

(b) 4 : 25

(c) 25 : 4

(d) 49 : 9.

58. in young's double slit experiment , fringe width is found ot be 0.4 min. on immersing the whole apparatus in water having refractive index 1.333, new fringe width will be

(a) 0.30 mm

(b) 0.40 mm

(c) 0.53 mm

(d) 0.35 mm

59. Two beams of light having intensities I and 4I interfere to produce a fringe pattern on the screen . phase difference between the beam is $\pi/2$ at point A and π at point B. then between the intensities at A and B is

(a) 3I

(b) 4I

(c) 5I

(d) 6 I

60. in young's double slit experiment , 12 fringes are obtained to be formed in a certain segment to the screen when light of 600 nm is used. If wavelength of

light is changed to 400 nm, no. of fringes obtained in the same segment of the screen is given by

(a) 12

(b) 15

(c) 18

(d) 21.

61. if ordinary light incident on a glass slab at polarizing angle suffers a deviation of 22^0, value of angle of refraction in glass in this case shall be

(a) 34^0.

(b) 22^0.

(c) 12^0.

(d) 56^0.

62. intensity of light does not depend on

(a) velocity

(b) frequency

(c) wavelength

(d) amplitude

63. in young's double slit experiment , if distance between the slit is doubled . then to keep fringe width unchanged

(a) wavelength should be doubled

(b) distance between screen and slit should be made double.

© both should remain constant

(d) none of these.

64. Device used for producing two coherent sources are

(a) Lloyd's mirror

(b)ordinary mirror

(c) two torches

(d) Fresnel biprism.

65. Which of the following can produce coherent sources ?

(a) Ordinary prism

(b) young's double slit

© Lloyd's mirror

(d) Fresnel 's biprism.

66 Which are the following are not essential for producing interference in young's double slit experiment

(a) equal intensity

(b) equal amplitude

(c) constant phase

(d) same frequency

67. Which of the following are essential for producing interference in young's double slit experiment?

(a) constant phase

(b) same wavelength

(c) same amplitude

(d) same intensity

68. Which of the following phenomenon could not be explained by wave nature of light ?

(a) reflection

(b) polarization

(c) photo electric effect

(d) black body radiations .

69. White light is used to illuminate the two slits in young's double slit experiment , separation between the slits is

b and the screen is at a distance d (>>b) from the slits. At a point on the screen , directly in front of the slits, certain wavelengths are missing. Some of these missing wavelengths are

(a) b^2/d

(b) $2b^2/d$

(c) $2b^2/3d$

(d) $b^2/3d$

70. in young's double slit experiment, interference pattern is found to have an intensity ratio between dark and bright fringes as 9. then

(a) intensities on the screen due to two slits are 5 units and 4 units respectively

(b) amplitude ration is 2

© amplitude ratio is 9

(d) intensities at the screen due to two slits are 4 units and 1 unit respectively.

71. four light waves are represented by

(i) $y_1 = a_1 \sin \omega_1 t$.

(ii) $y_2 = a_2 \sin \omega_2 t$.

(iii) $y_3 = a_3 \sin [\omega_1 t. + (\pi/2)]$

(iv) $y_4 = a_4 \sin [\omega_1 t. - (\pi/2)]$

then interference fringes may be produced due to the superposition of

(a) (i) & (iii)

(b) (ii) & (iv)

(c) (ii) & (iii)

(d) (i) & (iv)

72. Light moving in a straight line bends by a small angle due to

(a) reflection

(b) refraction

(c) dispersion

(d) diffraction.

73. light is considered as electromagnetic wave. When light propagates in vacuum the electric and magnetic field.

(a) have zero average value

(b) are mutually perpendicular

© are perpendicular to the direction of propagation

(d) are constant in time.

74. Light waves can travel in

(a) vacuum

(b) only vacuum

(c) material medium

(d) only material medium.

75. Tow monochromatic coherent point sources S_1 & S_2 are separated by a distance L. Each source emits light of wavelength λ where L >> λ Line S_1S_2 when extended meets a screen perpendicular to it at point A. select the correct statement

(a) Point A is always an intensity maximum for any separation L.

(b) Point A on intensity maximum if L = nλ (n= integer)

© interference fringes on the screen are circular in shape .

(d) interference fringes on the screen are straight lines perpendicular to line S_1S_2A.

76. Which of the followings properties of light do not ensure wave nature of light ?

(a) Light obeys laws of refraction.

(b) light obeys laws of reflection

© light propagates slowly in water

(d) Light shows diffraction.

77. if a young's double slit experiment is performed by using electron waves produced by an electron gun, then fringe width will decrease if .

(a) acceleration voltage of electron gun is decreased

(b) accelerating voltage of electron gun is increased

© distance between the slits is increased

(d) distance between slit and screen is decreased.

78. Which of the following properties of light conclusively supports wave nature of light.

(a) light obeys law of reflection

(b) light obeys law of refraction

(c) light shows diffraction

(d) speed of light is less in water as compared to air.

79. Unpolarised light can be converted into partially or plane polarized light by many processes. Which of the following does not do that

(a) diffraction

(b) interference

(c) scattering

(d) polarization

80. Which of the following are correct

(a) light waves are transverse in nature

(b) light waves are longitudinal in nature.

© light waves can be diffracted

(d) only light ways can be deflected.

81. Diffraction effects are more easier to notice in case of sound waves than light waves because

(a) sound waves are of longer wavelength

(b) size of obstacles are of the order of wavelength of light waves.

(C) size of obstacles are of the order of wavelength of sound waves.

(d) speed of sound waves is less than that for light waves.

NUMERICAL BANK.

82. A radar operates at wavelength 50.0 cm. if the beat frequency between the transmitted signal and the signal reflected from the aircraft is 1 kHz. Then the velocity of the aircraft will be

(a) 800 km /hr.

(b) 900 km /hr.

(c) 100 km /hr.

(d) 1032 km /hr.

83. A plane electromagnetic wave of frequency ω_0 falls .normally on the surface of a mirror approaching with a

relativistic velocity ν . Then frequency of the reflected wave will be [given $\beta = \nu/c$]

(a) $[(1-\beta) / (1+\beta)]\omega_0$.

(b) $[(1+\beta) / ((1-\beta) \omega_0\}$

© $\{ (1+\beta)\omega_0\} / (1-\beta)$.

(d) $[(1-\beta) / ((1+\beta) \omega_0\}$

84. a spectral line of wave length of 0.59 μm is observed in the directions to the opposite edges of the solar disc along its equator . A difference in wavelength equal to $(\Delta\lambda)$8 picometer is observed. Period of Sun's revolution around its own axis will be about

(radius of sun = 6.95×10^8)

(a) 30 days

(b) 24 hours.

(c) 25 days

(d) 365 days.

85. if the wavelength of light coming from distant galaxy is found to be 0.5% more than that coming from a source on earth. Then velocity of the galaxy will be

(a) 3×10^{10} ms^{-1}.

(b)1.5×10^{10} ms^{-1}

. (c) 1.5×10^{8} ms^{-1}.

(d) 1.5×10^{6} ms^{-1}.

86. Minimum separation between two points on the moon which can be resolved by a reflecting telescope with mirror diameter 5 m will be about

(ν = 0.55 μm, D = 3.9×10^{5} km)

(a) 35 m.

(b) 5 m

(c) 53 m

(d) 25m.

87. if light with wavelength 0.50 μm falls on a slit of width 10 μm and at an angle $\theta = 30^0$ to its normal. Then angular position of first minima located on right sides of the central Fraunhoffer's diffraction will be at

(a) 33.4^0.

(b) 26.8^0.

(c) 39.8^0.

(d) none of these.

89. Angular width of central maximum in the Fraunhoffer's diffraction pattern is measured. Slit is illuminated by the light of wavelength 6000 A^o.if the slit is illuminated by

the light of another wavelength, angular width decreases by 30%. Wavelength of light used is

(a) 3500 A^o.

(b) 4200 A^o.

(c) 4700 A^o.

(d) 6000 A^o.

PHYSICAL WORLD AND MEASUREMENT

SMART BULLETS - SHOT THE TARGET

*Length, mass and time are the three basic or fundamental quantities.

*The units of measurement of all other physical quantities, which can be obtained from fundamental

units are called derived units. **For example, unit of speed (i.e. ms $^{-1}$) is a derived unit.**

* SYSTEMS OF UNITS

A system of units is the complete set, of units,

both fundamental and derived, for all kinds of physical quantities. Each system is named in terms of fundamental units on which it is based. The common systems, of units used in mechanics are given below:

(a) The **FPS** system is the British Engineering system of units, which uses **foot** as the unit of length, **pound** as the unit of mass and **second** as the unit of time.

(b) The **C.G.S** system is the Gaussian system which uses **centimetre, gram and second** as the three basic units for length, mass and

time respectively.

(c) The **MKS** system is based on **meter, kilogram and seco**nd as the fundamental units of length, mass and time respectively.

* The conversion factors in common use are:

(i) **1 foot = 30.48 cm = 0.3048 metre**

(ii)**1 pound = 453.6 gm = 0.4536 kg**

* For measuring very small areas, the unit used is

1 barn = 10^{-28} m^2 Nuclear cross sections are measured in barns.

* For measuring heavy masses, the units used are

(i) **1 tonne or 1 metric ton = 1000 kg**

(ii) **1 quintal = 100 kg**

* **1 shake = 10^{-8} sec.**

* **1 Lunar month = 27. 3 days**

* For measuring pressures, the units used are:

(i) **1 bar = 1 atmospheric Pressure = 10^5 N/m^2**

= 760 mm of Hg column

1 bar = 760 Torr

(ii) **1 Torr = 1 mm. of Hg column**

* The chosen standard of measurement of a quantity, which has essentially the same nature as that

of the quantity, is called the unit of the quantity.

* SI The name SI is an abbreviation' of "Le Systeme International d' unites", which is French equivalent of *International system of units.*

* The SI is based on the following seven fundamental units and two supplementary units:

Basic Physical Quantitiy	Fundamental unit	Symbol used
1. Mass	kilogram	kg
2. Length	metre	*m*
3. Time	second	*s*
4. Temperature	kelvin	K
5. Electric current	ampere	A
6. Luminous intensity	candela	Cd
7. Quantity of matter	mole	mol

1 metre = 100 cm = 3.281 ft. 1 kg = 1000 gm = 2.205 pound.

*** Supplementry Units**

Supplementary physical quantity

Supplementary unit

1. Plane angle	**radian**	**rad**
2. Solid angle	**steradian**	**sr**

* **Dimensions**

The dimensions of a physical quantity are the fundamental units like mass, length, time etc. must be raised in order to represent that physical quantity.

* **Principle of Homogeneity**

According to this principle, the dimensions of two physical relations must be same.

e.g. let us have the relation $[M^a L^b T^c] = [M^x L^y T^z]$ Then, $a = x$,$b = y$, $c = z$

* The following quantities have no **dimensions specific gravity, Poisson's ratio, strain and angle.**

* The dimensional formula of **frequency, angular frequency, angular velocity and velocity gradient are same i.e. $[M^0 L^0 T^{-1}]$.**

* **Strain, angle, solid angle, trigonometrical**

ratio's, refractive Index relative density, relative permeability and relative permitivity have no dimensions.

*. Work kinetic energy, potential energy, internal energy, torque, moment of force, heat have the same dimensional formula $[M^1L^2T^{-2}]$.

*. Energy density, pressure, stress, Young' s Modulus bulk Modulus and Modulus of rigidity all has the same dimensional formula i.e. $[M^1L^{-1}\ T^{-2}]$.

*. Thermal capacity, Boltzmann constant and entropy, Universal gas constant have the

same dimensions [$M^1L^2T^{-2}$ K^{-1}].

***. L/R , $(hC)^{1/2}$ and RC all have the dimension of time. i.e. [$M^0L^0T^1$].**

***. The dimension of V^2/ R ,VI , I^2R , qV , LI^2 , q^2/c and CV^2 all have the dimensions of energy**

*. A quantity like angle has no dimensions but it has units. .The reverse is not true. .

*. The order of magnitude of a quantity gives us a value nearest to the actual value of the quantity in suitable powers of 10. For this, a number less than 5 is treated as 1 and a

number between 5 and 10 is treated as 10.

*. The distances/lengths that we come across vary from 10^{-l5}m (radius of proton) to 10^{26}m (size of universe).

*. A metre scale is used for measuring distances from 10^{-3}m to 10^{2} m. A vernier callipers is used for measuring distances upto 10^{-4}m. A spherometer and a screw gauge are used for measuring distances upto 10^{-5} m.

*. **For large distances, the indirect methods used are Avogadro's method and Rutherford scattering method.**

*. The masses we come across vary from 10^{-30} kg (mass of electron) to 10^{55}kg (mass of universe).

*. An inertial balance is used for measuring inertial mass of a body and a common balance is used for measuring gravitational mass of a body.

*. The time interval that we come across vary from 10^{-22} sec. (time taken by light to cross a distance of nuclear size) to 10^{18} sec (age of sun).

*. For measuring small time intervals, we

used electric oscillators, electronic oscillators, solar clocks, quartz crystal clocks, atomic clocks, decay of elementary particles technique for measuring large time intervals we used radioactive dating technique.

*. Note that only like quantities can be added or subtracted from one another.

* Significant figures in the measured value of a physical quantity represent the accuracy of measurement.

*. In any mathematical operation, the result must be rounded off appropriately so as to

represent the proper precision in measurement.

*. Error of measurement is the difference in the true value and measured value of a quantity. The errors can be systematic errors, random errors and gross errors.

*. Mean absolute error (Δa) is arithmetic mean of the magnitudes of absolute errors in all the measurements.

*. Relative error or fractional error is the ratio of mean absolute error and mean value of the quantity. It can be expressed in terms of

percentage.

* In sum and difference of the quantities, we sum up the absolute errors in the individual quantities.

*. In Multiplication and division, fractional errors in individual quantities are added to obtain fractional error in the results.

*. The fractional error in a quantity raised to power n is n times the fractional error in the quantity itself.

*. In any formula the quantity with maximum power should be measured with highest

degree of accuracy.

* Some important Dimensional Formula:

Planck' s constant (h)	Energy / frequency	$[M^1L^2T^{-1}]$	*Js*
Gravitational constant	Force*(distance)2 / (mass)2	$[M^{-1}L^3 T^{-2}]$	Nm^2kg^{-2}
Coefficient of elasticity	Stress/strain	$[M^1L^{-1} T^{-2}]$	Nm^{-2}
Coefficient of viscosity	Force / Area * velo.grad.	$[M^1L^{-1}T^{-1}]$	$Nm^{-2}s$
Spring constant	Force /displacement	$[M^1L^0T^{-2}]$	Nm^{-1}
Solar constant	Energy received / Time* area	$[M^1L^0T^{-3}]$	Kgs^{-3}

Wave intensity	Energy received Time* area	$[M^1L^0T^{-3}]$	$Kg\ s^{-3}$
Current	Charge / time	$[M^0L^0T^0A]$	A
Electric potential	Work/ charge	$[M^1L^2T^{-3}A^{-1}]$	$Kg\ m^2s^{-3}A^{-1}$
Density	Mass /volume	$[M^1L^{-3}T^0]$	$Kg\ m^{-3}$
Slap	Acceleration /time	$[M^0L^1T^{-3}]$	ms^{-3}
Pressure gradient	Pressure / length	$[M^1L^{-2}T^{-2}]$	$Kg\ m^{-2}s^{-2}$

Significant figures

* The number of digits required to explain the measurement of a physical quantity are called significant figures.

* Rules to determine significant digits:-

* All zeroes to the right of a decimal point are significant but to the left of non-zero digit are not significant provided there is only a zero to the left of decimal point.

*Greater the number of significant figures in a measurement, lower will be the percentage error it.

* All non-zero digits are significant.

*All zeroes between two non zero digits are significant.

*The last digit in the significant figures of a no. is its uncertain digit. no.12.6 , ‘ 6’ is

uncertain digit.

*When there is no decimal the final zeros are not significat.A no. 1260000 has only ‘ 3’ significant figures.

*All the zeros lying in-between the decimal point and the first non zero digit on its right side are not significant. A no. 0.00126 has three significant digits.

Important Points

* The number of significant figures does not vary with choice of different units. For example, if length of a rod is recorded as 46

cm, then the number of significant figures remain unchanged when we write it as 0.46 m. or 0.00046 Km i.e. the no of significant remains two in each case.

*When a number is written in exponential form the exponential term does not contribute towards the significant figures. Hence the number 8.76×10^6 contains only three significant figures.

* Mean absolute error. It is the arithmetic mean of the magnitudes of absolute errors in all the

measurements of the quantity. It is represented by Δa. Thus

$$\overline{\Delta a} = \frac{\Delta a_1 + \Delta a_2 + \Delta a_3 + \ldots\ldots\ldots + \Delta a_n}{n}$$

* Relative error or Fractional error

The relative error or fractional error of measurement is defined as the ratio of mean absolute, error to the mean value of the quantity measured. Thus

$$\text{Relative Error or Fractional error} = \frac{\text{Mean absoluteerror}}{\text{mean value}}$$

When the relative/fractional error is expressed in percentage, we call it percentage error. Thus

* Percentage error = $\frac{\Delta a}{a_m} \times 100\ \%$

* **Error in sum of the quantities**

Suppose $x = a + b$

Let Δa = absolute error in measurement of a

Δb = absolute error in measurement of b

Δx = absolute error in x Le. sum of a

and b.

then $\pm \Delta x = \pm \Delta a \pm \Delta b$

*** Error in difference of the quantities**

Let $x = a - b$ $\pm \Delta x = \pm \Delta a \pm \Delta b$

*** Error in product of quantities**

Let $x = a \times b$ $\pm [\Delta x/x] = \pm [\Delta a/a] \pm [\Delta b/b]$

*** Error in division of quantities**

Let $x = (a/b)$ $\pm [\Delta x/x] = \pm [\Delta a/a] \pm [\Delta b/b]$

*** Error due to power or a quantity**

Let $x = a^n / b^m$ $\Delta x/x = \pm n\Delta a/a \pm m\Delta b/b$

Forces in nature: Forces operative in nature are of following kinds

(1) Gravitational force **(2) Electromagnetic force** **(3) Nuclear force**

(A) Gravitational force: According to Newton's law of gravitation, the force of attraction (F), between two objects *(of* masses M_1 and M_2) held at a distance r is giyen as

$F = GM_1M_2 / r^2$ where G = Gravitational constant = 6.66×10^{-11} N-m^2 Kg^{-2}.

Gravtational force obeys inverse square law.

It is a long range force (extending upto-infmity), always attractive but weakest force in nature. It is a conservative force.

Example of gravitational force from daily life.

(i) Due to gravitational force of earth all objects near its surface fall towards it centre.

(ii) Gravitational force of earth keeps the satellites revolving around it.

(iii) Gravitational force of the sun accounts for the motion of planets around it.

(iv) Gravitational force of moon causes tides in the seas.

(B) Electromagnetic forces. These incude electric and magnetic forces. The electrostatic force (F) between two charges (q_l andq_2) held at a distance r, governed by the coulomb's law, is given as

$$F = q_l q_2 / 4\pi\varepsilon_0 r^2 = K q_1 q_2 / r^2$$

Where K = a constant == 9×10^9 $Nm^2 C^{-2}$ (in space)

* A moving charge produces a magnetic field around it. When two charges are in motion both produce magnetic field around

themselves. Then, the charge (q) moving with velocity (v), inside the magnetic field (B) produced by the other charge, experiences electromagnetic force (F) given as

$$\vec{F} = q (\vec{v} \times \vec{B})$$

Electromagnetic force obeys inverse square law. It is also a long range force which may be attractive or repulsive. It is 1036 times stronger than gravitational force. It is a conservative force.

Examples of electromagnetic force from daily

life:

(i) In a substance, electrons revolve around the nucleus atom interact with those of another atom. The electromagnetic force between them holds them together to form a molecule.

(ii) Two parallel conductors carrying current in the same force.

(iii) In a cyclotron, alpha-particle is placed in the magnetic field. It experiences electromagnetic force due to which it is accelerated.

(C) Nuclear Force. The force operating inside the nucleus of an atom, between nucleons is called nuclear force. It is a short range attractive force. It varies inversely with some higher power of distance. The relative strength of various forces is

Examples of nuclear force in daily me-:

(i) Nuclear force is responsible for keeping protons, neutrons etc. inside the nucleus.

(ii) The phenomenon of radioactivity is the result of inadequate nuclear force between proton and neutrons inside heavy nuclei.

2. Conservation Laws:

1. Law of Conservation of linear momentum:

If no external force acts on a system, the linear momentum of the system remains constant. If P_1 and P_2 are linear momentas of two bodies, at any instant, then in the absence of external force, $P_1 + P_2 =$ constant.

Examples from daily life

(i) When a bullet is fired from a gun, the recoil of the gun can be explained on the basis of this law.

(ii) Two billiard balls. after collision, obey this law.

(ill) When a heavy nucleus disintegrates into two smaller nuclei, the products move in opposite directions.

(iv) Motion of the rocket is obeyed by this law.

2. Law of conservation of energy: Energy can neither be created nor destroyed, however it may change from one form to another.

Examples from daily life:

(i)When a body falls freely under gravity, its mechanical energy (potential + kinetic)

remains constant throughout.

(ii)Mechanical energy of a vibrating pendulum remains the same.

(iii) Total energy of the reactants and products in nuclear reactions remains constant.

3. Law of conservation of angular momentum:

If no external torque acts on a system then total angular momentum of the system always remains constant.

Examples from daily life:

(i) When a planet moves around the sun in an

elliptical orbit, its velocity increases when it comes close to the sun and decreases when it moves away from the sun.

(ii) A diver jumping from a spring board exhibits somersault in air before touching the water surface.

(iii) A ballet dancer increases her angular velocity by folding her arms and bringing the stretched leg close to the other leg

(iv) The inner layers of whirl-wind in a tornado has extremely high speed.

Coherent System of units: is defined as that

system which is based on certain set of fundamental units from which all other units can be derived by multiplication or division.

MEASUREMENT

Meter

Meter is the unit of length in S.I.system.

Meter is defined as "The distance between the two marks on a Platinum-Iridium bar kept at 0 C in the International Bureau of Weight and Measures in Paris."

One meter = 100 cm = 1000 mm

Kilogram

Kilogram is the unit of mass in S.I.system.

"Kilogram is defined as the mass of a platinum cylinder placed in the International Bureau of Weight and Measures in Paris."

One kilogram = 1000gram

Second

Second is the unit of time in S.I. system.

A second is defined in terms of the time period of Cs-133 atoms.

i.e." one second is equal to 9,192,631,770 periods of vibrations of Cs-133 atoms."

60 seconds = one minute & 3600 seconds = one hour

Least Count

Minimum measurement that can be made by a measuring device is known as " LEAST COUNT.

Least count (vernier callipers) = minimum measurement on main scale / total number of divisions

on vernier scale

Least count (screw gauge) = minimum measurement on main scale / total number of divisions on

circular scale

Smaller is the magnitude of least count of a measuring instrument, more precise the measuring instrument is. A measuring instrument can not measure any thing whose dimensions are less than the magnitude of least count.

Least Count of Vernier Callipers = 0.01 cm

Least Count of Micrometer Screw gauge = 0.001 cm

Zero Error

It is a defect in a measuring device (Vernier Callipers & Screw Gauge).

When jaws of a Vernier Callipers or Screw Gauge are closed, zero of main scale must coincides with the zero of vernier scale or circular scale in case of screw gauge.

If they do not coincide then it is said that a zero error is present in the instrument.

Types Of Zero Error

Zero error may be positive or negative.

A positive zero error in the instrument shows a larger measurement than the actual measurement.

In order to get exact measurement, positive zero error is subtracted from the total reading.

A negative zero error in the instrument shows a smaller measurement than the actual measurement.

In order to get exact measurement, negative zero error is added to the total reading.

Pitch

"Perpendicular distance between two consecutive threads of the screw gauge or spherometer is called PITCH."

Pitch = Distance traveled on main scale / total number of rotations

KINEMATICS- I, II
SMART BULLETS – SHOT THE TARGET

* MOTION IN ONE, TWO AND THREE DIMENSIONS

(i) **One-dimensional motion.** The motion of an object is said to be one-dimensional motion if only one out of the three coordinates specifying the position of the object changes with respect to time.

For example, motion of train along a straight railway track, an object dropped from a certain,

(ii) **Two-dimensional motion.** The motion of an object is said to be two-dimensional motion if two out of the three coordinates specifying the position of the object change with respect to time.

For example; an insect crawling over the floor, earth revolving around the Sun

(iii) **Three-dimensional motion.** The motion of an object is said to be three dimensional motion if all the three coordinates specifying the position of the object change with respect to time.

In such a motion, the object moves in a space.For example; a kite fly

Note. The path followed by a point object during its motion is called Trajectory.

*** DISTANCE AND DISPLACEMENT**

Distance. The length of the actual path traversed by an object during motion in a given interval of time is called distance travelled by that object.

Distance is a scalar quantity. Its value can never be zero

or negative, during the motion of an object. **Displacement**. The displacement of an object in a given interval of time is defined as the change in position of the object along a particular direction during that time and is given by the vector drawn from the initial position to its final position.

* **Characteristics of displacement:** 1. The displacement of an object has the unit of length.

2. The displacement of an object in a given interval of time can be positive, zero or negative.

3. The magnitude of the displacement of an object between two points gives the shortest distance between those two points.

4. The displacement of an object between two points does

not tell the type of motion followed by object between those two points.

5. The displacement of the object between two points has a unique value.

6. The actual distance travelled by the object in the given time interval can be equal to or greater than the magnitude of the displacement.

7. It is vector quantity.

*** SPEED:** Speed of an object is defined as the time rate of change of position of the object in any direction. It is measured by the distance travelled by the object in unit time in any direction. *i.e.*

Speed = distance traveled / time taken **Speed is**

a scalar quantity.

Average speed = total distance traveled / total time-taken

Instantaneous speed = $\underset{\rightarrow t \quad 0}{\mathrm{Lt}} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$

*** VELOCITY:** Velocity of an object is defined as the time rate of change of displacement of the object. It is also defined as the speed of an object in a given direction. Quantitatively,

velocity = displacement/time

Average velocity = total displacement traveled / total time-taken

* If a particle moves along a straight path 4 the 1st half

distance with velocity v_1 and 2nd half with velocity v_2, then the average velocity V_{av} is given by $V_{av} = 2v_1v_2 / v_1 + v_2$

* If particle moves along a straight road for the 1st half time with velo. v_1 and 2nd half time with velo. v_2 then average velo. is $V_{av} = (v_1 + v_2) /2$

In general $V_{av} = (v_1t_1 + v_2 t_2) /(t_1 + t_2)$

* Instantaneous velocity = $\underset{\Delta t \to 0}{\mathrm{Lt}} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$

*. The velocity and acceleration of a body may not necessarily be in the same direction.

* The velocity and acceleration of a body may not be zero simultaneously.

* When a body is in equilibrium, its acceleration is zero.

* If a body is thrown upwards, it will go vertically until its vertical velocity becomes zero.

* If air resistance is neglected, the body returns to the starting point with the same magnitude of velocity with which it was thrown vertically upwards.

* If a body travels with a uniform acceleration ‘ a_1’ for time t_l and with uniform acceleration ‘ a_2’ for a time t_2, then average acceleration $a = (a_l t_l + a_2 t_2) / t_1 + t_2$

* The total distance travelled by the body in the given time is equal to the area which velocity time graph encloses with time axis. The area is to be added without sign.

* The total displacement of the body in the given time is equal to the area which velocity-time graph encloses with time axis. The area is to be added with sign.

* If the velocity-time graph is a straight line normal to time axis, then the acceleration of the body is infinite. Such situation is not practically possible.

* If the velocity-time graph is a curve whose slope decreases with time, then the acceleration of the body goes on decreasing with time.

* If the velocity - time graph is a curve whose slope increases with time, then the acceleration of the body goes on increasing with time.

* If the velocity-time graph is a straight line inclined to time axis with negative slope then the body is moving with constant retardation.

* If the velocity-time graph is a straight line inclined to time axis with positive slope, then the body is moving with

constant acceleration.

* If the velocity-time graph is a straight line parallel to time axis, then the acceleration of the body is 0 .

* If the distance time graph is a curve whose slope decreases continuously with time, then the velocity of the body is decreasing continuously and the body is retarded.

* If the distance-time graph is a curve whose slope increases continuously with time, then the velocity of the body is increasing continuously and the body is accelerated.

* No line in distance-time graph can be perpendicular to the time axis because it will represent infinite velocity.

* If the distance time graph is a straight line inclined to time axis at an angle greater than 90° then the body is moving

with constant negative velocity.

* If the distance-time graph is a straight line inclined to time axis at an angle less than 90° then the body is moving with a constant positive velocity.

* If the distance-time graph is a straight line parallel to time axis, then the body is at rest.

* If during motion velocity remains constant through out a given time interval, the motion is said to be uniform motion. For uniform motion, the velocity v = constant = v_{av}. However the converse

may or may not be true i.e. if $\vec{v} = \vec{v}_{av}$ the motion mayor may not be uniform.

* For a body heaving same velocity if accelerated with a uniform acceleration, the distance travelled by the body in

successive seconds is in the ratio of 1 : 3 : 5 : 7 .

* If a body is starting from rest and is moving with a uniform acceleration, the distance travelled by the body in the first second, first two seconds, first three seconds etc. are in the ratio of 1 : 4 : 9 etc.

* If a body A is moving with velocity *u* on body B moving with velocity v the velocity of body A

relative to ground = u + v, which is in the direction of motion of bodies and is equal to (u - v) in the direction of body A, if they are moving in opposite directions.

* If rain is tailing vertically with a velocity $\vec{v_a}$ and a person is moving horizontally with speed $\vec{v_m}$ the person can protect himself from the rain if he holds his umbrella in the direction of relative velocity of rain with respect to the person.

* An object can be considered as a point object if during motion in a given time, it covers distances much greater than its own size.

* **Equations of Motion** (when the motion is uniformly accelerated)

(i) $v = u + at$ (ii) $v^2 - u^2 = 2as$

(iii) $s = ut + \frac{1}{2} at^2$ (iv) $S_{nth} = u + a/2 (2n - 1)$

* Various graphs related to motion:

(1) Displacement – time graph:

* For stationary object the position time graph is straight line parallel to time axis (Fig1).

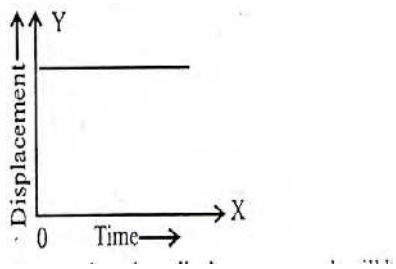


Fig 1

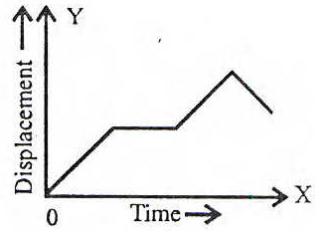
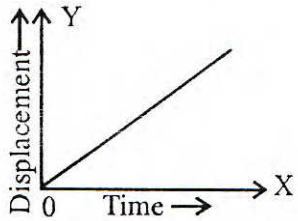


Fig 2



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*When the velocity of a body is constant then time displacement graph (Fig 2) will be an straight line.

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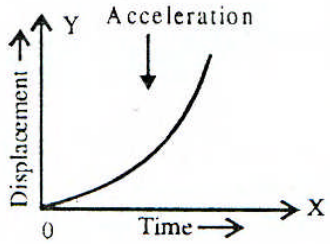
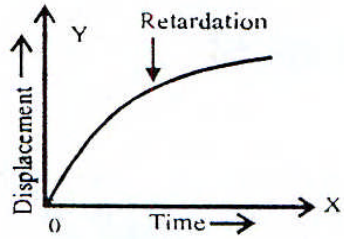


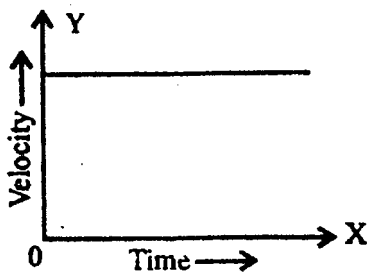


* For an Accelerated motion the slope of displacement time curve increases with time where as for deaccerated motion

it decreases with time.

(2) **Velocity – time graph:**

* When velocity of particle is constant or acceleration is zero. (Fig 1)



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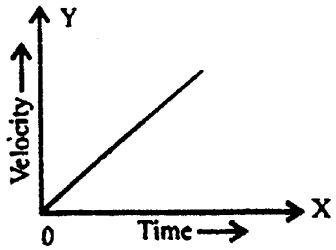

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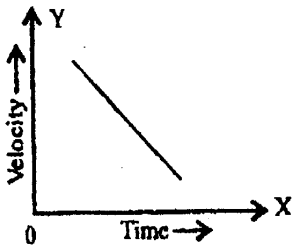

Fig 3

* When particle is moving with constant acceleration and its initial velocity is zero. (Fig 2)

* When particle is moving with constant retardation and initial velocity is not zero. (Fig 3)

* Ignoring air resistance, all objects fall under earth's

gravity at the same rate 9.81 m/s^2. This will not effect horizontal velocity, so this will usually remain constant.

* Instantaneous velocity is the slope of a displacement graph at a point.

* Based on a displacement time graph, the average velocity can be found by taking the start and end points, drawing a line between them, and then finding the slope of the resulting line. Instantaneous velocity is the same except the line is the tangent to the curve at the point in question. The units will always be m/s.

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resulting line. Instantaneous acceleration is the same except the line is the tangent to the curve at the point in question. Finding displacement is done by finding the area under the graph (but if the graph goes below the x-axis, the area is still positive.

* Calculate acceleration and velocity from strobe photos, light gates etc ... the easiest way is to draw a rough graph, but it can be done by using the above equations...finding the time between each point, and the distance, then finding the velocity...for each point, then the change between the velocities.

* A body moving with a velocity *v* is stopped by application of brakes after covering a distance s. If the same body

moves with a velocity nV, it stops after covering a distance n^2s by the application of same brake force.

* If a body is projected upwards or falls freely then the direction of acceleration is downwards in both cases (downwards).

* In the absence of air resistance, the velocity of projection is equal to the velocity with which the body strikes the ground. .

* In case of air resistance, the time of ascent is less than time of descent for a body projected vertically upward.

* For a body projected vertically upwards the magnitude of velocity at any point on the path is same whether the body is moving in upwards or downward direction.

* When atmosphere is effective, then buoyant force always

acts in upward direction whether body is moving in upward or downward direction and it depends on volume of the body.

* If bodies have same volume but different densities then even in the presence of atmosphere,

Time of ascent = Time of descent.

*If maximum height attained by a body projected vertically upwards is equal to the magnitude of velocity of projection. Then velocity of projection is *2g* and time of flight is 4 sec.

* If maximum height attained by a body projected upward is equal to magnitude of acceleration due to gravity *i.e. 'g',* the time of ascent is $(2)^{1/2}$ sec and velocity of projection is g $(2)^{1/2}$.

* Scalar has only magnitude. The scalars can be added or

subtracted by the simple laws of mathematics.

*. Vectors have magnitude as well as direction. Vectors are added and subtracted by the laws of vectors algebra; e.g. triangle law of vectors, parallelogram law of vectors, polygon law of vectors.

*. The maximum value of vector addition of A and B is (A + B) and minimum value is (A - B), in the direction of A.

*. A physical quantity is a vector only when it follows the commutative property.

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*. The vector difference does not follow commutative law i.e. $A - B \neq B - A$.

*. Dot product of two vectors A and B is a scalar, as it has only magnitude i.e. $A.B = AB \cos \theta$, where θ is smaller angle between A and B.

* Dot product of two- mutually perpendicular vectors is zero i.e. $A . B = AB \cos 90^0 = 0$.

* Dot product of self vector is equal to the square of its magnitude. $A . A = A^2$. Also $i.i = j.j = k.k = 1$.

* . Cross product of two vectors $\vec{A}$ and $\vec{B}$ is a vector, whose magnitude is AB sinθ and its direction is perpendicular to the plane containing A and B and is given by right handed screw rule.

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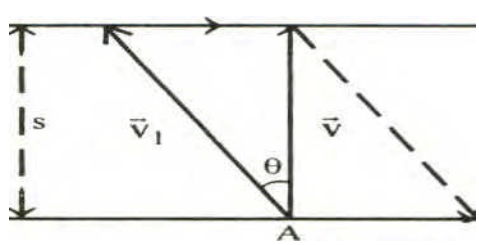
*. When a boat tends to cross a river along a shortest path, it

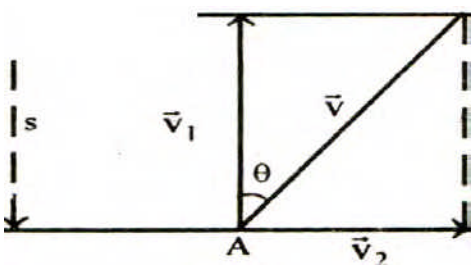


should be rowed up stream making an angle θ with AB such that AB gives the direction of resultant velocity v. Velocity of boat v_1 (= AD) and velocity of flow of river v_2 in Fig.

In ΔABD, $\sin\theta = v_2 / v_1$ and $v = (v_1^2 - v_2^2)^{1/2}$

It ‘ t’ is the time of crossing the river, then

$t = s / v = s / (v_1^2 - v_2^2)^{1/2}$

*. 

When a boat tends to cross a river in a shortest time the boat should go along AB. In fig. Now the boat will be going along AD which is the direction of resultant velocity v of velocity of boat v (= AD) and velocity of river v_2(=AC)

From ΔABD, $\tan\theta = v_2 / v_1$ and $v = (v_1^2 + v_2^2)^{1/2}$

Time of crossing t = s/v

The boat will be reaching to a point D instead of point B. If BD = x then $\tan \theta = v_2 / v_1 = x / s$

* To achieve maximum range, the object should be projected at an angle of *45°.*

*. The maximum horizontal range of projectile is u^2/g.

*. The horizontal range is same when angle of projection is θ and (90° - θ) or *(45°* +θ) and *(45°* - θ).

*. For a projectile given angular projection, the maximum height depends upon the vertical component of velocity of projection.

*. At the highest point of a projectile motion given angular projection, the velocity is not zero but it is u cos θ acting in the horizontal direction.

*. When the maximum range of projectile is R, then its

maximum height is R/4.

*. Range of projectile along the inclined plane is,= u^2 [sin(2θ - θ_0) - sin. θ_0]/(g $\cos^2\theta$)

where θ_o is the angle of inclined plane and e is the angle of projection with the horizontal direction.

*. Time of flight on an inclined plane is, T = 2usin(θ - θ_0)/ g

*. The maximum range on inclined plane is, $R_{max} = v^2 / g(1 + \sin\theta_0)$

*. The angle at which the horizontal range on the inclined plane becomes maximum is given as

$\theta = (\pi / 4) + (\theta_0 / 2)$

*. At the highest point of projectile path, the velocity and acceleration are perpendicular to each other.

*. The velocity of the projectile is minimum at the highest

point which is equal to u $\sin\theta$, where u is the velocity of projection and θ is the angle of projection of projectile.

*. The particle rectums to the ground at the same angle and with the same velocity with which it was projected.

*. In case of angular projection, the angle between velocity and acceleration varies from $0° < \theta < 180°$.

*. When a body moves with a constant angular velocity, then its acceleration always acts perpendicular to the velocity i.e. towards the centre of the circle along which the body is revolving and is called centripetal acceleration. $a_c = r\omega^2$

KINEMATICS- I, II
SMART BULLETS – SHOT THE TARGET

* MOTION IN ONE, TWO AND THREE DIMENSIONS

(i) One-dimensional motion. The motion of an object is said to be one-dimensional motion if only one out of the three coordinates specifying the position of the object changes with respect to time.

For example, motion of train along a straight railway track, an object dropped from a certain,

(ii) Two-dimensional motion. The motion of an object is said to be two-dimensional motion if two out of the three coordinates specifying the position of the object change with respect to time.

For example; an insect crawling over the floor, earth revolving around the Sun

(iii) Three-dimensional motion. The motion of an object is said to be three dimensional motion if all the three coordinates specifying the position of the object change with respect to time.

In such a motion, the object moves in a space.

For example; a kite flying\

on a windy day, random motion of a gas molecule, a flying aero plane.

Note. The path followed by a point object during its motion is called Trajectory.

* DISTANCE AND DISPLACEMENT

Distance. The length of the actual path traversed by an object during motion in a given interval of time is called distance travelled by that object.

Distance is a scalar quantity. Its value can never be zero or negative, during the motion of an object.

Displacement. The displacement of an object in a given interval of time is defined as the change in position of the object along a particular direction during that time and is given by the vector drawn from the initial position to its final position.

* Characteristics of displacement: 1. The displacement of an object has the unit of length.

2. The displacement of an object in a given interval of time can be positive, zero or negative.

3. The magnitude of the displacement of an object between two points gives the shortest distance between those two points.

4. The displacement of an object between two points does not tell the type of motion followed by object between those two points.

5. The displacement of the object between two points has a unique value.

6. The actual distance travelled by the object in the given time interval can be equal to or greater than the magnitude of the displacement.

7. It is vector quantity.

* SPEED: Speed of an object is defined as the time rate of change of position of the object in any direction. It is measured by the distance travelled by the object in unit time in any direction. *i.e.*

Speed = distance traveled / time taken

Speed is a scalar quantity.

Average speed = total distance traveled / total time-taken

Instantaneous speed = $\underset{\Delta t \to 0}{\mathrm{Lt}} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$

* VELOCITY: Velocity of an object is defined as the time rate of change of displacement of the object. It is

also defined as the speed of an object in a given direction. Quantitatively,

velocity = displacement/time

Average velocity = total displacement traveled / total time-taken

* If a particle moves along a straight path 4 the 1st half distance with velocity v_1 and 2nd half with velocity v_2, then the average velocity V_{av} is given by

$V_{av} = 2v_1v_2 / v_1 + v_2$

* If particle moves along a straight road for the 1st half time with velo. v_1 and 2nd half time with velo. v_2 then average velo. is $V_{av} = (v_1 + v_2) /2$

In general $V_{av} = (v_1t_1 + v_2 t_2) /(t_1 + t_2)$

* Instantaneous velocity = $\underset{\Delta t \to 0}{\mathrm{Lt}} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$

*. The velocity and acceleration of a body may not necessarily be in the same direction.

* The velocity and acceleration of a body may not be zero simultaneously.

* When a body is in equilibrium, its acceleration is zero.

* If a body is thrown upwards, it will go vertically until its vertical velocity becomes zero.

* If air resistance is neglected, the body returns to the starting point with the same magnitude of velocity with which it was thrown vertically upwards.

* If a body travels with a uniform acceleration ‘ a_1’ for time t_l and with uniform acceleration ‘ a_2’ for a time t_2, then average acceleration

$a = (a_l t_l + a_2 t_2) / t_1 + t_2$

* The total distance travelled by the body in the given time is equal to the area which velocity time graph encloses with time axis. The area is to be added without sign.

* The total displacement of the body in the given time is equal to the area which velocity-time graph encloses with time axis. The area is to be added with sign.

* If the velocity-time graph is a straight line normal to time axis, then the acceleration of the body is infinite.

Such situation is not practically possible.

* If the velocity-time graph is a curve whose slope decreases with time, then the acceleration of the body goes on decreasing with time.

* If the velocity - time graph is a curve whose slope increases with time, then the acceleration of the body goes on increasing with time.

* If the velocity-time graph is a straight line inclined to time axis with negative slope then the body is moving with constant retardation.

* If the velocity-time graph is a straight line inclined to time axis with positive slope, then the body is moving with constant acceleration.

* If the velocity-time graph is a straight line parallel to time axis, then the acceleration of the body is 0 .

* If the distance time graph is a curve whose slope decreases continuously with time, then the velocity of the body is decreasing continuously and the body is retarded.

* If the distance-time graph is a curve whose slope increases continuously with time, then the velocity of the body is increasing continuously and the body is accelerated.

* No line in distance-time graph can be perpendicular to the time axis because it will represent infinite velocity.

* If the distance time graph is a straight line inclined to time axis at an angle greater than 90° then the body is moving with constant negative velocity.

* If the distance-time graph is a straight line inclined to time axis at an angle less than 90° then the body is moving with a constant positive velocity.

* If the distance-time graph is a straight line parallel to time axis, then the body is at rest.

* If during motion velocity remains constant through out a given time interval, the motion is said to be uniform motion. For uniform motion, the velocity v = constant = v_{av}. However the converse may or may not be true i.e. if $\vec{v} = \vec{v}_{av}$ the motion

mayor may not be uniform.

* For a body heaving same velocity if accelerated with a uniform acceleration, the distance travelled by the body in successive seconds is in the ratio of 1 : 3 : 5 : 7 .

* If a body is starting from rest and is moving with a uniform acceleration, the distance travelled by the body in the first second, first two seconds, first three seconds etc. are in the ratio of 1 : 4 : 9 etc.

* If a body A is moving with velocity u on body B moving with velocity v the velocity of body A relative to ground = u + v, which is in the direction of motion of bodies and is equal to (u - v) in the direction

of body A, if they are moving in opposite directions.

* If rain is tailing vertically with a velocity $\vec{v_a}$ and a person is moving horizontally with speed v_m the person can protect himself from the rain if he holds his umbrella in the direction of relative velocity of rain with respect to the person.

* An object can be considered as a point object if during motion in a given time, it covers distances much greater than its own size.

* Equations of Motion (when the motion is uniformly accelerated)

(i) $v = u + at$ (ii) $v^2 - u^2 = 2as$

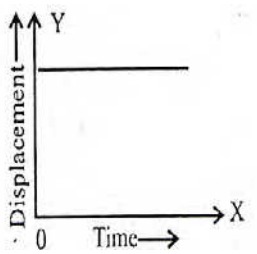
(iii) $s = ut + \frac{1}{2} at^2$

(iv) $S_{nth} = u + a/2 (2n - 1)$

* Various graphs related to motion:

(1) Displacement – time graph:

* For stationary object the position time graph is straight line parallel to time axis (Fig1).



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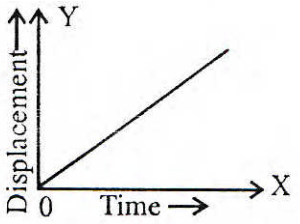

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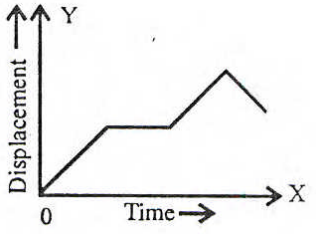

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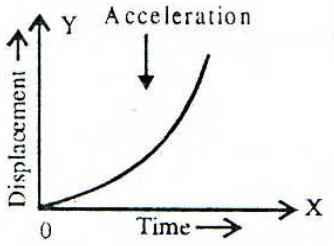

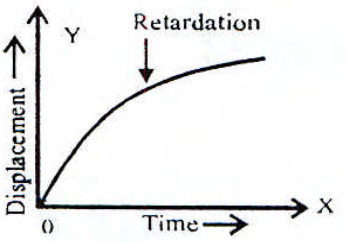

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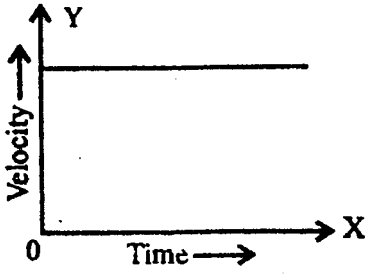

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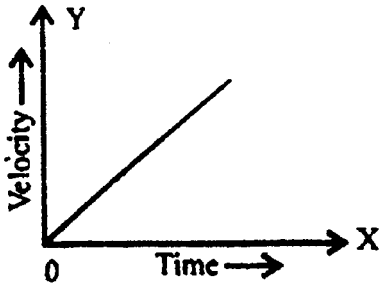

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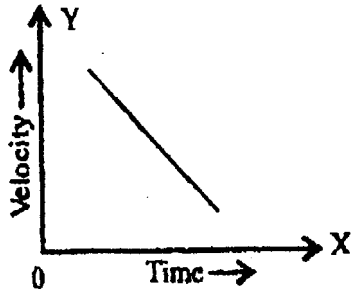

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$$\hat{A} = \vec{A} / A \text{ , If } \vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k},$$

then $A = A_x^2 + A_y^2 + A_z^2$

$$\hat{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k} / (A_x^2 + A_y^2 + A_z^2)^{1/2}$$

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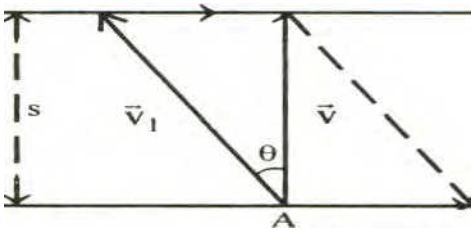

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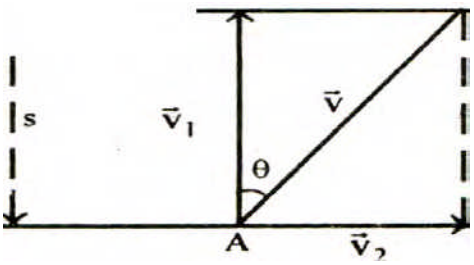
*. When a boat tends to cross a river in a shortest time the boat should go along AB. In fig. Now the boat will be going along AD which is the direction of resultant velocity v of velocity of boat v (= AD) and velocity of river v_2(=AC)

From ΔABD, $\tan\theta = v_2 / v_1$ and $v = (v_1^2 + v_2^2)^{1/2}$

Time of crossing t = s/v

The boat will be reaching to a point D instead of point B. If BD = x then tan $\theta = v_2 / v_1 = x / s$



* To achieve maximum range, the object should be projected at an angle of *45°.*

*. The maximum horizontal range of projectile is u^2/g.

*. The horizontal range is same when angle of projection is θ and (90° - θ) or *(45°* +θ) and *(45°* - θ).

*. For a projectile given angular projection, the maximum height depends upon the vertical component of velocity

of projection.

*. At the highest point of a projectile motion given angular projection, the velocity is not zero but it is u cos θ acting in the horizontal direction.

*. When the maximum range of projectile is R, then its maximum height is R/4.

*. Range of projectile along the inclined plane is,= u^2 $[\sin(2\theta - \theta_0) - \sin. \theta_0]/(g \cos^2\theta)$

where θ_o is the angle of inclined plane and e is the angle of projection with the horizontal direction.

*. Time of flight on an inclined plane is,

$T = 2u\sin(\theta - \theta_0)/ g$

*. The maximum range on inclined plane is,

$R_{max} = v^2 / g(1 + \sin\theta_0)$

*. The angle at which the horizontal range on the inclined plane becomes maximum is given as

$\theta = (\pi / 4) + (\theta_0 / 2)$

*. At the highest point of projectile path, the velocity and acceleration are perpendicular to each other.

*. The velocity of the projectile is minimum at the highest point which is equal to u $\sin\theta$, where u is the velocity of projection and θ is the angle of projection of projectile.

*. The particle rectums to the ground at the same angle and with the same velocity with which it was projected.

*. In case of angular projection, the angle between velocity and acceleration varies from $0° < \theta < 180°$.

*. When a body moves with a constant angular velocity, then its acceleration always acts perpendicular to the velocity i.e. towards the centre of the circle along which the body is revolving and is called centripetal acceleration. $a_c = r\omega^2$

VECTORS & PROJECTILE

SMART BULLETS – SHOT THE TARGET

* Scalar has only magnitude. The scalars can be added or subtracted by the simple laws of mathematics.

*. Vectors have magnitude as well as direction. Vectors are added and subtracted by the laws of vectors algebra; e.g. triangle law of vectors, parallelogram law of vectors, polygon law of vectors.

*. The maximum value of vector addition of A and B is (A + B) and minimum value is (A - B), in the direction of A.

*. A physical quantity is a vector only when it follows the commutative property.

*. If a vector is displaced parallel to itself it does not change.

*. If a vector is rotated through an angle other than multiple

of 360^0 (or 2π) it changes.

*. If a frame of reference is rotated or linearly moved, the vector does not change, though its component may change.

* Unit vector of a given vector A is given by

$$\hat{A} = \vec{A} / A \text{ , If } \vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k},$$

then $A = A_x^2 + A_y^2 + A_z^2$

$$\hat{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k} / (A_x^2 + A_y^2 + A_z^2)^{1/2}$$

*. A quantity having magnitude and direction is not necessarily a vector. For example, electric current, time pressure etc. have magnitude and directions both but they are scalar. It is so because they do not obey the laws of vector addition.

VECTORS

*. The vector difference does not follow commutative law i.e. $A - B \neq B - A$.

*. Dot product of two vectors A and B is a scalar, as it has only magnitude i.e. $A.B = AB \cos \theta$, where θ is smaller angle between A and B.

* Dot product of two- mutually perpendicular vectors is zero i.e. $A . B = AB \cos 90^0 = 0$.

* Dot product of self vector is equal to the square of its magnitude. $A . A = A^2$. Also $i.i = j.j = k.k = 1$.

* . Cross product of two vectors A and B is a vector, whose magnitude is $AB \sin\theta$ and its direction is perpendicular to the plane containing A and B and is given by right handed screw rule.

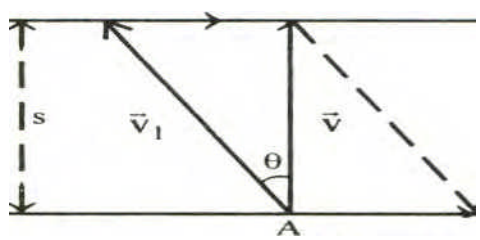
*. A unit vector perpendicular to A as well as B is

$$\hat{n} = \vec{A} \times \vec{B} / |\vec{A} \times \vec{B}|$$

*. Cross product of parallel vectors is zero.

*. The magnitude of cross product of two vectors is equal to the area of parallelogram whose two adjoining sides are represented by two vectors.

*. When a boat tends to cross a river along a shortest path, it should be rowed up stream making an angle θ with AB such that AB gives the direction of resultant velocity v. Velocity of boat v_1 (= AD) and velocity of flow of river v_2 in Fig.



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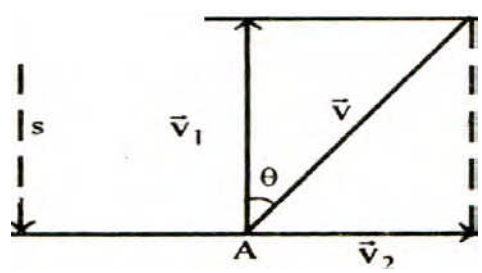

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Gravitation

Smart Bullets – Shot the Target

Some Important Points/Concepts of the Chapter:

1. Gravitational force is attractive force between two masses M, and M_2 separated by a distance r. It is given by F = G (M.M/r). Where G is gravitational constant. $G = 6.67 \times 10^{-11}\ Nm^2\ kg^{-2}$

2. Gravitation is the central force. It acts along the line joining the particles.

3. It is a conservative force. The work done by or against it is independent of the path followed.

4. It is the weakest force in nature. It is 10^{38} times smaller than nuclear force and 10^{36} times smaller than electric force.

5. Gravitation is independent of the presence of other bodies around it.

6. The mass of any body is the cause of gravitation.

7. The gravitational pull of the earth is called gravity.

8. The value of the acceleration due to gravity on the moon is about one sixth of that on the earth and on the sun is about 27 times that on the earth.

9. Among the planets, the g is minimum on the mercury.

10. Acceleration due to gravity on the surface of the earth is given by $g = G M/R^2$, where M is the mass of the earth and R is the radius of the earth.

11. Acceleration due to gravity at a height h above the surface of the earth is given by;

$g_h = G M/(R + h)^2 = g (1 - 2h/R)$. The approximation is true when $h << R$.

12. Value of g at depth d from earth's surface

(i) $g' = g[1-(d/R)]$

(ii) $g' = GM_e(R_e-d)/R_e^3 = 4\pi G (R_e - d)\rho/3$, ρ = density of earth

13. For $h << R$, the rate of decrease of the acceleration due to gravity with height is twice as compared to that with depth.

14. The value of g at a Latitude λ is

(i) $g' = g - \omega^2 R_e \cos^2\lambda$

(ii) At the equator $\lambda = 0$ $g' = g - \omega^2 R_e$

(iii) At the poles $\lambda = \pi/2$, $g^1 = g$

15. g increases with the increase in latitude. Its value at latitude is given by : $g_\theta = g - R\omega^2\cos^2\lambda$. Where g_P is the acceleration due to gravity at the poles.

16. The decrease in g with latitude is caused by the rotation of the earth about its own axis. A part

of g is used to provide the centripetal force for rotation about the axis.

17. The rotation of the earth about the SUIT has no effect on the value of g.

18. Decrease in g in going from poles to the equator is about 0.35%.

19. If the earth stops rotating about its axis, the value of e at the equator will increase by about 0.35%, but that at the poles will remain unchanged.

If the earth starts rotating at the angular speed of about 17 times the present value, there will be weightiness" on the equator, but g at the poles will

remain unchanged. In such a case, the duration of the day will be about 84 minutes.

20. The weight of the body varies in the same manner as the g does.

21. The gravitational force of attraction acting on a body of unit mass at any point in the gravitational field is defined as the intensity of gravitational field (E) at that point.

$E_g = F/M = GM/r^2$

22. The gravitational potential energy of a mass m at a point above the surface of the earth at a height h is given as -GMm/(R+h). The negative sign implies that as R increases, the gravitational

potential energy decreases and becomes zero at infinity.

23. Suppose, we assume the gravitational potential energy on the surface of the earth as zero. Then for $h << R$, the gravitational potential energy of a mass m at a height h above the surface of the earth is mgh.

24. Gravitational potential at a point above the surface of the earth at a height h is: $-GM/(R + h)$

25. **Inertial and** gravitational mass -

(a) Inertial mass (M_i)

(i) It is defined by Newton's law of motion.

(ii) If we apply equal force (F) on each of the two objects whose masses are M_1 and M_2, then

$F = (Mi)_{iai} =(Mi),a,$ => $M_1 = [a_2/a_1]M_2$

(b) **Gravitational mass (M)**

(i) It is defined by Newton's law of gravitation.

(ii) The gravitational force (F) exerted by a massive body M on an object is proportional to the mass of the object (M).

(iii) It is actually the gravitational mass which we measure using a spring balance.

26. **Geostationary Satellites**

Let ω_0 = angular speed of the satellite, v_0 = orbital speed, then $v_0 = (R + h\omega_o$, where R = radius of the

earth and h = height of the satellite above the surface of the earth. Let g = acceleration due to gravity on the surface of the earth, T = time period of the satellite, and g_Q = acceleration due to gravity at the location of the satellite, M = mass of the earth. Then different quantities connected with satellite at height h are

(i) $\omega = [GM/(R + h)^3]^{1/2} = [g_0/(R + h)]^{1/2} = R\,[g/(R + h)^3]^{1/2}$

(ii) $T = 2\pi /T$ and frequency of revolution $n = \omega/2\pi$

Very near the surface of the earth, we get the values by putting h = 0 that is

(i) $\omega = [GM/R^3]^{1/2} = [g/R]^{1/2}$

(ii) $T = 2\pi\ [R/g]^{1/2}$= 5078 seconds 1 hour 24.6 minutes.

27. The gravitational potential of the earth at a height h above the surface of the earth is given by:

Its unit is joule per kilogram.

28. The gravitational potential energy of a satellite of mass m is $U_p = -\ G\ Mm/r$ where r is the radius of the orbit.

29. Kinetic energy of the satellite is

$U_k = 1/2\ mv_0^2 = GMm/2r$

30. Total energy of the satellite

$U = U_p + U_k = -\ GMm/2r$

-VE sign indicates that it is the binding energy of the satellite.

31. Total energy of a satellite at a height equal to the radius of the earth

$= -GMm/2(R + R) = - GMm/4R = (1/4) mgR$

where $g = GM/R^2$ is the acceleration due to gravity on the surface of the earth.

When the total energy of the satellite becomes zero or greater than zero, the satellite escapes from the gravitational pull of the earth.

32. If the radius of planet decreases by n%, keeping the mass unchanged, the acceleration due

to gravity on its surface increases by 2n% That is

$\Delta g/g = -2\Delta R/R$

33. If the mass of the planet increases by m% keeping the radius constant, the acceleration due to gravity on its surface increases by m% [$\Delta g/g = \Delta M/M$\ where R = constant.

34. If the density of planet decreases by x% keeping the radius constant, the acceleration due to gravity decreases by x%.

35. If the radius of the planet decreases by x% kceping the density constant, the acceleration due to gravity decreases by x%.

36. For the planets orbiting around the sun, the angular speed, the linear speed and kinetic energy change with time but the angular momentum remains constant.

37. If two spheres of same material, mass and radius are put in contact, the gravitational attraction between them is directly proportional to the fourth power of the radius.

$F = 1/4\ G(4\pi\sigma/3)^2\mathbf{R^4}$

38. There is no atmosphere on the moon because the escape velocity of the gases on the moon is low.

39. If the orbital radius of the earth around the sun be one fourth of the present value, then the duration of the year will be one eighth of the present value.

40. The satellites revolve around the earth in plane that coincides with the great circle around the earth.

41. When a body falls from a height h above the surface of the earth, its velocity on reaching

$$v = [2GM(1/R - 1/\{R+h\})]^{1/2}$$

when $h << R$ we find $v = \sqrt{2gh}$

42. If the gravitational attraction of the sun on the planet varies as the nth power of distance, then

year of the planet will be proportional to $r^{(n+1)/2}$

where r = distance of the planet from the sun.

43. Total energy of a projectile fired with velocity v at the surface of the earth is : $1/2\ mv^2 - GMm/R$.

44. If a body is projected vertically upwards with a velocity v then neglecting friction, the maximum height (h) to which it rises is given,

by $v^2 = [2GM(1/R - 1/\{R+h\})]^{1/2}$

45. Work done in moving unit mass from infinity to any point in space is called gravitational potential at that point.

46. Intensity of the gravitational force is equal to the acceleration due to gravity.

47. **Polar Satellites:** Polar satellites revolve in polar orbit which passes over the north and south poles of the earth and is usually close to it.

(i) As the earth rotates about its axis, a polar satellites passes over a different part of the earth during each revolution.

(ii) It can survey and scan the entire surface of the earth by making use of scanners, sensors and cameras

(iii) As a weather satellite it records temperature, takes pictures of clouds and make forecasting of climatic changes.

(iv) As a monitoring satellite, it monitors the trend of green hou^e effect and **ozone** layer.

(v) **For military purposes,** it **keeps eye** on **the** movement of ships, troops. It can be used for spying and surveillance.

Keplers First Law

According to Kepler, all the planets revolve around the sun in elliptical orbits.

Keplers Second Law

(i) Assuming that a planet revolves in circular orbits around the sun, its areal velocity remains constant dA/dt = constant.

(ii) This law follows from the law of conservation of angular momentum.

Kepler's third law

(i) The square of the period of revolution (T) of a planet around the sun is directly proportional to the cube of the radius (r) of the circular orbit i.e. $T^2 \propto r^3$

WORK POWER ENERGY SMART BULLETS – SHOT THE TARGET

Some Important Points/Concepts of the Chapter:

* Work (W) done by a force $\vec{F}$ in displacing a body through $\vec{dr}$ is given by W = F . dr.

* Work is zero when angle θ between F and dr is = $\pi/2$.

* Work is -ve when θ lies between $\pi/2$ and π. The -ve work retards the body.

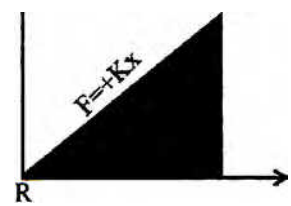
* Work is +ve, when angle π between F and dr lies between 0 and $\pi/2$. The +ve work accelerates the body.

Force-Displacement Graph

(a) The work done by variable force in displacing a particle from X_1 to X_2

$\int dW = \int F.\, ds$ or $W_{ab} = \int F\, ds \cos\theta$ = = Area of shaded region.

between curve and displacement axis.



W = Area enclosed by F-x curve and displacement axis from X_l to X_2

(b) Work done in stretching a spring against restoring force

W = Area of Δ PQR = $-1/2(Kx^2)$

(c) The work done by or against a conservative force neither depends upon the path along which the particle is displaced nor it depends upon the time taken in traversing that path.

$\rightarrow \rightarrow \rightarrow \rightarrow \rightarrow$

* Power $P = dW/dt = F \cdot dr/dt = F \cdot v$ where v is the velocity of the body.

* Work is said to be done by a force when the force produces a displacement in the body on which it acts in any direction except perpendicular to the direction of the force. .

* Work done by a force is said to be positive if the applied force has a component in the direction of the displacement. .

* Work done by a force is said to be negative if the applied force has a component in a direction opposite to that of the displacement.

* Energy is the capacity or ability of a body to do work.

* Kinetic energy is the energy possessed by a body by virtue of its motion.

* Potential energy is the energy possessed by a body by virtue of its position in a field of force or by its configuration.

* The conversion of energy from one form to another is called transformation of energy.

* If the amount of work done against a force depends only on the initial and final positions of the object moved, then such a force is called a conservative force.

* Power is defined as the time rate of doing work.

* Instantaneous Power is the power at any given instant.

* A collision is said to take place when either two bodies physically collide against each other or when the path of one body is changed by the influence of the other body.

* A collision is said to be an elastic collision if both the kinetic energy and momentum are conserved in the collision.

* A collision is said to be an inelastic collision if the kinetic energy is not conserved in the collision. However the momentum is conserved.

* If the two bodies stick together after the collision, the collision is said to be perfectly inelastic.

* One-dimensional elastic collision is that elastic collision in which the colliding bodies move along the same straight line path before and after the collision.

* If the colliding bodies do not move along the same straight line path, then the collision is said to be an oblique collision.

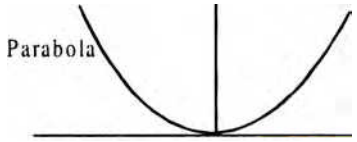
* Potential energy p of a body of mass M raised through a height h is Mgh.

* Kinetic energy p of a body of mass M moving with velocity v

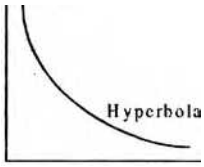
is 1/2 Mv^2.

* Relation between P and E_k , $E_k = P^2 / 2m$

Where p is the momentum of the particle and m is its mass.



(A)



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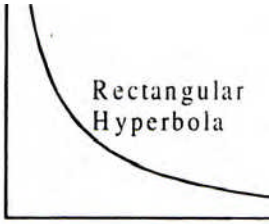


(C)

* The graph between $(E)^{1/2}$ and p is a straight line, provided m is constant. (A)

* The graph between $(E\ )^{1/2}$ and 1/P is a rectangular hyperbola, provided m is constant.(B)

* The graph between E_k and m is a rectangular hyperbola, provided p is constant. (C)

* If a body rolls on a horizontal surface then its total kinetic energy = linear kinetic energy + rotational kinetic energy.

$E_k = ½ (mv^2) + ½(I\omega^2)$

(i) If two bodies have equal momentum then the kinetic energy of lighter body will be more.

$P_l = P_2$ or $(2m_lE_{kl})^{1/2} = (2m_2E_{k2})^{1/2}$

$(E_{k1}/ E_{k2}) = (m_2 / m_1)$

(ii) If two bodies have same kinetic energy then the momentum of heavier body will be more.

$E_{k1} = E_{k2}$ Or $P_1 /P_2 = (m_1/ m_2)$

(iii)When a ball released from a cannon explodes in air then its momentum remains constant but its kinetic energy increases because the chemical energy of gun powder in the ball gets converted into its kinetic energy.

* Conservation of mechanical energy implies sum of kinetic energy and potential energy is constant i.e. $E = E_k + U$

= constant

* Total energy of an isolated system of particles remains constant. However it may change from one form to another.

* According to the work energy theorem the work done on a system to set it in motion is equal to the kinetic energy acquired by it.

* Mass is a form of energy. According to the Einstein's mass energy relation $E = Mc^2$, where E is energy equivalent of mass M, and. c is the speed of light. .

* Work done against friction on horizontal surface = μ Mgx.

* Work done against force of friction on inclined plane = (μmg cosθ)x.

* Stopping distance of the vehicles = (Kinetic energy

/Stopping force)

* If a body moving with velocity v comes to rest after covering a distance x on a rough surface having coefficient of friction μ, then: $2\mu g\, x = v^2$.

* Two vehicles of masses M_l and M_2 are moving with velocities V_l and V_2 respectively. When they are stopped by the same force, their stopping distance are in the ratio as follows:

$$X_1 / X_2 = ½(m_1v_1^2) / 1/2m_2\, v_2^2 = E_{k1} + E_{k2}$$

where E_{kl} & E_{k2} are the kinetic energies. And their stopping times $t_1$and t_2 are:

$$t_1/t_2 = m_1v_1 /m_2v_2 = P_1/P_2$$

where P_l & P_2 are the respective momenta.

* Consider a car and a bus of masses M_l & M_2 respectively (i)

If they are moving with same velocity, then the ratio of their stopping distances, by the application of same retarding force is given by $x_1/x_2 = M_1 / M_2$

And the ratio of their retarding times are as follows:

$t_1 / t_2 = M_1 / M_2$ $x_1/x_2 = M_1 / M_2 = t_1 / t_2$

* Suppose the car and the bus are moving with the same kinetic energy, then their stopping distances due to same retarding force are equal ($X_l = X_2$) But stopping time of the bus is more than that of the car Also, $t_1 / t_2 = (M_1 / M_2)^{1/2}$

* If the car and the bus are moving with the same momentum, then their stopping time due to same retarding force are equal ($t_l = t_2$) but the stopping distance for the car will be more than

that for the bus. $x_1 / x_2 = (M_1 / M_2)^{1/2}$

* During elastic collisions both the momentum and kinetic energy are conserved.

* Let two bodies of masses M_l and M_2 moving with velocities u_l and u_2 along the same straight line, collide with each other. Let $u_l > u_2$. Suppose V_l and V_2 respectively are the velocities after the elastic collision, then:

$$V_l = (M_1 - M_2)\, u_1 / (M_1 + M_2) + 2M_2u_2(M_l + M_2)$$

$$V_2 = (M_2 - M_l)u_1 / (M_1 + M_2) + 2M_lu_1 / (M_l + M_2)$$

* (i) If $M_1 = M_2$ and $u_2 = 0$ then $V_l = 0$ and $V_2 = u_l$ Under this condition the first particle comes to rest and the second particle moves with the velocity of first particle before collision. In this state there occurs maximum transfer of

energy.

(ii) If $M_l >> M_2$ and $u_2 = 0$ then $v_1 = u_1$ and $V_2 = 2u_l$ under this condition the velocity of first particle remains unchanged and velocity of second particle becomes double that of first.

(iii) If $M_l << M_2$ and $u_2 = 0$ then $v_l = -u_1$ and $v_2 = (2M_1/M_2)u_1 = 0$ under this condition the second particle remains at rest while the first particle moves with the same velocity in the opposite direction.

(iv) If $M_l = M_2 = M$ say but $u_2 = 0$ then $v_l = u_2$ and $v_2 = u_1$ i.e., the particles mutually exchange their velocities.

* Also, $u_l – u_2 = v_2 – V_1$

* $e = -(v_l - v_2) / (u_l - u_2)$ is called coefficient of restitution. $0 <= e >= 1$;e=1 for perfectly elastic collision. Maximum transfer of energy occurs when $M_l = M_2$

* If k_i and k_f be the initial and final energies of the ball of mass M_l, then, fractional decrease in energy is

$$(k_i - k_f)/ k_i = 1 – (v_1/u_1)^2$$

If $M_2 = n M_l$ and $u_2 = 0$, then $(k_i - k_f) / k_i = 4n / (1 + n)^2$

* Suppose, a body is dropped from a height ho and it strikes the ground with velocity v_o. After the (inelastic) collision let it rise to a height h_1 If V_l be the velocity with which the body rebounds, $e = v_1/vo = (2gh_1 / 2gh_o)^{l/2} = (h_1/h_o)^{l/2}$

* If after n collisions with the ground, the velocity is v n and the height to which it rises be h_n, then

$e^n = v_n/v_0 = (h_n / h_0)^{1/2}$

* The loss of kinetic energy during inelastic collision is given by: $\Delta E = 1/2 [M_l M_2(M_l + M_2)] (e^2 - 1) (u_1 – u_2)^2$

* If a body is projected on a rough horizontal surface, then it

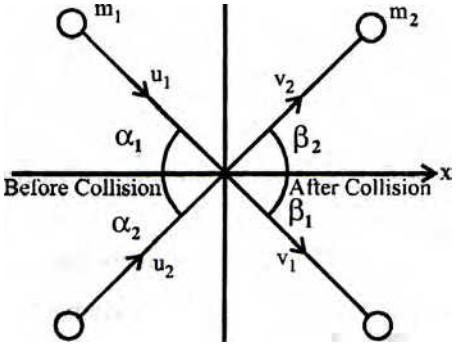
comes to rest after covering a distance

$x = ½(mv^2) / \mu mg = KE / \mu mg$

* If the speed of a vehicle is made n times, then its stopping distance becomes n^2 times.

* When the momentum of a body increases by a factor n. then its kinetic energy is increased by factor n^2.

*** Oblique collisions:**



(i) The collision between two particles in which the particles move in the same plane at different angles before and after the collision, is defined as obljque collision.

(ii)According to the law of conservation of linear momentum

along x-axis $P_{1x} + P_{2x} = P'_{1x} + P'_{2x}$

$$m_1u_1\cos\alpha_1 + m_2u_2\cos\alpha_2 = m_1v_1\cos\beta_1 + m_2v_2\cos\beta_2$$

(along X-axis)

$$P_{1y} + P_{2y} = P'_{1y} + P'_{2y}$$

$$m_l u_1 \sin\alpha_l + m_2u_2\sin\alpha_2 = m_l v_l \sin\beta_1 + m_2v_2 \sin\beta_2$$

(along y-axis)

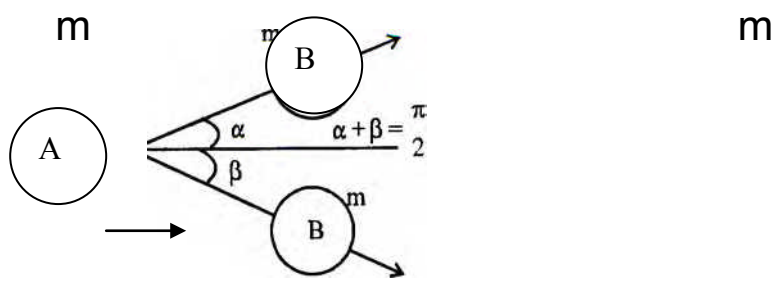
* According to law of conservation of mechanical energy

$$E_{k1} + E_{k2} = E'_{k1} + E'_{k2}$$

$$\frac{1}{2} m_1u_1^2 + \frac{1}{2}(m_2u_2^2) = \frac{1}{2}(m_1v_1^2) + \frac{1}{2}(m_2v_2^2)$$

* If $m_1 = m_2$ and $(\alpha_1 + \alpha_2) = 90°$ then $(\beta_1 + \beta_2) = 90°$ which means that if two particles of same mass moving at right angles to each other collide elastically then after collision also they move at right angles to each other

* If a body A collides elastically with another body of same mass at rest at a glancing angle then after the collision the two bodies move at right angles to each other, i.e.,



* Stoppmg distance of a body = Kinetic energy / Retardmg force

* Work done by a centripetal force is always zero.

* If a ball is dropped from a height h on the ground and the coefficient of restitution be e. then after striking the ground n times, it rises to a height $H = e^{2n}h$.

*. If a body of mass m moving with velocity V, collides elastically with a rigid wall, the change in the momentum of the body is 2 mV.

* Potential energy of a system increases when a conservative force does work on it.

* If a light and a heavy body have equal momenta, then lighter body has greater kinetic energy.

* In an elastic collision of two equal masses, their kinetic energies are exchanged.

* When the water is flowing through a pipe with speed v, then its power is proportional to v^3.

* If kinetic energy of body is doubled, then its momentum becomes $(2)^{1/2}$ times.

* The energy stored in a spring is potential energy.

* If two bodies of masses m_1 and m_2 have same momentum, then their kinetic energies are inversely proportional to the respective masses. i.e. if $m_1v_1 = m_2v_2$.

Then $\frac{1}{2}(m_1v_1^2) / 1/2(m_2v_2^2) = m_2 / m_1$

* If two bodies of masses m_1 and m_2 have same kinetic energy, then their momenta are directly proportional to the square root of the respective masses. That is, if

$$\frac{1}{2}(m_1v_1^2) = 1/2(m_2v_2^2)$$

Then $m_1v_1 / m_2v_2 = (m_1/m_2)$

* If two bodies of masses m_1 and m_2 have same kinetic energy, then their velocities are inversely proportional to the square root of the respective masses.

i.e $1/2(m_1v_1^2) = 1/2(m_2v_2^2)$

Then $v_1/v_2 = (m_2 / m_1)$

* Two bodies; one is heavier and the other is lighter are moving with same kinetic energy. If they are stopped by the same retarding force then

* As energy E = FS, the two bodies cover equal distances before coming to rest.

* The time taken to come to rest is lesser, for lighter body as it has less momentum. (t = P /F)

* The time taken 'to come to rest is more for heavier body as it has greater momentum (t = P /F)

* Two bodies, one is heavier and the other is lighter are moving with same velocity. If they are stopped by same retarding force. Then

* The heavier body covers greater distance before coming to

rest because it has greater KE. (s =E/ F)

* The heavier body takes more time to come to rest because it has greater momentum ('.' t = P / F)

* A body can have energy without having momentum but a body cannot have momentum without having energy.

* a projectile at its maximum height has both P.E. and KE. but a body thrown vertically up at its maximum height has only P.E.

* The elastic potential energy of a spring increases whether the spring is stretched or compressed.

* The angle between the initial and final positions of radius vector is called .the angular displacement.

OSCILLATIONS AND WAVES

SMART BULLETS – SHOT THE TARGET

Some Important Points/Concepts of the Chapter:

1. Oscillations of a particle are simple harmonic when the force acting on it is proportional to the displacement and directed opposite to the displacement.

2. The displacement of a particle executing SHM is given by $x = A \sin(\omega t + \Phi)$

Velocity $v = \omega[A^2 - x^2]^{1/2}$ Acceleration $a = -\omega^2 x$

Restoring force $F = -M\omega^2 x$ Kinetic energy $U_k = 1/2\, M\omega^2(A^2 - x^2)$

Potential energy $= 1/2\, M\omega^2 x^2$

3. Total energy of SHM $= 1/2\, M\omega^2 A^2$

4. The kinetic and potential energy of SHM varies sinusoidally with a frequency twice that of SHM.

5. (i)**Phase angle**—The parameter, by which the position of a particle from its mean position is represented, is known as phase angle.

(ii) **Same phase**—Two vibrating particles are said to be in same phase if the phase difference between them is an even multiple of π or path difference is an even multiple of $\lambda/2$ or time interval is an even multiple of T/2 .

7. Time period of a simple pendulum is given by :$T = 2\pi[l/g]^{1/2}$

8. If a mass M is suspended from the spring and the length of the spring changes by Δl, then

$T = 2\pi[\Delta l/g]^{1/2}$. 9. Liquid in U-Tube $T= 2\pi\sqrt{(h/g)}$

$l=2h$, $h=1/2$ $T=2\pi\sqrt{(l/2g)}$

l = Total length of liquid column, h = height of liquid column in any one tube

10. Rectangular block floating in a liquid $T=2\pi\sqrt{(h'd'/gd)}$ where d =

11. Vibrations of a gas system in a cylinder with friction-less piston $T=2\pi\sqrt{(mh/AP)}$, where m = mass of gas, A = cross sectional area of piston, P = pressure exerted by gas on the piston, h = height of piston

12. Oscillations of a system, of its own and without external influence, are called free oscillations.

13. Frequency of free oscillations is called natural frequency.

14. Oscillations under the influence of frictional force are called damped oscillations.

15. In case of damped oscillations the amplitude goes on decreasing and ultimately the system comes to a rest. 16. Damping decreases the frequency of oscillations

17. The oscillations of a system under the action of external periodic force are called forced oscillations. External periodic force can maintain the amplitude of damped oscillatons.

19. When the frequency of the external periodic force is equal to the natural frequency of the system, resonance takes place.

20. The amplitude of resonant oscillations is very very large. In the absence of damping, it may tend to infinity.

21. At resonance, the oscillating system continuously absorbs energy from the agent applying external periodic force.

24. If a particle executes simple harmonic oscillations, then its velocity as well as acceleration also vary simple harmonically. And velocity amplitude = ω x displacement amplitude

i.e. $v_{max} = \omega \times y_{max} = \omega \times A$ Also acceleration amplitude = ω x velocity amplitude = ω^2 x displacement amplitude i.e. $a_{max} = \omega \times v_{max} = \omega^2 y_{max} = \omega^2 \times A$

25. In simple harmonic motion, the phase relationship between the displacement (y), velocity (v) and acceleration (a) is as follows:(i) a is ahead of y by π(ii) v is ahead of y

by $\pi/2$(iii) a is ahead of v by $\pi/2$ 26. (i) When y = A/2, the velocity $v = 0.86\ v_{max}$.

(ii) When $v = v_{max}/2$, the displacement y = 0.87 A Note the similarity among the following relations.

$$v = \omega(A^2-y^2)^{1/2} \text{ and } y = (\omega^2A^2 - v^2)^{1/2}/\ \omega=(v^2_{max} - v^2)^{l/2}/\omega$$

(iii) When y = A/2, the kinetic energy of SHM is 75% of the total energy and potential energy is 25% of the total energy.

(iv) When the kinetic energy of SHM is 50% of the total energy, the displacement is 71 % of the amplitude.

27. The time period of a simple pendulum of length l on the surface of moon is given by:

$$T= [R/\{1+(R/l)\}g]^{1/2} = 2\pi\ [lR/(l+R)g]^{1/2}$$

Where R = radius of the earth and g is the acceleration due to gravity on the surface of the earth.

(i) When $l << R$, we find $T = 2\pi\sqrt{(l/g)}$ (ii) W

(iii) When $l = \infty$, we find $T = 2\pi[R/2g]^{1/2} = 86.4$ minutes.

Thus maximum of T is 86.4 minutes.

(iv) Under weighlessness or in the freely falling lift $T = 2\pi[l/0]^{1/2} = \infty$ This means, the pendulum does not oscillate at all.

28. If a simple pendulum oscillates in a non – viscous liquid of density σ, then its time period is given by $T=2\pi[l/\{1-(\sigma/\rho)\}]$ Where ρ = density of the bob.

29. The time period of the mass attached to spring does not change with the change in acceleration due to gravity.

30. If the mass m attached to a spring oscillates in a non

viscous liquid density σ, then its time period is given by

$T=2\pi[(m/k)\{1-(\sigma/\rho)\}]$ Where k = force constant and p is

density of the mass suspended from the spring.

Waves

Some Important Points/Concepts of the Chapter:

1. Sound waves arc mechanical waves.

Range of frequencies of sound waves : The frequencies which are audible to human beings range between 20 Hz to 20,000 Hz. This range is called the audio frequency range (a.f. range). The frequency of a grown up male varies from 100 Hz to 250 Hz whereas frequency of children and women varies from 200 Hz to 450 Hz. The frequency of sound given by a honey bee is about 440 Hz; of a mosquito around 500 to 600 Hz and that of an ordinary housefly is around 350 Hz.

Those frequencies which are below 20 Hz are called the infrasonic and those above 20 kHz are called ultrasonic.

The frequency of the note produced by bats varies from 30 kHz to 50 kHz.

2. The velocity of longitudinal waves or the sound waves in gases is given by $c = [\gamma\rho/\rho]^{1/2}$ Where p is the pressure, ρ is the density and γ is the ratio of specific heats of the gas at constant pressure and constant volume.

3. The velocity of sound in air or gases varies directly as the square root of temperature. That is $c \propto \sqrt{T}$

4. There is no effect of the change in pressure on the velocity of sound in air or gases.

5. If a string of length 1, having mass per unit length as μ and under tension F vibrates in p segments, then the frequency of the note produced is given by: $f = p/2l\ [F/\mu]'^{1/2}$

6. If D be the diameter of the string and p be the density of the material of the string, the $\mu = \pi(D^2/4)\rho$. Hence f=p/ l D[F/$\pi\rho$]$^{1/j}$

7. When the string vibrates in one segment, the sound produced is called fundamental note. The string is said to vibrate in fundamental mode. 22. The fundamental note is called first harmonic.

8. If the fundamental frequency be f_1 then $2f_1$ $4f_1$ . . . are respectively called second, third, fourth . . . harmonics. 9. If an instrument produces notes of frequencies f,, f_2, f_3, f_4. . . . Where $f_1 < f_2 < f_3 < f_4$. . . ., then f_2 is called first overtone f_3, is called second overtone, f_4 is called third overtone.....

10. Harmonics are the integral multiples of the fundamental frequency. If f_1 be the fundamental frequency, then nf_1 is the frequency of nth harmonic.

11. Overtones are the notes of frequency higher than the fundamental frequency actually produced by the instrument. 12. In the open organ pipe all the harmonics are produced.

13. Multiple reflections which are responsible for a series of waves falling on listener's ears, giving the impression of a persistence or prolongation of the sound are called reverberations.

14. The time gap between the initial direct note and the reflected note upto the minimum audibility level is called reverberation time.

15. Sabine derived an expression for the reverberation time which is given by $T = 0.158V/\alpha S$. Where V is the volume and S is the surface area of the room, α is called absorption coefficient of the room or auditorium.

16. The standard reverberation time is defined as the time taken by the sound intensity to fall by a factor 10^{-6} 80. The y, v, A of SHM vary simple harmonically with the same time period and frequency.

17. The equation of simple harmonic wave travelling in the positive X-direction is given by

$y = A \sin(\omega t - kx)$ Here y is the displacement of the particle located at JC at any time t. Also $\omega = 2\pi/T$ and $k = 2\pi/\lambda$

18. The particle velocity in a wave is given by $v = dy/dt$ and the wave velocity is given by $c - dx/dt$.

19. The wave traveling in the negative X-direction is given by : $y = A \sin(\omega t + kx)$.

20. **Waves incident on the surface of separation of two media**

If a wave $y = A \sin(\omega t - kx)$ is incident on the surface of separation of the two media, then a part of the wave may be reflected and a part of it may be transmitted.

21. Refractive index for the sound waves. The reflection as well as refraction of sound occurs according to the usual laws. For refraction, the sound obeys the snell's law and the refractive index is given by:

$$\mu = \frac{\sin i}{\sin r} = \frac{\text{velocity of wave in the medium of incidence}}{\text{velocity of the wave in the medium of refraction}}$$

22. Wave velocity in different medium: The longitudinal (mechanical M>U) waves can be propagated through solids, liquids as well as gases. (i)(a) In solids the velocity of the transverse waves is given by

$c = [\eta/\rho]^{1/2}$ P where η=- modulus of rigidity and ρ = density of the medium.

(b) In strings, the velocity of the transverse waves is given by: $c = [T/\mu]^{1/2}$ Where T = tension or stretching force and U = mass per unit length of the string.

(ii)(a) The general expression for the velocity of the longitudinal waves in the solids in bulk is

$c= [\{k+(4/3)\ \eta\}/\rho]^{1/2}$ where K - Bulk modulus of the medium.

(b) When the solid is in the form of a log rod, the wave velocity is given by: $c = [Y/\rho]^{1/2}$

where Y = Young's modulus of the medium.

(c) For liquids and gases $\eta = 0$. The velocity of the longitudinal waves in liquid is $c = [K/\rho]^{1/2}$

For gases it reduces to : $c = \sqrt{(\gamma p/\rho)}$ where γ = ratio of the specific heats and p is the pressure of the gas.

SIMPLE HARMONIC MOTION

SMART BULLETS-SHOT THE TARGET

Important terms, Fact & Formulae

1. Periodic motion : That repeats after equal interval of time.

2. Oscillatory motion To and fro motion of particle is called oscillatory motion.

3. All the oscillatory motion are periodic but periodic motion may or may not be oscillatory

4. the motion of particle is said to be SHM if acceleration of particle is directly proportional to the displacement and directed toward mean position.

i.e. $\vec{\alpha} \propto -\vec{y}$ - Linear SHM

$$\vec{\alpha} \propto -\vec{\theta}$$ or - Angular SHM

5. Force or torque acting or particle executing SHM is given by

$$\vec{F} = m\vec{\alpha} = -m\omega^2\vec{y}.$$

& $$\vec{\tau} = I\vec{\alpha} = -I\omega^2\vec{\theta}.$$

6. Number of oscillation per second undergone by particle is called frequency of oscillations

7. In SHM, the particle vibrates between two extreme position. The mid point of two extreme positions is called mean position and maximum displacement of particle from mean position is called amplitude.

8. The SHM is represented by

$y_1 = \alpha \sin\omega t$ [if particle starts from mean position]

or $y_2 = b \cos \omega t$ [if [particle starts from extreme position]

Linear combination of y_1 and y_2 also represents the SHM.

i.e $y = \alpha \sin \omega t + b \cos \omega t = r \sin (\omega t + \phi)$

where $r = \sqrt{(a^2 + b^2)}$ and $\phi = \tan^{-1} (b/a)$

here r is called amplitude ; $(\omega t + \phi)$ is called phase and ϕ is called apoch.

Kinematics of SHM

$y = r \sin\omega t$ [if particle starts from mean position]

$$v = r\omega \cos\omega t.$$

$$\alpha = -r\omega^2 \sin \omega t$$

9. Variation of velocity and acceleration in terms of displacement.

$$v = \omega\sqrt{(r^2-y^2)}$$

$$a = -\omega^2 y$$

10. At mean position velocity of particle $v_0 = rw$ is maximum and acceleration is zero.

And at extreme position, the velocity is zero and acceleration is maximum $\pm \omega^2 r$.

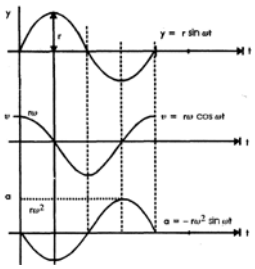
i.e. at mean position,

$y = 0$, $v = \pm\omega r$ and $\alpha = 0$

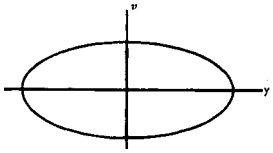
At extreme position

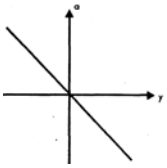
$Y = \pm r$, $v = 0$ and $a = \pm\omega^2 r$.

11. Graphs of displacement, velocity and acceleration versus time.

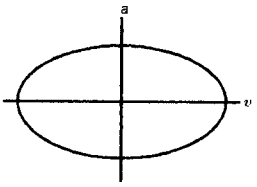


12. Graph of velocity versus displacement





13. Graph of acceleration versus displacement $\alpha = -\omega^2 y$.



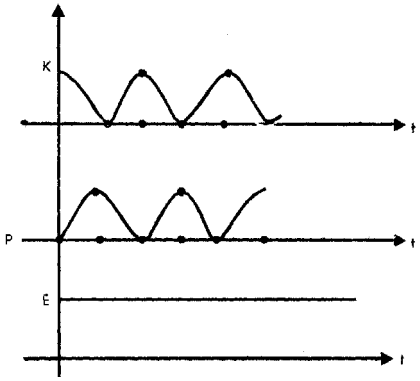
14. Graph of acceleration versus velocity

$$v = r\omega \cos \omega t = v_0 \cos \omega t.$$

$$\alpha = -r\omega^2 \sin \omega t = -a_0 \sin\omega t.$$

or $$v^2/v_0^2 + a^2+a_0^2 = 1$$

15. Graphs for K, P and E versus time



16. if a Particle vibrates with frequency v, then the frequency of variation of KE and P.E is 2v.

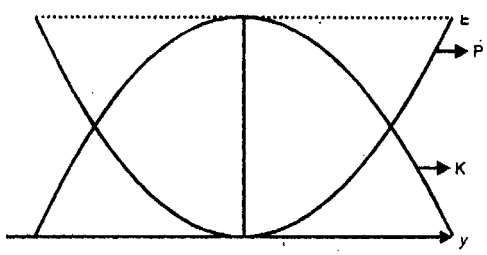
17. Average K.E and average P.E of particle executing SHM is ¼ $m\omega^2r^2$.

18. Differential from of SHM

$d^2y/dt^2 + \omega^2y = 0$ Linear SHM

$d^2\theta+dt^2+\omega^2\theta = 0$ Angular SHM

19. Graph for K,P and E versus displacement

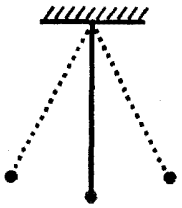


20. Energy of particle executing SHM.

$K= ½ mv^2 = ½ m\omega^2r^2\cos^2\omega t = ½ m\omega^2(r^2-y^2)$

$P = ½ m\omega^2y^2 = ½ m\omega^2 r^2 \sin^2\omega t.$

$E = K + P = ½ m\omega^2 r^2$.



21. Simple harmonic Oscillators

(i) Simple pendulum : it consists of a point mass suspended from massless, flexible and inextensible string suspended from rigid supports.

Time periods of simple pendulum of finite length is

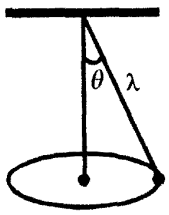
$T = 2\pi\sqrt{(l/g)}$

(ii) Loaded spring : Motion of loaded spring is also SHM.

Time period of oscillation is given by $T = 2\pi \sqrt{(m/k)}$.

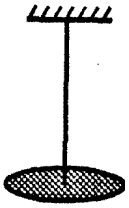
where m is mass of load and k is spring constant

(iii) Time period of oscillation of liquid in U-tube is $T = 2\pi\sqrt{(L/g)}$ where L is the length of liquid in one limb of U tube.



(iv) Time period of canonical pendulum $T = 2\pi\sqrt{(l \cos\theta/g)}$

(v) time period of oscillations of a body dropped in tunnel dug along the diameter of the earth is



$T = 2\pi\sqrt{(R/g)} = 5078s$

(vi) Time period of torsional pendulum is $T = 2\pi(I/C)$ where I is the moment of inertia and C is twisting constant

(vii) time period of oscillation of a cylinder floating in liquid is

$T = 2\pi\sqrt{(h/g)} = 2\pi\sqrt{(H\sigma/\rho g)}$

Where H is the height of cylinder, σ is the density of the cylinder, ρ is the density of the liquid and h is the height of the cylinder inside the liquid.

22. Time period of oscillation of simple pendulum of length l comparable to R (radius of the earth) is

$$T = 2\pi\sqrt{[lR/(l+R)g]}$$

It l = R, then $t = 2\pi\sqrt{(R/2g)}$

It $l = \infty$, then $T = 2\pi\sqrt{(R/g)}$

23. Length of second pendulum is nearly 1m.

24. Time period of simple pendulum in lift accelerating with acceleration 'a' is $T = 2\pi\sqrt{[l / (g \pm a)]}$

+ve sign if lift accelerates upwards and -ve sign if it accelerates downward.

25. time period of oscillation of simple pendulum in no viscous liquid is

$$T = 2\pi \sqrt{[l / g\{1 - (\sigma/\rho)\}]}$$

Where σ is the density of liquid and ρ is the density of bob.

26. Spring in series and parallel

(i) if two springs are connected in series then equivalent spring constant is $1/K = 1/K_1 + 1/K_2$….. (ii) if springs are connected in parallel then equivalent spring constant is $K = K_1 + K_2$.

27. Time period of oscillation of spring pendulum does not change in non viscous media

28. if masses m_1 and m_2 are attached with two ends of spring then the time period of oscillation is

$$T = 2\pi\sqrt{(\mu/k)}$$

Where μ is called reduced mass is given by

$$\mu = m_1m_2/(m_1+m_2)$$

29. when a system oscillates under the influence of some external force, then it oscillates are called forces oscillations. The frequency of forces oscillations is same as that of frequency of external force applied but amplitude of vibration is inversely proportional to the difference of square of natural frequency and frequency of external force applied.

30. when frequency of external force applied is equal to the natural frequency then the amplitude of vibration is maximum and oscillations are called resonant.

31. The oscillation of system under the influence of external resistive force is called damped oscillation. If F = -bv is the resistive force acting an oscillator , then its amplitude of oscillation decreases exponentially as A = A0e-bt/2m and frequency of oscillation is less then natural frequency.

$$\omega = \sqrt{(\omega_0^2 - (b2/4m^2)}\}$$

Magnetic Effects of Current

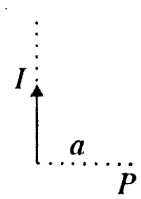
1. Magnetic field: It is the space around the magnet in which any other magnetic material place will feel the force of attraction or force of repulsion.

2. Orested Experiment: Acc. To Orested there is present magnetic field around the current carrying conductor.

3. Biot Savart's law: Acc to this law magnetic field due to current carrying conductor is given by

$$dB = \mu_0 /4\pi \ (I\ dl \sin\theta)/r^2$$

4. For the long straight conductor

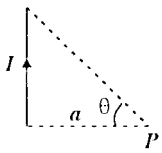


(a) $B = \mu_0/4\pi \ (I/a) \ (\sin\theta_1 + \sin\theta_2)$

(b) Magnetic field near the end of a long conductor

→

$B = \mu_\theta I/4\pi a$



(at p)

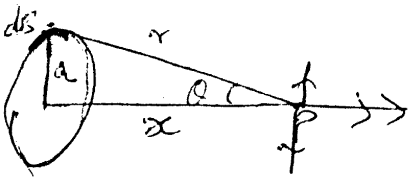
(c) Magnetic field near the end of a finite sized conductor

$\rightarrow$

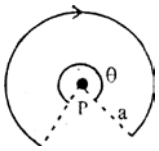
$B = (\mu_\theta I/4\pi a)(\sin\theta)$ (at p)

5. (a) Magnetic field at a point on the axis of symmetry of a circular coil, at a distance "x" from its centre:

$B = \mu_\theta NI\, a^2/2(a^2+x^2)^{3/2}$ *N:* total number of turns, a: coil radius



(b) At the centre of a circular coil, $B = \mu_\theta NI/2a$



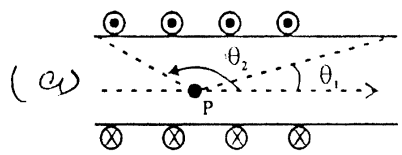
(c) Magnetic field at the centre of a circular arc carrying current

$\rightarrow$

$B = (\mu_\theta I/2a)\, x(\theta / 360)(-k)$ (at p)

6. Magnetic field inside a current

carrying solenoid



(a) finite size solenoid

$\rightarrow$

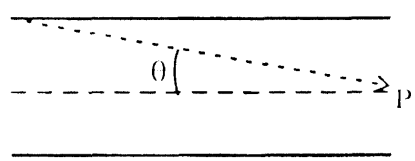
B= (μ_θnI/2 (cosθ_1- cosθ_2) n=N/l=no. of transfer unit earth

(at p)

(b) Near the end of a finite solenoid

B= (μ_θnI/2) cosθ ;(θ_1= θ & θ_2 = c/2)

(c) In the middle of a very long



solenoid

B = (μ_θnI)

(d) near the end of a very long solenoid

B= (μ_θnI/2)

n is the number of turns per unit length of solenoid.

$\vec{}$ $\vec{}$

7. **Ampere's circuital law:** $\int \vec{B}.\vec{dl} = \mu_\theta I$ where I is the net current inside the loop.

8. **Application of Ampere's circuital law to:**

(a) Toroid gives $B = \mu_\theta nI$, n= N/2πR

(b) Solenoid gives $B = \mu_\theta nI$, $n = N/l$

$\vec{}$ $\vec{}$ $\vec{}$ $\vec{}$ $\vec{}$

9. Force on a charge *q* moving in magnetic field *B* with velocity v ; $F = q(v \times B)$

$\vec{}$ $\vec{}$ $\vec{}$

10.Force on current carrying conductor of length / in magnetic field *B* : $F = I(l \times B)$

11.Unit of *B* from the expression above is N/Am

12. Flemings left hand rule is applied when I and *B* are mutually perpendicular. It states that if the fore finger, central finger and thumb are stretched at right angles to each other then if the central finger represents the direction of current and fore finger represents field, the thumb will represent the direction of force experienced by the current carrying conductor.

13. Force between infinitely long conductors placed parallel to each other at distance *d:*

Force per unit length = (F/l) =($\mu_\theta/4\pi$) ($2I_1I_2/d$)

If currents arc pointing in same direction, the force is of attractive nature ami if currents are oppositely directed the force is of repulsive nature.

14. Lorentz force equation: for a charged particle *q* moving in region of simultaneously applied electric

field $\vec{E}$ and magnetic field $\vec{B}$, the force experienced by it is given by

$$\vec{F} = q[\vec{E}+(\vec{v} \times \vec{B})$$

15. For galvanometers with their coils in uniform *B*

$I = C\theta /NAB \sin \theta$

C: torsional rigidity of suspension wire'

For galvanometer with concave pole-pieces: radial magnetic field.

$I = (C / NAB)\theta$ or $I = K\theta$

Note : All galvanometer used in practice have concave pole-pieces, for making the magnetic field radial.

16. Torque on a current loop in uniform magnetic field $\vec{B}$ is given by

$\vec{\tau} = (\vec{M} \times \vec{B})$ where $\vec{M}$ is the magnetic moment of coil.

$\vec{M} = -NIA\hat{n}$ unit normal along magnetic field due to current in the loop.

17. When a particle having mass m and charge *q.* moving with velocity v enters a uniform magnetic field of strength B in a direction perpendicular to the field lines, then a magnetic force $F_{mag} = qvB$ acts on the particle perpendicular to velocity

and the field both and it provides the centripetal force to enable the particle to curl around the field lines in a circular path. The time period $T=2\pi m/qB$is independent of v.

18. A charged particle entering uniform magnetic field at an angle executes helical path.

Radius of the helix, $R = mv \sin\theta / qB$

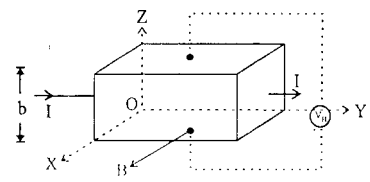
Angular frequency of rotation, $\omega = (2\pi/T) = qB/m$

Pitch of the helix = $v \cos\theta\, T = 2\pi mv\cos\theta / qB$

$v \sin\theta$ = Component of velocity perpendicular to $\vec{B}$

$v \cos\theta$ = Component of velocity parallel to $\vec{B}$.

19. In a cyclotron, time required to describe a circular path is independent of path radius or velocity. Cyclotron frequency, v = $qB/2\pi m$ (Hz)



20. Hall effect : P.D is generated, in current carrying rectangular plate placed in a magnetic field, jn a direction perpendicular to both current and magnetic field.

21. Hall effect can determine nature of current (charge) carriers in the material.

22. Hall voltage $V_H = bBI/ n e A$

where n is the number density of charge carriers

b = Thickness of plate, B = Magnetic field,

I = Current flowing through plate, A = Area of cross-section of plates

23. Unit of magnetic field is tesla (T). It is also expressed as gauss (G*).* 1 T= 10^4G

24. The speed and kinetic energy of the charged particle moving perpendicular to the magnetic field do not change because force is always perpendicular to velocity, but momentum *o(* particle changes due to change in direction of motion in the magnetic field.

25. The momentum of the charged particle moving along the direction *o(* magnetic field does not change, since the force acting on it due to magnetic field is zero. !

26. Lorentz force between two charges q_1 and q_2 moving with velocity v_1, v_2 separated by distance r is given by:

$F_m = \mu\theta/4\pi \{(q_1v_1)(q_2v_2)\}/r^2$

27. If the charges move, the electric as well as magnetic fields arc produced. In case the charges move with speeds comparable to the speed of light, magnetic and electric forces between them would become comparable.

28. A current carrying coil is in stable equilibrium if the magnetic dipole moment $\vec{M}$, is parallel to B and is in unstable equilibrium when $\vec{M}$ is antiparallel to $\vec{B}$.

29. In order to increase the range of voltmeter n times, its total resistance should also be increased by n times. So the resistances to be connected in series is $R = (n - 1)$ G.

30. In order to increase the range of an ammeter n times, the value of shunt resistance to be connected in parallel is given by:

$S = G / (n - 1)$

Magnetism

Brief Review :

1. Magnets and magnetism. The substances which have the property of attracting small pieces of iron, nickel, cobalt, etc., are called magnets and this property of attraction is called magnetism. Natural magnets, called lndestones, were found as early as the sixth century *B.C.* in the province *of'* Magnesia in ancient Greece, from which the word magnetism derives its name.

2.**Properties of magnets** :

(i) Attractive property. A magnet attracts small pieces of iron, cobalt, nickel, etc.

(ii) Directive property. A lively suspended magnet aligns itself nearly in the geographical north-south direction.

(iii) Law of magnetic poles. Like magnetic poles repel, and unlike magnetic poles attract each other.

(iv) Magnetic poles exist in pairs. Isolated magnetic poles do not exist. If we break a magnet into two pieces. we get two smaller dipolc magnets.

3. **Artificial magnets** : Pieces of iron and other magnetic materials can be made to acquire the properties *of* natural magnets. Such magnets are called artificial magnets. Their different forms are (i) Bar magnet (ii) Magnetic needle (iii) Morse-shoe-magnet and (iv) Ball ended magnet.

4. **Magnetic field** : The space around a magnet within which its influence can be experienced is called its magnetic field.

5. **Uniform** magnetic field : A uniform magnetic field is one where the strength of the magnetic field is the same at all

points *of* the field. In a uniform field, all the magnetic lines of force are parallel to one another.

6. **Magnetic force** : It is the force experienced by an electric charge when moving in a magnetic field in a direction other than parallel to the field lines.

7. **Magnetic poles** : These are the regions of apparently conceniraled magnetic strength where the magnetic attraction is maximum.

8. **Magnetic axis** : The line passing through the poles of a magnet is called its magnetic axis.

9. **Magnetic equator** : The line passing through the centre of the magnet and at right angles to the magnetic axis is called the magnetic equator of the magnet.

10. **Magnetic length** : The shortest distance between the two poles of a magnet is called its magnetic length. It is less than the geometrical length of the magnet. Magnetic length/Geometrical length = 0.84.

11. **Magnetic moment** : The magnetic moment of a magnet may be defined as the torque acting on the magnet, when it is placed at right angles to a uniform magnetic field of unit strength. It is equal to the product of the pole strength (m) and the magnetic length (2l).

$M = m \times 2l$

12. **Coulomb's law of magnetic force** : It states:

(i) The force of attraction or repulsion between two magnetic poles is directly proportional to the product of their pole strengths.

(ii) The force of attraction or repulsion between two magnetic poles is inversely proportional to the square of the distance between them. This law is also known as inverse square law.

$F = \mu\theta/4\pi\ (m_{12}m_2)\ /r^2$

where m_1 and m_2, are the pole strengths of the two magnetic poles, r is the distance between them, and $\mu\theta$ is the permeability of free space.

13. Unit magnetic pole : A unit magnetic pole may be defined as the pole which when placed in vacuum at a distance of one metre from an identical pole, repels it with a force of 10^{-7} newton.

14. Torque on a magnet in a magnetic field : A magnet of dipole moment M suspended freely in a

$\rightarrow$

magnetic field *H* experiences a torque τ given by

$\vec{\tau} = \vec{M} \times \vec{B}$

15. Oscillations of a magnet in a magnetic field : A freely suspended magnet of magnetic moment *M* and of moment of inertia / oscillates simple harmonically in a magnetic field *B* with frequency

$v = \frac{1}{2}\pi\sqrt{(MB/I)}$

16. Magnetic line of force : It may be defined as the curve the tangent to which at any point gives the direction of the magnetic field at that point. It may also be defined as the path along which a unit north pole would tend to move if free to do so.

17. No two lines of force can cross each other : If they do so that would mean that there are two directions of the magnetic field at the point of intersection, which is impossible.

18. Compass needle : It is a small and light magnetic needle pivoted at the centre of a small circular brass case provided with a glass top. It is used to trace the lines of force of any magnetic field.

19. Circular current as Magnet: A small plane loop of current behaves as a magnet with a definite dipole moment given by

$\rightarrow$ ^

^

M= I An (where *A* is the area *oi'* the loop, I the current in the loop and n is a unit vector perpendicular to the plane of the

loop, and its direction is decided by the sense of flow of current I using the Fleming's right hand rule.

20. Potential energy of a magnetic dipole in magnetic field :

Potential energy of a magnetic dipole (magnetic dipole moment M) in a magnetic field $\vec{B}$ is given by

$$U = -MB\cos\theta = \vec{M}.\vec{B}$$ where θ is the angle between $\vec{M}$ and $\vec{B}$

21. Magnetic flux : The magnetic flux through a given area may be defined as the total number of magnetic lines of force passing through this area. It is equal to the product of the normal components of the magnetic field B and the area *over* which it is uniform. In general

Magnetic flux, $\phi = \int \vec{B}.\vec{dA} = \int_A BdA \cos\theta$. Where θ is the angle between normal to the area dA with magnetic field B.

22. S.I. unit of magnetic flux is weber (Wb) : If a magnetic field of 1 tesla passes normally through a surface of area 1 square metre, then the magnetic flux linked with this surface is said to be 1 weber.

23. Relation between the units of quantities associated with magnetic field :

$1A = 1JT^{-1} m^{-2} = IJ\ Wb^{-1}$ $IT = 1JA^{-1} m^{-2} = Wb\ m^{-2}$ $IWb = 1JA^{-1} = ITm^2$

$[B] = NA^{-1} m^{-1} = T = Wb\ m^{-2}$ $[M] = A\ m^2 = JT^{-1} = J\ m^2\ Wb^{-1}$

$[\mu_\theta] = NA^{-2} = T^2\ m^2\ N^{-1} = Wb^2\ J^{-1}\ m^{-1}$

24.s Gauss' theorem in magnetism : This theorem states that the surface integral of a magnetic field over a closed surface is always zero or the magnetic flux through any closed surface is always zero.

$$\int_s \vec{B}.\vec{ds} = 0$$

25. Geographic meridian: The geographic meridian at a place is the vertical plane passing through the geographic axis at that place.

26. Magnetic meridian : The magnetic meridian at **a** place is the vertical plane passing through the magnetic axis of a freely suspended small magnet. The earth's magnetic field acts in the direction of magnetic meridian.

27. **Elements of earth's magnetic field** : The earth's magnetic field at a place can be completely described by three independent parameters called elements of earth's magnetic field. These are declination, dip and horizontal component of earth's magnetic field.

28. **Magnetic declination (α):** The angle between the geographical meridian and the magnetic meridian at a place is called the magnetic declination at that place.

$\rightarrow$

29. **Angle of dip (δ)** : The angle made by the earth's total magnetic field B with the horizontal is called angle of dip at any place.

30. **Horizontal component of earth's magnetic field. It** is the component of the earth's total magnetic

$\rightarrow$

field B in the horizontal direction and is given by $B_H = B \cos \delta$

31. Tangent galvanometer : It is a moving type galvanometer in which the coil through which the current flows is fixed while the magnet moves. Its working is based on the tangent law which states that; when a magnet is suspended under the combined action of two uniform fields of intensities F and H acting at 90° to each other the magnet comes to rest making an angle θ with direction of H, such that $F = H \tan\theta$. $I = (2R.B_H) / (\mu_\theta N)\}\tan\theta = K\tan\theta$ where $K = (2R.B_H) / (\mu_\theta N)\}$is called the reduction factor of the tangent Galvanometer.

32. Magnetic field of a bar magnet at an axial point : For a short magnet $B = (\mu_\theta/4\pi)\ (2M/r^3)$, M = Magnetic moment

33. Magnetic field of a bar magnet at an equatorial point : For a short magnet

$B = (\mu_\theta/4\pi)\ (M/r^3)$, M = Magnetic moment

34. Neutral point : Neutral point is the point where the magnetic field due to a magnet is equal and opposite to the horizontal component of the earth's magnetic field. The resultant magnetic field at the neutral point is zero.

35. Magnetising Field : It is defined as the magnetic field produced by a current of ampere turns per metre flowing in a solenoid. It is denoted by *H* and is given by H = ni ampere-turn/metre

when *n* is number of turns per metre length of solenoid. This is used to magnetise a specimen and does not depend upon

the medium of material. The relation between magnetic induction B and magnetising

field $\vec{H}$ is $\vec{B}=\mu \vec{H}$, μ being permeability of medium.

36. Intensity of magnetisation I : When a material is placed in a magnetising field, it acquires magnetic moment *M.* The intensity of magnetisation is defined as the magnetic moment per unit volume i.e., I = M/V, *V* being volume of material. If the material is in the form of a bar of cross-sectional area A, length 2l and pole strength *q.* then *M* = *mx2l ; V* = *A* 2l I= M/V=m.2l/A.2l = m/A

That is the intensity of magnetisation may also be defined as the pole strength per unit cross-sectional area.

37. Magnetic Susceptibility : The magnetic susceptibility is defined as the intensity of magnetisation per unit magnetising field i.e., $X = 1/H$.

38. Magnetic Permeability : The magnetic permeability of a material is the measure *of* degree to which the material can be permeated by a magnetic field and is defined as the ratio *of* magnetic induction *(B)* in the material to the magnetising field.

i.e $\mu = B/H$

39. Relation between magnetic susceptibility and permeability

We have magnetic induction in material ,

$B = \mu H$ Also $B = B_\theta + B_M$

Where B_θ = magnetic induction in vacuum produced by magnetising field

B_m = magnetic induction due to magnetisation of material.

But $B_\theta = \mu_\theta H$ and $B_m = \mu_\theta$

$\therefore \quad B = \mu_\theta H [1+(I/H] = B_\theta [1+x]$

$B/B_\theta = [1+x]$

$B/B_\theta = \mu H/\mu_\theta H = \mu_r$ relative magnetic permeability

$\mu_r = 1+x$ This is required relation.

40. Classification of Materials : According to the behaviour of substances in magnetic field, they are classified into three categories :

(a) **Diamagnetic** Substances. These are substances which when placed in a strong magnetic field acquire a feeble magnetism opposite to the direction of magnetising field.

The examples are copper, gold, antimony, bismuth, alcohol, water, quartz, hydrogen, etc. The characteristics of diamaenetic substances arc

(i) They are feebly repelled by a strong magnet

(ii) Their susceptibility is negative

(iii) Their relative pcrmcahilitv is less than 1.

(iv) Their susceptibility is independent of Magnetising field and temperature (except for Bismuth at low temperature).

(b) Paramagnetic Substances. These are the materials which when placed in a strong magnetic field acquire a feeble magnetism in the same sense as the applied magnetic field. The examples are platinum, aluminium, chromium, manganese, $CuSO_4$. O_2, air, etc.

The characteristics of paramagnetic substances are

(i) They are attracted by a strong magnet

(ii) Their susceptibility is positive but very small

(iii) Their relative permeability is slightly greater than unity.

(iv) Their susceptibility and permeability d*o* not change with the variation of magnetising field.

(v) Their susceptibility is practically independence of temperature.

(c) Ferromagnetic Substances. These are the substances which arc strongly magnetised by relatively weak magnetising field in the same sense as the magnetising field. The examples are Ni; Co, iron and their alloys.

The characteristics of ferromagnetic substances arc:

(i) They are attracted even by a weak magnet.

(ii) The susceptibility is very large and positive.

(iii) The relative permeability is very high (of the order of hundreds and thousands).

(iv) The intensity of magnetisation is proportional to the magnetising field H for smaller values, varies rapidly for moderate values and attains a constant value for larger values of H.

(v) The susceptibility of a ferromagnetic substance is inversely proportional to temperature i.e.,

$X \propto I/T \Rightarrow x = C/T$ = curie constant.

This is called Curie law. Above a temperature called curie temperature, ferromagnetic substance becomes paramagnetic. The curie temperatures for Ni, Fe and Co are 360° C. 740^0C and 1100°C respectively.

41. **Hysteresis** : When **a** bar of ferromagnetic material is magnetised by a varying magnetic field and the intensity of magnetisation I induced is measured for different values of magnetising field *H,* the graph of I versus H is as shown is fig. The graph shows

(i) When magnetising field is increased from O the intensity of magnetisation I increases and becomes maximum (i.e. point a). This maximum value is called the saturation value.

(ii) When *H* is reduced, I reduces but is not zero when *H* = 0. The remainder value ob of magnetisation when *H* = 0 is called the residual magnetism or retentivity.

(iii) When magnetic field *H* is reversed, the magnetisation decreases and for a particular value of *H,* it becomes zero i.e., for H = OC, 1 = 0. This value of H is called the coercivity.

(iv) When field *H* is further increased in reverse direction, the intensity of magnetisation attains saturation value in reverse direction (i.e., point d).

(v) When *H* is decreased to zero and changes direction in steps, we get the part d f g a.

Thus, complete cycle of magnetisation and demagnetisation is represented by a b c d f g a. In the complete cycle the intensity of magnetisation I is lagging behind the applied magnetising field. This is called hysteresis and the closed loop a bc d f g a i s called hysteresis cycle.

The energy loss in magnetising and demagnetising a specimen is proportional to the area of hysteresis loop.

42. Properties of soft iron and steel :

For soft iron, the susceptibility, permeability and retentivity are greater while coercivity and hysteresis loss per cycle are smaller than those of steel.

Permanent magnets are made of steel and cobalt while electromagnets are made of soft iron.

43. **Magnetic Field Strength** : For a bar magnet of magnetic moment *M.*

In general the magnetic field at any point having polar coordinates */r,* 0) relative to centre of magnet or loop

$(\mu_\theta/4\pi) (M/r^3) \sqrt{(1+3\cos^2\theta)}$ and direction is given by

$\tan \theta = 1/2$ or $\theta=\tan^{-1}(1/2)$

44. **Deflection Magnetometer :**

(a) tan A Position : In this position the magneto- meter is set perpendicular to magnetic meridian so that, magnetic field

due to magnet is in axial position and perpendicular to earth's field and hence

$(\mu_\theta/4\pi) \{2Md/(d^2 - l^2)^2\} = H \tan \theta$

where *d* = distance of needle from centre *of* magnet and 2l = length of magnet.

(b) tan B Position : The arms of magnetometer are set in magnetic meridian, so that the field is at equatorial position and hence

$H\tan \theta = (\mu_\theta/\pi) \{M/(d^2 + l^2)^{3/2}\}$

45. **Tangent Galvanometer** :-

$I=(2RB_H/N\mu_\theta) \tan \theta$ or $1 = K \tan \theta$ (Tangent law)

where, $K =(2RB_H/N\mu_\theta)$ = Reduction factor; and is constant at a given place, N = number of turns, R = radius of the coil, I =

current flowing through the coil, B_H = horizontal component of earth's magnetic field, θ = deflection produced.

46. Vibration Magnetometer:

Time period of a magnetic needle in magnetic field: Let a small magnetic needle of magnetic moment *M* be in earth's field. When it is given a displacement such that it makes an angle θ with the magnetic field *H,* then restoring couple = -MH sin θ acts on the needle.

If I is moment of inertia of needle then

$T = 2\pi \sqrt{(I/MH)}$

47. Every atom acts as a dipole of magnetic moment

$M=n(\mu_B)$ where $\mu_B = eh/4\pi m$, when μ_B is called Bohr magneton and is equal to 0.92×10^{-23} amp-m^2 and *n* is an integer =1,2, 3,.....

48. Magnetic field of earth extends nearly upto five times the radius of earth i.e., 3.2×10^4 km. The magnetic field of earth is fairly uniform and can be represented by equidistant parallel lines.

49. For shielding a certain region of space from magnetic field, we surround the region by soft iron rings. Magnetic field lines will be drawn into the rings and the space enclosed will be free of magnetic field.

50. Most of the magnetic moment is produced due to electron spin, the contribution of the orbital revolution is very small.

,51. By alloying soft-iron with 4% silicon 'transformer steel' is produced. It has a higher relative permeability and is an ideal

material for cores of transformers. Alloys of iron and nickel called 'permalloys', have also very large permeabilities.

Electro-Magnetic Induction

Brief Review :

1.Electromagnetic Induction: It is the phenomenon of generating an e.m.f. by changing the number of magnetic lines of force associated with a circuit or in other words by changing the magnetic flux linked with a coil. The e.m.f. so generated is called induced e.m.f. and the corresponding current is called induced current.

2. Magnetic flux: The number of magnetic lines of force crossing a surface is called magnetic flux linked with the surface. It is represented by]

$$\phi = \vec{B}.\vec{A} = BA\cos\theta$$

where B is strength *oi'* magnetic field, A is area of the surface and θ is (he angle which normal to the area (unit area vector) makes with the direction of magnetic field.

The S.I. unit of magnetic flux is weber which is the amount of magnetic flux over an area of 1 m^2 held normal to a uniform magnetic field of one tesla. The c.g.s. unit of ϕ is maxwell. 1 weber = 10^8 maxwell.

3. Laws of EMI : Two due to Faraday and one due to Lenz.

4. (a) Faraday's 1st law: Whenever there is a change in the magnetic flux linked with a circuit, an e.m.f. is induced, which lasts so long as there is a change in magnetic flux.

(b) Faraday's 2nd law: The magnitude of e.m.f. induced in a circuit is directly proportional to the rate of change of magnetic flux linked with the circuit, i.e.,

$|\varepsilon| = (\phi_2 - \phi_1) / t$ or $|\varepsilon| = d\phi/dt$

4.Lenz's law : The direction of induced e.m.f. is given by Lenz's law. According to this law, the direction of induced e.m.f. in a circuit is such that it opposes the very cause which produces it.

Thus, $\varepsilon = - d\phi/dt$

Lenz's law is in accordance with the principle of conservation of energy. Infact, work done in moving the magnet w.r.t. the coil changes into electric energy producing induced current. There is also another law for finding the direction of induced current. This is Fleming's right hand rule. According to this rule, if we shvich the first finger, the central finger and thumb of our right hand in mutually perpendicular directions, such that first finger points along the magnetic field and thumb

points along the direction of motion of the conductor, then central finger would give us the direction *o(* induced current.

5. External mechanical work done is converted into electrical energy.

6. Total flow of charge due to change of flux $\Delta\phi$:

$Q = \Delta\phi/R$

7.Methods of inducing e.m.f. : As is known, e.m.f. is induced in a circuit only when amount of magnetic flux linked with the circuit changes. As ϕ = B*A* cosθ, therefore three methods *n*l′ producing induced e.m.f. are (i), by changing B, (ii) by changing A and, (iii) by changing θ (orientation of the coil). When a conductor of length l moves with a velocity r in a magnetic field of strength B so that the magnetic flux linked

with the circuit changes, the e.m.f. induced *(ε)* is given by *v. = B l v.*

8. Induced e.m.f. and determinations of its direction :

(a) Conducting rod: The induced e.m.f. generated on account of rotation of a conducting rod in a perpendicular magnetic field

$\varepsilon = -Bl^2\omega/2$ where $\varepsilon = -BAf$ where f = frequency of rotation and $A = \pi l^2$, ω = angular velocity, l = length of conducting rod.

(b) Disc: Induced cm.l. generaicd in a disc rotating with a constant angular velocity in a perpendicular magnetic field

$\varepsilon = -B\pi r^2 f = -Br^2\omega/2$ where $\varepsilon = -BAf$ and A = area of disc $= \pi r^2$, *r* = radius of disc, ω = angular velocity of disc.

(c) Two coils: When two coils are arranged as shown in the figure

(i) When key K is closed then current in P will flow in clockwise direction and consequently induced current in Q will flow in anticlockwise direction.

(ii) When key K is opened then current in P falls from maximum to zero and consequently induced current in Q will flow in clockwise direction.

(d) Three coils arranged coaxially: Three coils P, *Q* and *R* are arranged coaxially. Equal currents are flowing in coils *P* and *R* as shown in the figure. Coils *Q* and *R* are fixed. Coil *P* is moved towards *Q.* The induced current in *Q* will be in anti-clockwise direction so that it may oppose the approach of P

according to Lenz's law. As the face of *P* towards *Q* is a south pole hence plane of *Q* towards *P* will also be a south pole. As there is no relative motion between *Q* and A\ hence *no* current is induced in *Q* due to *R.*

(e) **Current in** straight conductor increase: When current in the straight conductor is increased then (i) The direction of induced current in the loop will be clockwise so that it may oppose the increase of

magnetic flux in the loop in upward direction.

(ii) The direction of induced current in the loop will be anti-clockwise so that it may oppose the increase of magnetic flux in the loop in upward direction.

(f) Magnet dropped freely in long vertical copper tube:

The resistance of copper tube is quite negligible (being a continuous medium) and hence maximum induced currents are generated in it due to the motion of the magnet. Due to these induced currents the motion of magnet is also opposed maximum. Consequently the acceleration of the magnet will be zero *(a =(g-g)*

(g) **Magnet dropped freely into a long solenoid of copper wire:** The resistance of copper solenoid is much higher than that of copper tube, hence the induced current in it, due to motion of magnet, will be much less than that in the tube. Consequently the opposition to the motion of magnet will be less and the magnet will fall with an acceleration (a) less than g. (i.e. *a < g).*

(h) **Fleming's Right hand rule:** The direction of an induced current can always be found by using Lenz's law, but if the current is being induced by the motion of a straight conductor, it is more convenient **to** use Fleming's right-hand (dynamo) rule.

If the First finger, Central finger and the thumb of the right hand are placed comfortably **at** right angles to each other, with the First finger pointing in the direction of the Magnetic Field and the thumb pointing in the direction of the Motion, then the Central finger points in the direction of the induced current (Figure).

Applying the rule to the conductor shown in figure (b) reveals that the induced current is directed into the paper.

(i) Magnitude of induced e.m.f. in conducting rod

$\varepsilon = Blv$

where B is magnetic field strength, 1 is length of conductor; v is velocity of conductor.

9. **Eddy currents:** When a thick conductor is moved in a magnetic field or when a thick conductor is placed in a varying magnetic field, certain loops of currents are formed inside the thick conductor. These loops of currents are called eddy currents. These currents are also called Foucault currents. The magnitude of eddy currents is given by $i = -\varepsilon/R = (d\phi/dt)/R$ where R is resistance ol the conductor. 1 he direction ol eddy currents is given by Lenz's law or Flemming's right hand rule.

Some of the important applications of eddy currents arc: Electromagnetic damping, induction motor, speedometers

and in diathermy i.e., deep heat treatment of parts of human body.

Some of the undesirable effects of eddy currents are that they oppose the relative motion, involve loss of energy in the form of heat and reduce the life of electrical devices. To minimise eddy currents, we use laminated cores.

10. **Uses of eddy currents :** Induction furnace, Magnetic brakes, speedometers, damping in galvanometers, dead beat galvanometer.

11. **Self inductance:** Self induction is the property of an electrical circuit by virtue of which the circuit opposes any change in the strength of the current flowing through it by inducing an e.m.f. in itself.

When a current I flows through a coil, the magnetic fluxϕ linked with the coil is ϕ = LI, where *L* is coefficient of self induction or self inductance of the coil. On differentiating, we get

$$d\phi/dt\ L(dI/dI) = -\varepsilon$$

If dI/ *dt* = 1; *L* = -ε. Hence self inductance of a coil is equal to e.m.f. induced in the coil when rate of change of current through the same coil is unity. Coefficient of self induction of a coil is also defined as equal to the magnetic flux linked with a coil when 1 ampere current flows through the same coil. The value of L depends *on* geometry of the coil and is given by *L* $=\mu_\theta N^2A/l$

where l is length *of* the coil (solenoid) *N* is total number *of* turns of solenoid and *A* is area of cross section of the solenoid.

The S.I. unit of *L* is henry. Coefficient of self induction of a coil is said to be one henry when a current change at the rate of 1 amperc/scc. in the coil induces an e.m.f. of one volt in the coil.

12. Mutual Inductance: Mutual induction is the property of two coils by virtue of which each opposes any change in the strength of current flowing through the other by developing an induced e.m.f.

If ϕ is the amount of magnetic flux linked with one coil when a current I flows through the other coil, then $\phi = MI$, where M is coefficient *of* mutual induction *of* two coils.

As $\varepsilon = d\phi/dt$

$= -d/dt\ (MI) = -M\ dI/dt$

$\therefore$ If $dI/dt = 1$, then $\varepsilon = -M \times 1$ or $M = -\varepsilon$

Hence coefficient of mutual induction of two coils is equal to the e.m.f. induced in one coil, when rate of change of current through the other coil is unity. Coefficient *o(* mutual induction is also defined as equal to the magnetic flux lined with one coil when a current of I ampere flows in the other coil. The S.I. unit of *M* is henry. Coefficient of mutual inductance of two coils is said to be one henry, when a current change at the rate of 1 ampere/sec, in one coil induces an e.m.f. *of* one volt in the other coil. The value of *M* depends on geometry of two coils, distance between two coils, relative placement of two coils etc.

The coefficient of mutual inductance of two long co-axial solenoids, each of length l, area of cross section A, wound on an air core is $M = \mu_\theta N_1 N_2 A / l$, where N_1 N_2 are total number of turns of the two solenoids.

13. For a pair of coils, $M_{12} = M_{21} = \mu_\theta N_1 N_2 A$ *A/L* when wound on one another.

14. For pair of coils having self inductances L_1 & L_2

$M = K\sqrt{(L_1 L_2)}$

K : Coupling co-efficient, $K_{max} = 1$

15. Unit of inductance : henry

16. **Combination of isolated inductances**

(a) Series combination $L = L_1 + L_2 + \ldots$

(b) Parallel combination $1/L = 1/L_1 + 1/L_2$

17. Inductance is pure geometrical factor, independent of current or applied e.m.f.

18. Work done in establishing current I_0 through an inductor :

$W = LI_0^2/2$

Electromagnetic Waves

Brief Review :

1. **Maxwell's modificiition of Ampere's circuital law** :

Displacement current. In 1864, Maxwell showed that Ampere's circuital law is logically inconsistent for non-steady currents. He modified Ampere's laws as

$\int B.dl = \mu_\theta[I+\varepsilon_\theta(d\phi_E/dt)]$

The term $I_d = \varepsilon_\theta(d\phi_E/dt)$

is called displacement current. It is that current which comes into existence, in addition to the conduction current whenever the electric field .mil henee the electric flux changes with time

2.**Maxwell's equations:** Maxwell found that all the basic principles of electromagnetism can be formulated in terms *oi'*

four fundamental equations, called Maxwell's equations.

These are :

(a) Gauss law of electrostatics :

$\vec{\rightarrow}$ $\vec{\rightarrow}$

$\int E.ds = q / \varepsilon_\theta$

(b) Gauss law of magnetism :

$\vec{\rightarrow}$ $\vec{\rightarrow}$

$\int B.ds = 0$

(c) Faraday's law of electromagnetic induction :

$\vec{\rightarrow}$ $\vec{\rightarrow}$ $\vec{\rightarrow}$ $\vec{\rightarrow}$

$\int E.dt = -d\phi_B/dt = -d/dt \quad [\int B.ds = 0]$

(d) Modified Ampere's law :

$\vec{\rightarrow}$ $\vec{\rightarrow}$

$\int B.dt = \mu_\theta[I+\varepsilon_\theta(d\phi_E/dt)]$

3. Electromagnetic waves: In 1865, Maxwell-on the basis of four basic equations of electromagnetism theoretically predicted the existence of electromagnetic wave. An electromagnetic wave is the one constituted by oscillating electric and magnetic fields which oscillate in two mutually perpendicular planes; the wave itself propagates in a direction perpendicular to both the directions of oscillations of electric and magnetic fields.

4. Properties of electromagnetic waves :

(a) The direction of oscillations *of E* and *B* fields are perpendicular to each other as well as to the direction *of* propagation. So electromagnetic waves are transverse in nature.

(b) The electric and magnetic fields oscillate in same phase.

(c) The electromagnetic waves travel through vacuum with the same speed.

$C=1/\sqrt{\mu_\theta \varepsilon_\theta} = 3x10^8\ ms^{-1}$

(d) The energy density ol electric field is $1/2\varepsilon_\theta E^2$ and that of magnetic field is $1B2/2\mu_\theta$, so the energy density of the electromagnetic wave is

$u=1/2[(\varepsilon_\theta E^2)+(B^2/\mu_\theta)]$

where *E* and *B* are the instantaneous values of the electric and magnetic field vectors. *E* 1

(e) The ratio $E/B = c = 1/\sqrt{\mu_\theta \varepsilon_\theta}$

5. Production of electromagnetic waves : An accelerated charge emits electromagnetic waves. An oscillating charge, as in an LC-circuit, has non-zero acceleration, it continues to.emit electromagnetic waves. The frequency of

electromagnetic waves is the same as that of the oscillating charge.

6. In a plane electromagnetic wave, the average energy densities of electric and magnetic fields are equal. In vacuum, the average electric density is given by

$u_E = 1/2\varepsilon_\theta E^2 = (½)\varepsilon_\theta (E_\theta /\sqrt{2})^2 = 1/4(\varepsilon_\theta E^2_\theta)$

The average magnetic density is given by

$U_B = B^2 /2\mu_\theta = (B_\theta /\sqrt{2})^2 /2\mu_\theta = B^2_\theta /4\mu_\theta$

Total average energy density = $u_E + u_B = 2u_E = 2u_B$

$$= 1/2\varepsilon_\theta E^2_\theta = B^2_\theta / 2\mu_\theta$$

7. Hertz's experiment : **In** 1888, Hertz succeeded in experimentally confirming the existence of electromagnetic waves. By using oscillatory LC-circuits, he not only produced and detected electromagnetic waves, but also demonstrated

their properties of reflection, refraction and interference and established beyond doubt that light radiation has wave nature.

8. **Electromagnetic spectrum** : All the known radiations form a big family of electromagnetic waves. We call this family as the complete electromagnetic spectrum. It includes: gamma rays, X-rays, ultraviolet light, visible linht, infrared lieht, microwaves and radio waves.

S..no.	Name	Wavelength Range(m)	frequency Range (hz)	Source
1.	Gamma rays	$6x10^{-14}$ to $1x10^{-11}$	$5x10^{22}$ to $3x10^{19}$	Nuclear origin sudden
2.	X-rays	$1x10^{-11}$ to $1x10^{-8}$	$3x10^{19}$ to 1x1	decelertion of energy
3.	Ultra violet	$6x10^{-10}$ to $4x10^{-7}$	$5x10^{17}$ to $8x10^{14}$	Excitation of atom ,

4. Visible light $4x10^{-7}$ to $8x10^{-7}$ $8x10^{14}$ to $4x10^{14}$

Excitation of valency

electron

5. Infra red $8x10^{-7}$ to $3x10^{-5}$ $4x10^{14}$ to $1x10^{13}$

Excitation of atoms

6. Heat Radia $10^{-5}$to $1x10^{-1}$ $3x10^{13}$ to $3x10^{9}$

7. Micro-waves 10^{-3} to 0.3 $3x10^{11}$ to$1x10^{9}$

8. Ultra high $1x10^{-1}$ to 1 $3x10^{9}$ to $1x10^{8}$

9. very high 1 to 10 $3x10^{8}$ to $3x10^{7}$

10. radio 10 to ^{104} $3x^{1}0^{7}$ to $3x^{104}$ \

9. Uses of electromagnetic spectrum: The following are some of the uses of electromagnetic spectrum

1. Radio and micro wave radiations are used in radio and T.V. communication systems

2. Infrared radiations arc used (a) in revealing the secret writings on the ancient walls (b) in green houses to keep the plants warm (c) In warfare, for looking through haze, *(og* or mist as these radiations can pass through them.

3. Ultraviolet radiations arc used in the detection of invisible writing, forged documents, finger prints in forensic laboratory and to preserve the food stuffs.

4. The study of Infrared, visible and ultraviolet radiations helped us to know through spectra, the structure of the molecules and arrangement of electrons in the external shells.

5. X-rays can pass through flesh and blood but not through bones. This property of X-rays is used in medical diagnosis, after X-rays photographs are made.

6. The study of X-rays has revealed the atomic structure and crystal structure.

7. The study of y-rays provides us valuable information about the structure of the atomic nuclei

8. Electromagnetic waves of suitable frequencies are used in medical science for the treatment of various diseases.

9. Super high frequency electromagnetic waves (3000 to 30,000 MHz) are used in Radar and Satellite communication.

10. Electric waves (frequency 50 to 60 Hz) are used for lighting. These are weak waves having wavelength 5×10^6 to 6×10^6 m and can be produced from A.C. circuits.

10. In electromagnetic wave, the rate of flow of energy crossing a unit area is described by the Poynting

$\rightarrow$

vector S as

$\vec{S} = 1/\mu_\theta (\vec{E} \times \vec{B})$

$S = 1/\mu_\theta |\vec{E} \times \vec{B}| = 1/\mu_\theta (EB) \sin 90^0 = 1/\mu_\theta (EB)$

11. The intensity of a sinusoidal plane electromagnetic wave is defined as average value of Poynting svector taken over one cycle. Thus

$I = S_{av} = 1/\mu_\theta (E_\theta/\sqrt{2}) ({}_\theta/\sqrt{2}) = E_\theta B_\theta/2\mu_\theta = E_\theta/2\mu_\theta c = cB^2{}_\theta//2\mu_\theta$

11. The pressure exerted by electromagnetic waves is called as radiation pressure *(P).* When an

$\vec{}$

electromagnetic wave with Poynting vector S is incident on a perfectly absorbing surface, then radiation pressure on surface is

$\rightarrow$

P=S/C

13. Different layers in the earth's atmosphere : The earth's atmosphere has been divided into four layers: Troposphere, Stratosphere, Mesosphere and Ionosphere. Ionosphere is composed of electrons and positive ions while the remaining three layers are composed of neutral molecules. The lower layer- troposphere - has large concentration of water vapours. The upper region of stratosphere is rich in ozone and is called ozone layer. Ozone layer absorbs harmful ultraviolet

radiations from the sun, and prevents them from reaching the earth's surface and causing damage to life.

14. Greenhouse effect : It is the phenomenon which keeps the earth's surface warm at night. The earth absorbs solar radiation and reflects back only infrared rays due to its low temperature. These-rays are reflected back by the clouds and the gas molecules of the lower atmosphere. This keeps the earth's surface warm at night.

15. Propagation of radio waves through the atmosphere: It takes place in three ways : (a) Ground wave propagation, (b) Sky wave propagation and (c) Space wave propagation.

(a) Ground wave propagation : When the radio wave can travel directly from one point to another following the surface of the earth, it is called ground or surface wave. This type of

transmission is possible only with waves of wavelengths above 200 m or frequencies below 1500 k Hz.

(b) Skywave propagation : When a radiowave is directed towards the sky and is reflected by the ionosphere towards desired location on the earth, it is called sky wave. This method is useful for the transmission of waves of wavelengths less than 200 m or frequencies above 1500 k Hzupto 30 MHz.

(V) Space wave propagation : lor ihc transmission *o/* tclc\ ision signals (frequencies in the range 100—200 M Hz), space wave propagation method is used, in which the wave travels directly from a high transmitting antenna to the receiving antenna. The relation between the height 7/' of the.

transmitting antenna and the distance ‘d’upto which TV signal can be received is

where R is the radius of the earth.

16. Microwaves : The radiowaves having frequencies higher than TV signals are called microwaves. Their wavelength is of the order of few millimetres. Because of smaller wavelengths, microwaves are useful to beam signals in a particular direction. They are used in radars and in telecommunications via the use of geostationary satellites.

Measurement & Units

1. Radian is the unit of triangle

Ans. (D)

2. 1 km = 1000 m = 1000 x1000 mm =10^6 mm.

Ans. (B)

3. 1 A = 10^{-10} m = 10^{-10} x 10^3 mm = 10^{-7} mm.

Ans. (B)

4. Knowledge based questions.

Ans. (A)

5. knowledge based questions.

Ans. (B)

6. A.U = 1 . 496 x 10^{11} m and angstrom unit (A) = 10^{-10} m. Ans. (D)

7. The kW is the unit of power.

Ans. (B)

8. knowledge based questions.

Ans. (B)

9. Correct symbol or abbreviation for centimeters is “cm” ad NOT “cms” Ans. (D)

10. For the given physical quantity NU = constant. Ans. (C)

11. Unit of Planck’s constant is joule second.

Ans. (D)

12. [Energy] = [Force x Distance]

Ans. (C)

13. $[\sqrt{CL}]$ = [frequency] = [velocity gradient]

Ans. (C)

14. K/p is unit less quantity

Ans. (D)

15. $[P] = [F]\,[t] = (kg\ ms^{-2})\,(s) = kg\ ms^{-1}$. it is also the unit of momentum. Ans. (B)

16. (Latent heat) = $Q/M = m^2s^{-2} = (velocity)^2$.

Ans. (C)

17. $[\eta] = Ns/m^2$ = [impulse/area]

Ans. (A)

18. $Nm^2kg^{-2} = (Nm)m\ kg^{-2}\ Jm\ kg^{-2}$.

Ans. (C)

DIMENSIONAL ANALYSIS

1. Here only the potential gradient has non zero dimensions. Others are dimensionless. Ans. (B)

2. [work] = ML^2T^{-2} and stress = $ML^{-1}T^{-2}$.

   Ans. (D)

3. Here kx is dimensionless.

   Ans. (B)

4. Here [r] = [y]. So [r/y] is dimensionless. Same is the case with kx. Ans. (B)

5. Here ($\omega t + \phi_0$) is dimensionless.

   Ans. (D)

6. $[gR] = (M^0LT^{-2})\ (M^0LT^0) = M^0L^2T^{-2}$.

Ans. (B)

7. All are dimensionless quantities.

Ans. (D)

8. here y/A is dimensionless and so are ωt , kx or $\omega t/kx$

however ω/k has the dimensions of x/t.

Ans. (A)

9. [gravitational field strength] = [gravitational force per unit mass]

= [gravitational acceleration] = $M^0L^2T^{-2}$.

Ans. (A)

10. Here $[\tan\theta] = [\ v^2/rg] = M^0LT^{-2}$. also in the actual expression for the angle of banking of a road, there is no numerical factor involved. Therefore, the relation in both numerically and dimensionally correct.

Ans. (A)

11. Here m represents mass per unit length of the string. Ans. (B)

12. $n = F/v = MLT^{-2} / LT^{-1} = MT^{-1}$.

Ans. (D)

13. (Displacement x momentum) = ML^2T^{-1}.

Other have the dimensional formula = ML^2T^{-2}.

Ans. (D)

14. $[CV^2]$ = [energy]

Ans. (B)

15. Here F = tension in the string.

Ans. (B)

16. [K] = work, [Bx] = [K] [$x^2 + A^2$]

or [B] = [K] [$x^2 + A^2$] / x.

Ans. (B)

17. Energy $qV = CV^2 = q^2/c$.

Ans. (C)

18. it can not be used to derive relations involving exponentials or sum of two terms. Ans. (D)

19. Use the method of dimensional analysis with the relation $\nu^2 \propto g^a \lambda^b \rho^c$. Ans. (B)

20. $[KC^{-2}] \backslash (ML^2T^{-2})(M^0L^{-2}T^{+2}) = M$.

Ans. (A)

21. $F = k\nu$. That is $MLT^{-2} = [k](LT^{-1})$

hence $[k] = MT^{-1}$.

Ans. (B)

22. $T = 2\pi [I/PmB]^{1/2}$ = Time period

Ans. (C)

23. A,B, C have the dimensions of velocity. Also ω/k = [velocity] but not ωk. Ans. (D)

24. The dimensional for each of the term in (V-b) is same.

Since V is volume, therefore b also represents volume. Ans. (B)

25. The dimensional formula for each of the term in $[P + (a/V^2)]$ is same. That is $[p] = [a/V^2]$

Ans. (C)

26. $[p + (a/V^2)]$ (V-b) is same. That is $[p] = [a/V^2]$

hence $[a] = [pV^2]$

Ans. (C)

27. From the equation (i) in the hint for Q. 26, we find :

$[ab/V^2] = [RT]$

or $[ab/RT] = [V^2] = [M^0L^6T^0]$

Ans. (D)

28. From equation (i) in the hint or Q. 75, we find :

$[pV] = [RT]$

or $[RT] = [pV] = (ML^{-1}T^{-2})\ (M^0L^3T^0)$

$= ML^2T^{-2} = [\text{Energy}]$.

Ans. (A)

29. [Frequency] = T^{-1}.

[Angular frequency] = T^{-1}.

[Angular velocity] = T^{-1}.

[Velocity gradient] = T^{-1}.

[Potential energy gradient] = $(ML^2T^{-2}) / L$

$= MLT^{-2}$ = [force] Ans. (B)

UNITS, DIMENSIONS AND ERRORS OF MEASUREMENT

QUESTIONS FROM THE COMPETITIVE EXAMS

1. Check which of the dimensions has the

dimensions of volume.

$pR^4t/\eta L = (ML^{-1}T^{-2})$ '$(L)^4$ (T) / $(ML^{-1}T^{-1})$ (L)

$= L^3$.

2. Let $\nu^2 \propto \lambda^\alpha g^\beta$.

here $[\lambda] = L$ and $(g) = LT^{-2}$.

Hence $[\nu^2] = L^2T^{-2}. = L^{\alpha + \beta} T^{-2\beta}$.

Comparing the powers of L and T ,

we find $\alpha = \beta = 1$.

3. Refer to memory tips.

4. $[F] = MLT^{-2} = (10g)\ (10cm)\ (0.1)^{-2}$ s.

$= (10^{-2}\ kg)\ (10^{-1}\ s)^{-2}. = 10^{-1}$ N.

5. $p = (F/A) = F/L^2$. hence $\Delta p/\rho = \Delta F/F + 2\Delta L/L$.

6. Solar constant is energy received per unit area

per second i.e. $ML^2T^{-2} / L^2T = M^1T^{-3}$.

7. As $E = h\nu$. therefore, Planck's constant.

$[h] = [E] / [\nu] = ML^2T^{-2}/T^{-1} = ML^2T^{-1}/T^{-1}$.

And angular momentum (L) = mvr.

$L = [MLT^{-1}]\ [L] = ML^2T^{-1}$.

8. Given eqn. is

$[P + (a/V^2)] (V-b) = RT.$

According to principle of homogeneity of dimensions, dimensions of P = dimensions of a/v^2.

$[P] [V^2] = a.$

or $[a] = [F/a] [(x^3)^2]$

Substituting the dimensions of the respective physical quantities, we get

$[a] = [MLT^{-2}/L^2 . L^6] = [ML^5T^{-2}]$

Similarly,

$[b] = [V] = L^3.$

9. As we know that, $\mu = B/H$

As $B = F/q_0v = [MLT^{-2}] / [AT] [LT^{-1}]$

$= [ML^0T^{-2}A^{-1}]$

and $H = nI = [L^{-1}A]$

or $H = I/t$

$\mu = B/H = [MLT^{-2}A^{-2}]$

10. Knowledge based questions

11. Dimensional formula for work is given by :

$W = [ML^2T^{-2}]$

If length, mass and time each be doubled, then we have .

$W' = [(2M) (2L)^2(2T)^{-2}]$

On solving we get

$W' = 2[ML^2T^{-2}]$

$W' = 2W.$

12. From ideal gas equation for 1 mole , we have :

$PV = RT$

$R = PV/T$

Now, dimensional formula for pressure P is

$P = F/A = [MLT^{-2}] / [L^2] = [ML^{-1}T^{-2}]$

Dimensional formula for volume V is

$V = [L^3]$

Dimensional formula for temperature T is

$T = [\theta]$

Substituting all the formulae in equation (1), we get

$R = [ML^2T^{-2}\theta^{-1}]$

13. Surface tension is given by

$T = \text{Force/Length} = F/l$

Substituting the dimensions of F and l , we get

$[T] = MLT^{-2} / L = MT^{-2}.$ (1)

Now, dimensions of tension T is same as that of force

That is $[T] = [F] = MLT^{-2}.$ (2)

It is clear from the relation (1) and (2) that dimensional formulae for surface tension and relation are not same.

14. Momentum is given by

$$P = m\nu$$

Substituting $m = [M]$, ν = displacement/ time

$= [LT^{-1}]$, we get

$$p = [MLT^{-1}]$$

Further, impulse is given by :

J = Force x time = F x t

Substituting $F = [MLT^{-2}]$; $t = [T]$ we get :

$$J = [MLT^{-1}]$$

From 1 and 2 it is clear that momentum and impulse have the same dimensions.

15. knowledge based questions

16. Energy is given by

$$E = h\nu \qquad \Rightarrow \quad h = E/\nu$$

Substituting the dimensions we get ;

$$H = ML^2T^{-2} / T^{-1} = [ML^2T^{-1}]$$

Similarly , angular momentum is given by

$$L = I\omega = ML^2T^{-1} = [ML^2T^{-1}]$$

Hence Planck's constant h has same dimensions as that of angular momentum.

NUMERICALS BANK

17. β Pascal = $\beta[N/m^2]= \beta [10^5 \text{ dyn} / (100 \text{ cm})^2] =$ 10β dyn/cm^2.

18. Here unit of a is ms^{-2} and that of b is ms^{-1}.

19. In cos [(t/p) – qx] , the expression [(t/p)-qx] is dimensionless. Which is the case of a is ms^{-3} and c is ms^{-1}.

20. Here [Q] = MT^{-1}, which is not the case in any of the given cases.

21. Let F = $h^x G^y C^z$.. substituting the dimensional analysis b comes out to be 2.

22. The coefficient of friction is dimensionless quantity. If ν = velocity, a = acceleration, l =length, then ν^2/al is dimensionless.

23. Here [p] = [RT/ (V-b)] = [RT/V]

    Also aV/RT is dimensionless, therefore

$[a] = [RT/V] = [p]$

24. $T^2 = \rho^a r^b \sigma^c = (ML^{-3})^a (L)^b (ML^{-2})^c$.

$= M^{a+c} L^{-3a+b} T^{-2c} =$

that is $a + c = 0$, $-3a+b = 0$ and $-2c = 2$

this gives $a = 1$, $b = 3$ and $c = -1$.

25. Here $[N] = M^0 L^{-2} \times T^{-1}$;

$[N_1] = [N_2] = M^0 L^{-3} T^0$. and $[Z_1] = [Z_2] =$

$M^0 L T^0$.

Hence $[D] = [N/N_1] \times [Z_1]$

$= (M^0 L^{-2} T^{-1} / M^0 L^{-3} T^0) \times M^0 L T^0 \; M^0 L^2 T^{-1}$.

ERRORS OF MEASUREMENT

1. 1 pitch = least count x [no. of divisions on the head or circular state]

   = 0.005 mm x 200 = 1.0 mm

2. Zeros to the left of non zero digit are not significant and those to right of non zero digit are significant.

3. Smaller the least count higher is the accuracy of measurement.

4. Factual statement.

5. Random errors or expected to be symmetrically distributed about the true value.

6. Random errors are expected to be symmetrically distributed about the true value. Larger number of observation will yield mean, very near to the true value.

7. Most probable error is equal to the least count.

8. See the rules for significant digits.

9. Volume = $\pi D2l/4 \Rightarrow dV/V = 2\ dD/D + dl/l$

   or $dV/V = (2 \times 0.01) / 4 + (0.1/5) = 0.005 + 0.02$

   or $dV/V = 0.02$ (rounding off)

10. $\Delta V/V = 3 \times (\Delta r/r)$. here $\Delta r/r = 1\% = 1/100$.

    Hence $\Delta V/V = 3/100 = 3\%$.

11. Error in time period is $\Delta T = (0.1/20)s = 0.005$ s

Also $T = (20s /20) = 1s$.

12. Here $r = d/2 = 1.95$ cm/2

$= 0.975$ cm $= 0.98$ cm.

13. Mass of substance $= 11.20$ g – 10.00 g $= 1.20$ g

Loss of mass $= 11.20 - 10.95$ g $= 0.25$ g

%age loss of mass $= (0.25 / 1.20) \times 100\% =$

$0.2083 \times 100 = 0.21 \times 100 = 21\%$

14. Since $KE = ½ MV^2$. Therefore

$\Delta(KE)/KE = \Delta M/M + 2\ \Delta V/V = 1 + 2 \times 2 = 5\%$

15. here $\Delta t/t = 1/10^{11}$.

$\Delta t = (1/0^{11}) \times t = (1/10^{11}) \times 10^{11} = 1$.

Or $\Delta t = 1$ s.

Hence maximum difference in time between two such clocks = 2s.

On may be 1s faster and the other is a slower.

UNIFORM MOTION SOLUTIONS

1. Here $x = (1/2)at^2$. It is of the form $y = mx^2$. Therefore, the graph is a symmetric parabola. Ans. (B)

2. Here $x = ut + (1/2)at^2$. It is of the form $y = ax + bx^2$. So the graph is a symmetric parabola Ans. (C)

3. Since motion is on a curved path, magnitude of displacement is less then the distance covered . Ans.(D)

)

4. Since speed is uniform, acceleration can be centripetal. Or radial when the particle is moving

along a circular path

Ans. (A)

5. $v = a_1t_1 = a_2t_2$ hence $t_1/t_2 = a_2/a_1$.

Ans. (B)

6. Retardation is directed opposite to the direction of Ans. (D)

7. The velocity time graph of motion with uniform acceleration is inclined to both the time and velocity axis and passes through the origin.

Ans. (D)

8. Slope of time graph gives the acceleration or retardation. For retarded motion, the angle made

by the graph with time axis is more than $\pi/2$. Hence slope is negative. Ans. (B)

9. Particle may return to the starting point, giving zero displacement.

   Ans. (A)

10. For motion with uniform velocity, the magnitude of displacement = distance covered.

    Ans. (C)

11. The Particle is moving on the straight line path and there can be no reversal in the direction of motion. Here distance covered = magnitude of displacement Ans. (B)

12. Displacement can be zero either when the particle is at rest or when it returns to the starting point.

Ans. (D)

13. Uniform velocity implies no change in the magnitude and direction. Hence acceleration is zero.

Ans. (B)

14. Since the car returns to the starting points, its average velocity is zero Ans. (D)

15. Since the particle covers a distance of 20m in 2 seconds & its initially velocity is 10 ms^{-1}, so that

particle moves with the constant velocity.

Ans. (A)

16. Since the particle comes to rest so it must be retarded Ans. (B)

17. The area under a-t graph gives change in velocity. Ans. (C)

18. This equation cannot be used to find the relation between ν and t

Ans. (D)

19. Velocity = dx/dt = 18 + 18t. It depends upon time. For t = 2s, the velocity = 18+18 x 2 ms^{-1} =

$54\ ms^{-1}$.

Ans. (C)

20. $x = t^2 + 2t + 1$.

Hence $\nu = dx/dt = 2t + 2$. It increases with time.

Ans. (C)

21. $a = a\nu/dt = bt + c$.

$\nu = \int (bt + c)\, dt = bt^2/2 + ct$.

Ans. (B)

22. Velocity = $dx/dt = 7+20t$.

At t=0, initial velocity is $7\ ms^{-1}$.

Ans. (B)

23. Use $x_n = \nu 0 + (a/2)(2n-1)$

Ans. (B)

24. $dx/dt = (-5+16t)\ ms^{-1}$.

At t=0, $dx/dt = -5\ ms^{-1}$.

Ans. (A)

25. x (nth) = u + 1/2a (2n-1) = 10 + ½ x (-2)

(2 x 5-1) = (10-9)m = 1m.

Ans. (A)

26. Suppose they cross each other after time t. Then

$(1/2) \times 10 \times t^2 + [\ 50t - (1/2) + 10\ xt^2] = 100$. This

gives t = 2s.

Ans. (B)

27. Here $h_1 = (1/2)gt_1^2$ and $h_2 = (1/2)gt^2$

Ans.(C)

28. Distance covered in 2 seconds = $(1/2) \times 10 \times (2)^2$ = 20m. Total distance covered in 4 seconds = 40m.

Ans. (D)

29. Here $dx/dt = (k/b)e^{-bt}$ and $d^2x/dt^2 = -ke^{-bt}$.

Ans. (B)

30. $x_1 = ½ at^2$, $x_2 + x_1 = ½ a (2t)^2$.

Ans. (B)

RELATIVE VELOCITY

(SOLUTIONS)

1. The Relative velocity will be inclined with vertical and will appear to be coming from east.

2. The relative velocity f the train w.r.t. the passengers is zero.

3. when the particles move in opposite directions relative velocity is $\nu_1+\nu_2$.

4. $\nu_{12} = \nu_1 - \nu_2 = \nu - \nu = 0$.

5. Relative velocity of overtaking -40 m/s^{-1} – 30 ms^{-1} = 10 ms^{-1} . total distance covered with this relative velocity during overtaking will be =

100m + 200m = 300 m. Time taken t = 300 m /10 ms^{-1}. = 30s.

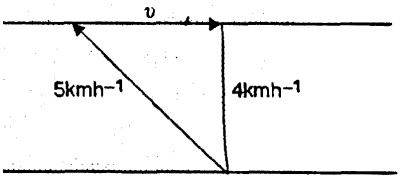
6. Let l be the length the train . Then $v^2-u^2 = 2al$. if the middle point crosses the velocity V, then $V^2 - u^2 = ½ [v^2-u^2]$

$V = [(v^2+u^2) /2]^{1/2}$.

7. Let the velocity of the river be ν. Then resultant velocity of the boat = $[5^2 - ν^2]^{½}$

Here 1 km/0.25h = 4 km h^{-1}. = $[25 - ν^2]^{1/2}$.

Therefore ν = 3 km h^{-1}.



UNIFORM & ACCELERATION MOTION (SOLUTIONS)

1.. here $x = (12/)at^2$.it is of the form $y = mx^2$., therefore the graph is symmetrical parabola.

2.. Here $x = ut + (1/2)at^2$. it is of the form $y = ax+bx^2$. so the graph is asymmetrical parabola.

3. Since motion is on a curved path , magnitude of displacement is less than the distance covered.

4. Since speed is uniform , acceleration can be centripetal or radial when the particle is moving along a circular path .

5. $\nu = a_1t_1 = a_2 t_2$. Hence $t_1 /t_2 = a_2 / a_1$.

6. retardation is directed opposite to the direction of.

7. The velocity time graph of motion with uniform acceleration is inclined to both the time and velocity axis and passes through he origin.
8. Slope of velocity time graph gives the acceleration retardation . for retarded motion , the angle made by graph with time axis is more than $\pi/2$.. hence slope is negative.
9. particle may return to the starting point giving zero displacement.
10. for motion with uniform velocity , the magnitude of displacement =distance covered.
11. The particle is moving on the straight line path and there can be no reversal in the direction of motion.

Hence distance covered = magnitude of the displacement.

12. Displacement can be zero either when the particle is at rest or when it return to the starting point.
13. Uniform velocity implies no change in the magnitude and direction . hence acceleration is zero.
14. Since the car return to the starting point , its average velocity is zero.
15. Since a particle covers a distance of 20 m in 2 seconds. And its initial velocity is $10ms^{-1}$. so the aprticle moves with constant velocity.
16. Since the particle comes to rest so it must be retarded.
17. The area under the a-t graph gives change in velocity.

18. This equation can not be used to find the relation between ν & t.

Numerical bank

1. Velocity dx/dt = 18+18t. it depends upon time. For t = 2s, the velocity = $18+18x2ms^{-1} = 54\ ms^{-1}$.

[P.94-Q.36]

2. $x = t^2 + 2t + 1$. **[P.94-Q.40]**

   Hence $\nu = dx/dt = 2t + 2$. it increase with time.

3. $a = av/dt = bt + c$. **[P. 94 –Q. 41]**

   $v = \int (bt + c)\, dt = (bt^2/2) + ct$

4. Velocity $= dx/dt = 7 + 20\ t$ **[P. 94 –Q.42]**

   at t = 0 , initial velocity is $7ms^{-1}$.

5. Use $x_n = \nu_0 + (a/2)\ (2n-1)$ **[P. 95 –Q. 45]**

6. $dx/dt = (-5 + 16t)ms^{-1}$. **[P. 95 –Q.47]**

At, t =0 $dx/dt = -5ms^{-1}$

7. x(nth) = u + (1/2)a (2n-1) = 10+(1/2) x(-2)

[P. 95 –Q. 48]

(2 x 5 - 1) = (10 – 9)m = 1m.

8. Suppose they cross each other after time t. then

[P. 95 –Q. 52]

$(1/2) \times 10 \times t^2 + [50t - (1/2) \times 10 \times t^2] = 100$. this gives

t = 2s

9. here $h_1 = (1/2)\, gt^2_1$ and $h_2 = (1/2)\, gt^2_2$ and

[P. 95 –Q. 53]

10. distance covered in 2 seconds $=(1/2) \times 10\, (2)^2 = 20m$.

total distance covered in 4 seconds =40m.

[P. 95 –Q. 55]

11. here $dx/dt = (k/b)\, e^{-bt}$.. and $d^2x/dt^2 = -ke^{-bt}$.

[P. 95 –Q. 56]

12. $x_1 = (1/2)\, at^2$., $x_2 + x_1 = ½\, a\, (2t)^2$. **[P. 96 –Q. 57]**

13 -15. here $h = (1/2)\, gt^2$, $h_n = (1/2)g\, (2n-1)$, $\nu = gt$.

[P. 96 –Q. 59,60,61]

16. $h = ½\ gT^2$., vertically downwards covered in time (T/2) will be $x = ½\, g \times (T/2)^2 = (1/4)\, (½\ gT^2) = h/4$.

hence height at time T/2 is given by : $h-x = 3h/4$.

[P. 96 –Q. 68]

17. Velocity at time t is $\tan 45^0 = 1$. velocity at time (t =1) is $\tan 60^0 = \sqrt{3}$. acceleration is change in velocity in one second = $\sqrt{3}-1$ **[P. 96 –Q. 69]**

18. $x = v^2/2\ [(a+b)/ab] = (30)^2/\ 2\ [\ (5+3)\ /(5x3)] = 240$ m. **[P. 96 –Q.70]**

19. velocity = $\tan\theta$ **[P. 97 –Q. 73]**

here $V_A/V_B = \tan 30^0/\tan 60^0$.

20. Use $v = u + at$? **[P. 97 –Q. 77]**

here v = 25% of u = u/4.

Hence u/4 = u-at

This gives t = 3u/4a

21. let $y = A \sin\omega t$, the acceleration $= d^2y/dt^2 = -A\omega^2 \sin\omega t$. **P. 97 –Q. 79]**

22. Let X-axis be along east. And Y-axis along north.

[P. 97 –Q. 80]

Then initial velocity $= \hat{i}\ ms^{-1}$. final velocity $= \hat{j}\ 5\ ms^{-1}$; $\Delta\vec{v} = (\hat{j} - \hat{i})5\ ms^{-1}$.. and $\Delta v = 5\sqrt{2}$ Acceleration $(\Delta v/\Delta t) = (5\sqrt{2}/10)\ ms^{-2}. = 1\sqrt{2}\ ms^{-2}$.

23. Double momentum means double velocity . since retardation is same in both cases, therefore $(2v)^2. = 2ay$ and $v^2 = 2ax$. Hence $y = 4x$ **[P. 97 –Q. 82]**

24. here differentiate w.r.t. time , we find ? **[P. 98 –Q. 86]**

$1 = 2px\,(dx/dt) + q(dx/dt) + 0$

that is $(2px+q)\,dx/dt = 1$

hence $\nu = dx/dt = 1/(2px+q)$

and $a = d\nu/dt = -2p\nu^2$.

Therefore $a \propto \nu^2$.

25. $t = ax^2 + bx$. **P. 98 –Q. 90]**

Hence $1 = (2ax)\,dx/dt + b\,dx/dt$

That is $dx/dt = 1/(2ax+b)$

Also acceleration $= d^2x/dt^2$.

Hence $d^2x/dt^2 = -(2adx/dt)/(2ax+b)^2 = -2a\nu^3$.

26. $x^2 = 1+t^2$. therefore $(2x)dx/dt = 2t$ **[P. 98 –Q. 92]**

That is $(x)\ dx/dt = t$

Diff. w.r.t. time again , we find

$(dx/dt)^2 + (x)\ d^2x/dt = 1$

on solving we find d^2x/dt^2.

$1/x\ [\ 1 -(dx/dt)^2] = 1/x - t^2/x^3$.

27. $x_n = a/2\ (2n-1)$ and $x(n) = (a/2)n^2$. **[P. 98 –Q. 94]**

Hence $x_n / x(n) = (2/n) - (1/n^2)$

28. initially horizontal velocity = $dx/dt = 6\ ms^{-1}$.

[P. 98 –Q.97]

Initially vertical velocity =[dy/dt at t= 0] = $8\ ms^{-1}$.

Resultant initially velocity = $[\ (6)^2+(8)^2]^{½} = 10\ ms^{-1}$.

29. $u_x = dx/dt = d/dt(\sqrt{21}t) = \sqrt{21}$ **[P. 98 –Q. 98]**

$u_y = dy/dt = d/dt\ (2t - 4t^2) = 2 - 8t^2$.

At t=0 we have ux $=\sqrt{21}$ and uy = 2.

Hence $u = \sqrt{(u^2_x + u^2_y)} = \sqrt{(21+4)} = 5$

30. at the highest point , the velocity of the shell = V cosθ, since one piece returns to the cannon. So, it has required a velocity -Vcosθ Applying the law of conservation of momentum we find

$MV\cos\theta = -(M/2)\ V\cos\theta + (M/2) \times V_2$. **[P. 98 –Q. 99]**

Therefore $V_2 = 3V\cos\theta$

31. Use $\nu^2 - \nu^2_0 = 2ax$. **[P. 99 – Q.103]**

here $\nu^2 - 0 = 2ax_1$.

Also $0 - \nu^2 = -2\beta x$.

Total distance covered is $x = x_1 + x_2$.

$= (\nu^2/2\alpha) + (\nu^2/2\beta)$

using $\nu = \nu_0 + at$,

we find $\nu = at_1 = \beta t_2$.

Total time taken $t = t_1 + t_2 = (\nu/\alpha) + (\nu/\beta)$

Average speed $(x/t) = [(\nu^2/2\alpha) + (\nu^2/2\beta)] /$

$[(\nu/\alpha) + (\nu/\beta) = \nu/2$

32. use $\nu = \nu_0 + at$.. in the first part of motion $\nu_0 = 0$.

P. 99 –Q.104]

hence $\nu = 10 \times 30\ ms^{-1}. = 300\ ms^{-1}$.

In the second part of motion $\nu_0 = \nu = 300\ ms^{-1}$.

Hence $t = \nu/a = 300/10 = 30s$. total time =30s+30s = 60s.

33. $\sqrt{x} = 2t+5$. hence $x = 4t^2+20t+25$. **[P. 99 –Q.105]**

Which gives $d^2x/dt^2 = 8$. it is +ve so, the motion is accelerated.

34. Using $x = \nu_0 t + (12/)\ at^2$., we find

[P.99 –Q.112

$x = ½\ a\ (10)^2 = 50\ a$. because $\nu_0 = 0$

and $x+y = ½\ a\ (20)^2 = 200a$.

hence $y = 200a – x = 200a - 50a = 150a$this gives y =3x.

35. each ball rises for one second also the velocity is reduced to zero in one second. Using $\nu = \nu_0 + at$, we find initially velocity is $\nu_0 = 10\ ms^{-1}$.so the height is h $= 10 \times 1 - (1/2) \times 10 \times (1)^2 = 5m$. **[P.100 –Q.115]**

36. Using $\nu^2 - \nu^2_0 = 2ax$ **[P.100 – Q.118]**

hence $x_1 = \nu^2/2a$ and $x_2 = \nu^2/2\beta$.

Which gives

$x = x_1 + x_2. = \nu^2/2a + \nu^2/2\beta$

or $\nu = [\{2\alpha\beta / (\alpha+\beta)\}x]^{1/2}$.

37. $x_1 = ½\ \alpha t_1^2$, $x_2 = ½\ \beta t_2^2$, **[P.100 – Q.119]**

Also $\nu = at_1 = \beta t_2$, .

Hence $x_1/x_2 = \alpha t_1^2 / \beta t_2^2$ & $t_1/t_2 = \beta/\alpha$

38. $x_n = \nu_0 + (a/2)(2n-1)$

[P.100 –Q.120]

here $h/2 = 0 + (10/2)(2n-1) = 10n-5$

also $h = ½ gt^2. = ½ gn^2. = 5n^2.$

Hence $5n^2 = 20n-10$ or $n^2-4n+2 = 0.$

Which gives $n = 2 \pm \sqrt{2}$

Here n can not be equal to $2-\sqrt{2}$ as it less than one and n is more than one as h/2 distance is traveled in last second. Hence h is traveled in more than on second.

39. Distance traveled = area under the curve AB = 25cm.

[P.101 –Q.125]

40. $x \propto \tan\theta$. **[P.101 – Q.127]**

41. Distance cannot decrease with time

[P.102 –Q.133]

42. a particle can not have two speed at the same instant

[P.102 –Q.134

43. the graph depicts two velocities of the particle at the same instant which is not possible. **[P.131 –Q.135]**

44. graph depicts two displacement for the particle at the certain instants. **[P.102 –Q.136]**

45. all other graph depicts two velocities of the particle at certain instants. **[P.103 –Q.138]**

46. Speed can not be negative.

[P.103 –Q.139]

47. same distance = 30 is covered in the first second and the next two seconds. **[P.103 –Q.142]**

SCALARS & VECOTRS.

1. A vector can be split into any number of component . however, it can be split into ONLY three RECTANGULAR components in space and only two RECTANGULAR components in its own plane.

Ans. (D)

2. Two vectors of equal magnitude and directed in opposite directions give zero resultant. Ans. (A)

3. Three vectors of unequal magnitude , which can be represented by the three sides of a

triangle taken in order, produce zero resultant.

Ans. (B)

4. Any one of them is possible.

Ans. (D)

$\rightarrow \rightarrow \quad \rightarrow \rightarrow$

$\rightarrow \quad \rightarrow$

5. $| P + Q | = P - Q$. This happens when angle between P and Q is 180^0.

Ans. (D)

6. here $\Delta v = |-iv - jv| = \sqrt{2}v$

Ans. (D)

$\rightarrow \rightarrow \quad \rightarrow \rightarrow \quad \rightarrow$

7. $(P + Q) + (P - Q) = 2P$.

Ans. (A)

8. Forces constitute a closed polygon of vectors.

Ans. (D)

9. These vectors form a closed polygon. Hence, their resultant is zero. Ans. (D)

10. Resultant of forces will be zero when they can be represented by the sides of a triangle taken in order. Sum of two smaller sides of the triangle is more than the third side. This is true only incase of (D)

Ans. (D)

11. Forces are mutually perpendicular, with resultant nearly 36 N. Ans. (B)

$\hat{\ }$ $\rightarrow$ $\rightarrow$

12. $A = A / |A|$

$\rightarrow$

here $|A| = (1^2 + 1^2)^{1/2} = \sqrt{2}$.

Ans. (C)

$\rightarrow$ $\rightarrow$ $\hat{\ }$ $\hat{\ }$ $\hat{\ }$ $\hat{\ }$

13. Projection of A on Y axis is given by A. j. here

$(3i + 4k)j = 0$ Ans. (D)

$\rightarrow$ $\rightarrow$ $\rightarrow$ $\rightarrow$ $\rightarrow$ $\rightarrow$

$\rightarrow$ $\rightarrow$

14. P + Q is in the plane containing both P and Q .

But P x Q is perpendicular to both P and Q.

Ans. (C)

$\vec{\ } \vec{\ }$ $\vec{\ } \vec{\ }$

15. P x Q is directed opposite to Q x P.

Ans. (C)

16. $|P \times Q| = PQ \sin\theta$ and $\sin\theta < 1$. Also $PQ \sin\theta$ can be equal to P/Q when $\sin\theta = 1/Q^2$. Ans. (C)

$\vec{\ }$ $\hat{\ }$ $\vec{\ }$ $\hat{\ }$ $\vec{\ }$

17. $2mV = i\, m\nu + j m\nu$.

Hence $V = \nu/\sqrt{2}$ north east

Ans. (B)

$\vec{\ } \vec{\ }$ $\vec{\ } \vec{\ } \vec{\ }$

$\vec{\ }$

18. Resultant of P + Q has magnitude between P + Q and P – Q. when displacement are 1 m and 4 m the magnitude of their resultant lies between 3m and 5m. Ans. (D)

$\rightarrow \quad \rightarrow \quad \rightarrow \rightarrow \qquad \rightarrow \quad \rightarrow$

19. if P + Q = P- Q. Then Q = -Q. which is possible when Q = 0 (null vector). Ans. (B)

20. $\tan\beta = Q \sin\theta / (P + Q \cos\theta)$. In none of these cases β comes out to be $\theta/2$.. Ans. (D)

$\rightarrow \quad \rightarrow$

21. Since, in this case $P^2 + Q^2 = R^2$. Therefore angle between P and Q is $\pi/2$. Ans. (D)

22. $\Delta v = (j\ 8 - I\ 6)\ ms^{-1}$. here $\Delta v = 10\ ms^{-1}$. and Δt = 10s. therefore $a = \Delta v/\Delta t = 1\ ms^{-2}$. Ans. (B)

23. Since $P^2 + Q^2 = R^2$. Hence angle between $\vec{P}$ and $\vec{Q}$ is 90^0. Ans. (C)

24. For two vectors to be perpendicular , their dot product should be zero. Ans. (B)

25. Since resultant $\vec{R}$ is equally inclined at 45^0 to both $\vec{P}$ and $\vec{Q}$, therefore angle between $\vec{P}$ and $\vec{Q}$ is 90^0.

In

this case P should be equal to Q.

Ans. (C)

26. Here PQ cos θ = PQ sin θ. Which gives cosθ = sinθ. This is true for $\theta = \pi/4$. Ans. (D)

27. here $(100)^2 + (173)^2 = (200)^2$. hence $\beta = 90^0$,

$\sin\theta = 173/200 = \sqrt{3}/2 = \sin 60^0$.

therefore $\theta = 60^0$ and $\alpha = 30^0$.

Ans. (A)

28. $\tan \beta = Q \sin\theta / (P + Q \cos\theta)$, here $\beta = 90^0$.

Hence $P + Q \cos\theta = 0$

Hence $\theta = \cos^{-1}(-P/Q)$

Ans. (B)

29. $\cos\theta = (R^2-P^2-Q^2) / 2PQ = \{(P + Q)^2 - P^2-Q^2\} / 2PQ = 2PQ/2PQ = 1$

hence $\theta = 0$.

Ans. (A)

30. Resultant displacement $[(\nu t)^2 + (\nu t)^2]^{1/2} = \sqrt{2}\ \nu t$.

time taken will be 2t. Average velocity $\sqrt{2}\ \nu t / 2t$

$= \nu/\sqrt{2}$

Ans. (D)

PROJECTILE MOTION SOLUTIONS

1 Ans. (D)

2. Ans. (D)

3. Ans. (C)

4. Ans. (C)

5. Ans. (C)

6. The vertical component of velocity is reduced to zero and kinetic energy corresponding to it is converted into potential energy.

   Ans. (A)

7. $h = (g/8)T^2$.

When T is doubled . j becomes four times.

Ans. (D)

8. Tan 45^0 = νy/νx ; hence νy = νx.

Ans. (C)

9 Tanθ = νy/νx . hence νy =νx.

Ans. (D)

10. height to which the projectile rises is largest when θ =90^0. Ans. (C)

11 Range is maximum when θ = 45^0.

Ans. (D)

12. R is same for θ and π/2 -θ

Ans. (A)

13. Range is same for θ and $\pi/2 - \theta$.

Ans. (B)

14. $y = v_0 t + (1/2) gt^2$.here $v_0 = 0$.

Ans. (D)

15. Horizontal velocity has no effect on the distance of vertical fall. Ans. (A)

16. at the highest point, the velocity is directed horizontally . the acceleration is vertically downwards.

Ans. (C)

17. $T = (2u \sin\theta) /g$. T is maximum when $\sin\theta$ is maximum Ans. (A)

18. on return to the ground the speed is same as on firing. Hence here is no change in kinetic energy.

Ans. (A)

19. $\Delta p = 2p\sin\theta = 2p \sin 30^0 = p$. hence $\Delta p/p = 100\%$.

Ans.(D)

$\rightarrow \rightarrow \quad \rightarrow \rightarrow$

20. $L = r \times p = R \times P$

where R = range = $(u^2 \sin 2\theta)/g$.

$\rightarrow \quad \rightarrow$

the angle between R & p is = θ.

Also p = mu.

Hence $L = [(u^2 \sin 2\theta) / g] \times mu \sin(-\theta) = -(2mu^3 \sin^2\theta \cos\theta] / g$. Ans. (B)

21. if y_m be the maximum height, then

$R = 4y_m \cot\alpha$.. therefore $\Delta R/R = \Delta ym/ym$.

Hence percentage increase in range is also equal to 5%. Ans. (A)

22. $y_m = u^2\sin^2\theta/2g$. hence $\Delta y_m/y_m = 2\Delta u/u$

since $\Delta u/u = 2\%$, therefore $\Delta ym/ym = 4$.

Ans. (C)

23. Range is same for angle of projection θ & $90-\theta$

$R = u^2\sin 2\theta/g$, $h_1 = u^2\sin^2\theta/2g$

$h_2 = u^2\cos^2\theta/2g$

hence $\sqrt{h_1 h_2} = u^2 \sin\theta \cos\theta / 2g$.

$= ¼ [u^2 \sin\theta / g] = R/4$

Ans. (D)

24. $Hm = u^2 \sin^2\theta/2g \quad = u^2 \sin^2\theta / [2 \times \{(11/10)g\}] \cong$

91% of $u^2 \sin^2\theta/2g$ Ans. (C)

25. $t = u\sin\theta /g' = u\sin\theta / (11/10)g \cong$ 91% of

$u\sin\theta/g$.

there will be a decrease of 9%.

Ans. (D)

26. The time to rise to the top .

= 91% of $u\sin\theta / g$. Also maximum height Hm =

91% of $u^2 \sin^2\theta/2g$. And time of fall $\cong$ using θ/g.

Hence time of flight is decreased by 9%.

Ans. (C)

27. $R/T^2 = (u^2 \sin 2\theta \times g^2) / (g \times 4u^2\sin^2\theta) = g/2 \cot\theta$.

Ans. (D)

28 Potential energies at the highest point are equal to the loss in kinetic energies. That is $(1/2\ mu^2)$ and $\frac{1}{2}\ m\ (u\cos 60^0) = \frac{1}{4} \times \frac{1}{2}\ mu^2$.

Ans. (C)

29. The velocity of the first ball at the highest point is zero. Ans. (D)

30. Use $v^2-u^2 = 2ax$. Here $0-u^2 = 2gh$.. and $0-4u^2 = 2gH$.. hence $h/H = \frac{1}{4}$.. that is $4h = H$.

Ans.

(C)

31. $x_n = (g/2)\ (2n-1)$ and $x_1 = g/2\ (2-1) = g/2$.

Ans. (B)

32. Use $v^2-u^2 = 2ax$, here $v = 3v$, $u = v$ and $a = g$.

hence $x = 4v^2/g$.

Ans. (C)

33. here $h = ut - (1/2)\ gT^2$.

that is $\frac{1}{2} gt^2 - ut + h = 0$

this is an quadratic equation in t.

hence $t_1 + t_2 = b/a = u / (\frac{1}{2} g) = u/5$.

That is $u = 5\ (t_1 + t_2)$

Ans. (D)

34. $h = ½\ gt^2$ and $[1 –(9/25)]\ h = ½\ g(t-1)^2$.

Ans. (A)

35. $vx = 2ct$ and $vy = 2\ bt$.. speed after one second

will be

$[(2b)^2+(2c)^2]^{½} = 2(b^2+c^2)^{1/2}$.

Ans. (C)

36. $R_1 = u^2 \sin 2\theta/g. = u^2 \sin 150^0/g.$

$= u^2 \sin 30^0/g. = u^2/2g.$

$= = u^2 \sin 90^0/g. = u^2/g.$

therefore $R_2 = 2R_1$. Ans.

(B)

37. Range is same for angles of projection θ and

(90-θ)

$t_1 = 2u \sin\theta/g$

$t_2 = [2u \sin (90 - \theta)] / g = 2u \cos\theta/g$.

hence $t_1t_2 = 4(u^2 \sin\theta \cos\theta / g^2) = 2/g [u^2 \sin\theta/g]$

$= (2/g)R$., Where R is range .

hence $t_1t_2 \propto R$ because R is constant.

Ans. (B)

38. Horizontal component of velocity remains

unchanged throughout th emotion. At the highest

point the vertical component of velocity is zero.

Ans. (B)

39. Range is maximum for $\theta = 45^0$. In such a case $y_m = R/4$. Ans. (D)

40. Since range is maximum therefore $\theta = 45^0$.hence $v_x = \nu \cos 45^0. = \nu/\sqrt{2}$. At the highest point the net velocity of the projectile is ν_x.

Ans. (B)

41. Initial velocity $= \hat{i}u$

Final velocity $= \hat{i}u + \hat{j}\sqrt{2gh}$

Hence $\Delta v = \sqrt{2gh}$.

Ans. (C)

42. $y_m = u^2 \sin^2 \theta / 2g$.

and y $m_1 y m_2 = \sin^2 60^0 / \sin^2 30^0. = (\sqrt{3}/2)^2 (1/2)^2$

$= 3/1$. Ans. (B)

43. Velocity at the highest point $= v \cos 45^0 = v/\sqrt{2}$

Maximum height $h = v^2 \sin^2 45 /2g = v^2/4g$.

L = angular momentum.

$= [m(v/\sqrt{2}) \times (v^2/4g) = mv^3 / 4\sqrt{2}g$

Since $v^2 = 4gh$.

Therefore $L = m (2gh^3)^{1/2}$. Which is not give.

Ans. (B)

PROJECTILE MOTION SOLUTIONS

1. Ans. (D)

2. Ans. (D)

3. Ans. (C)

4. Ans. (C)

5. Ans. (C)

6. The vertical component of velocity is reduced to zero and the kinetic corresponding to it is converted into potential energy.

   Ans. (A)

7. $h = (g/8)\ T^2$. When T is doubled, h becomes four times.

Ans. (D)

8. Tan 45^0 = ν_y/ν_x. Hence $\nu_y = \nu_x$.

Ans. (C)

9. Tan $\theta = \nu y/\nu x = 10\ ms^{-1} / 20ms^{-1} = 0.5$.

Ans. (D)

10. height to which the projectile rises is the largest when $\theta = 90^0$.

Ans. (C)

11. Range is maximum when $\theta = 45^0$.

Ans. (D)

12. R is same for θ and $(\pi/2)-\theta$

Ans. (A)

13. Range is same for θ and $(\pi/2)-\theta$

Ans. (B)

14. $y = v_0t+1/2\ gt^2$. Here $v_0 = 0$.

Ans. (D)

15. Horizontal velocity has no effect on the distance of the vertical ball. Ans. (A)

16. At the highest point, the velocity is directed horizontally. The acceleration is vertically downwards.

Ans. (C)

17. $T = (2u \sin\theta)/g$. T is maximum, when $\sin\theta$ is maximum. Ans. (A)

LAWS OF MOTION

QUESTIONS FROM THE COMPETITIVE EXAMS

SOLUTIONS.

1. Acceleration down the inclined plane in the two case are $g \sin\theta$ and $g \sin\theta - \mu g \sin\theta$.

2. Mass of the pieces are 1,1,3 kg . hence

   $(1 \times 21)^2 + (1 \times 21)^2 = (3 \times V)^2$. that is $V = 7\sqrt{2}$.

3. Hence $\nu = 72$ km/h. = 20 m/s.

   Retardation $a = \mu Mg/M = \mu g = 5\ m/s^2$.

   Using $\nu^2 - u^2 = 2ax$, we find

$0 - (20 \times 20) = 2 \times 5 \times x$

this gives $x = 40m$

4. Friction $= \mu Mg$ hence retardation $= \mu g.a =$ $0.5 \times 10 = 5\ ms^{-2}$..

Using $v^2 - u^2 = 2ax$, and taking $v = 0$, $u = 20$ ms^{-1}, we find $x = 40m$.

5. Friction on B due to floor

$= 0.5 \times (8 + 2) \times 10 = 50$ N

Applied force = 25 N. So the block B is not moving

NEWTON'S LAW OF MOTION SOLUTIONS

1. Due to inertia, the liquid is collected towards left side. – Ans. (C)

2. F = (M+m)a. – Ans. (C)

3. The net force on the body is zero. Weight of the body balanced by the reaction of the ground. - Ans. (C)

4. The reading of the spring balance will be less because the weight of the bird will now be

excluded. –

Ans. (B)

5. Body is moving with uniform velocity.

– Ans. (D)

6. Here $mv = (M + m) V$ –

Ans. (B)

7. Sum of magnitudes of forces is not zero.

– Ans. (C)

8. Concurrent forces cannot produce torque.

– Ans. (A)

9. When the body falls freely , it is accelerated

downwards . Hence a force acts on it. – Ans. (B)

10. The effect weight = M (-a) . Hence a = g. – Ans. (A)

11. Let the angle subtended by the wire at the point where the sparrow sits be 2θ. Then $2\ T \cos\theta = W$. Since θ is very near to 90^0, as the wire will sag by a small amount. Hence T >>W. - Ans. (D)

12. As the bus accelerates , due to inertia , the suit case slides backwards. – Ans. (C)

13. The horizontal component of the reaction of the ground n the horse makes the cart and horse moves forward. - Ans. (C)

14. The lift is falling freely. – Ans. (D)

15. Tension T = M (g-a). When climbing down very fast T can be less than Mg/2. – Ans. (B)

16 On taking off maximum force is experienced which gives the athlete a velocity. – Ans. (A)

17. Change in momentum per second = force = (50 g/s) (500 ms^{-1}) = 25 N. - Ans. (C)

18. The effective value of the download acceleration is [g – (-a)] sinθ = (g + a) sinθ. –Ans. (A)

19. Acceleration (retardation) produced = 25 ms^{-1} / 0.1s = 250 ms^{-2}.

Force applied = 0.100 kg x 250 ms^{-1} = 25N.

– Ans. (B)

20. Retardation a = [$(\nu/2)^2$ - ν^2] / [2 x 3] = -(1/8)ν^2.

- Ans. (A)

Distance of Penetration 2ax = 0. ν^2.

That us x = -ν^2/2 x (-ν^2/8) = 4cm.

21. F/M = 1 kg /wt / 9.8 kg = 9.8 N /9.8kg = 1 ms^{-2}.

- Ans. (A)

22. Impulse = change in momentum = 200 Ns. Hence

the recoil velocity ν = 200 Ns/10kg = 20 ms^{-1}.

- Ans. (A)

→ → ^ ^

23. $F = dp/dt = -i\ 2\sin t + j\ 2 \cos t$.

- Ans. (B)

$\rightarrow\rightarrow$

$\text{Cos}\ \theta = F.\ P / FP = 0.$ Hence $\theta = 90^0$.

24. Acceleration is proportional to $t^{-1/2}$.

- Ans. (D)

25. The tension between P & Q accelerates double the mass as compared to that between Q & R. `

Ans. (B)

26. Let the acceleration of the fireman be a. Then :

- Ans. (A)

Mg – R = Ma.. But maximum value of R = (3/4) Mg.

Hence Mg- (3/4) Mg = Ma. That is a g/4.

27. Let the force on the block be P, and acceleration of the system be a. Then a = F / (M + m) and P = Ma = MF / (M + m)

- Ans. ((A)

28. The tension at a distance x from the support will be weight of the rest of the rope having length (L-x) Mg/l. -

Ans. ((B)

29. Apply conservation of momentum.

$500 \times 600 = 1000 \times V$

- Ans. (B)

30. Apply the law of conservation of momentum

$V = 100\nu / 1000 = \nu/10.$ -

Ans. ((D)

$\rightarrow \rightarrow$

31. $T = [2M_1M_2 / (M_1 + M_2)] \ (g - f)$

$= 2[M_1M_2 / (M_1 + M_2)] \ (g - (-g)]$

$= 4[M_1M_2 / (M_1 + M_2)] \ g$

$= 4W_1W_1 / (W_1 + W_2)$ - Ans. (D)

32. $x = (1/2)\ at^2. = ½\ Ft^2/m$.. it is a relation of the type $y = mx^2$. So the graph is symmetric parabola.

– Ans. (B)

33. Here $\nu = at = Ft/m$. it is a straight line passing through the origin. - Ans. (A)

34. Action and reaction are always equal and opposite. - Ans. (D)

35. Maximum resultant force.

$= 8 + 6$ (N = 14 N.

Maximum acceleration $(14/7)\ ms^{-1}. = 2\ ms^{-1}$.

- Ans. (A)

36. Here mass of the body = (30/10) kg = 3kg

Force =15N. Therefore a = (15/3)ms^{-2}. = 5 ms^{-2}.

– Ans. (B)

37. The bob will have horizontal acceleration a and vertical acceleration g. Resultant will make angle $\beta = \tan^{-1} (a/g)$ – Ans. (A)

38. Ma = T-Mg = 56000 – 4000 x 10 = 16000 N

i.e. 4000 a = 16000 N. Hence a = 4 m/s^2..

and x = ½ at^2. = ½ x 4 x $(2)^2$ = 8m.

- Ans. (C)

39. T = F [(L-l) / L] = 10 [{L – (L/2)} / L] = 5N

- Ans.(D)

40. $a = F/M = \Delta p / \Delta t M = (1 \times 600) / (1 \times 120) = 5$ ms^{-2}.

Thrust = F = Ma = 120 x 5 = 600N.

After 100 seconds all the fuel will be exhausted

- Ans.(B)

41. The train is accelerating upwards, therefore the acceleration of fall will be (g+ a), where a is the acceleration of lift.

- Ans. (B)

42. Normal force = change in normal component of momentum per second .

$= 2\ m\nu \sin\theta = 2\ [\ a\nu\rho)\ \nu \sin\theta = 2a\nu^2 \sin\theta.$

- Ans. (A)

43. Let the acceleration of the system e a ,

Then $a = 5N / (6+4)kg = 0.5ms^{-2}$. Force on the

block of mass 4 kg = 4 x 0.5 N = 2N. – Ans. (C)

44. Momentum of the gun = impulse = 120 Ns. = 12

x ν.

Hence $\nu = 10\ ms^{-1}$.

- Ans. (B)

45. Here the block falls through a vertical height

equal to the radius of the circle.

Hence $\nu = (2gh)^{1/2} = (2 \times 10 \times 5)^{1/2}\ ms^{-1} = 10ms^{-1}$. - Ans. (B)

46. Ans. (A)

47. Suppose initial speed is u and it climbs distance l on the inclined plane of inclination θ. Then $u^2 = (2g\sin\theta)\, l$. Here $l = 17$ m or $\theta = 30^0$. if $\theta = 60^0$. then l comes out to be 10m.

48. Apparent weight = m (g + a). here m = 1 kg, g = 10 ms^{-2} , and apparent weight = 1.10 x 10N. This gives a = 1 ms^{-2}.

49. Here $4xa = 4 \times g \sin 30^0 - 2 \times g = 0$

50. $[1/2)m\ (2)^2 - (1/2)\ m\ (1)^2\ ] / [(1/2)\ m(2)^2\ ] = ¾ =$

75%

WORK , POWER & ENERGY SOLUTIONS.

1. Knowledge based question.

2. Knowledge based question.

3. Knowledge based question.

4. F = -dV/dr

5. $W = \int_0^4 cx\, dx = |(1/2)\, cx2|_0^4 = 8c.$

6. $X = K/F = ½\, mv^2/\mu mg = v^2 / 2\mu g.$ Hence $x \propto v^2$.

7. $W = \int F dx = \int (K/x)\, dx = K \log_e x.$

8. Gain in gravitational potential energy = work

done + energy lost by the spring.

9. Potential energy at the top = kinetic energy at the bottom + energy lost by the spring.

10. $F = kx$. Hence $w = \int F\,dx = \frac{1}{2} kx^2$.

11. In case of non conservative forces, the work done is dissipated as heat, sound etc.

12. The block will fall through a height equal to the radius of the ball. Hence $W = MgR$.

13. $U = (1/2) Mv^2$.

14. Mass can be assumed to be concentrated at the mid point, it will rise through height $l/2$.

15. Total kinetic energy at the bottom is equal to the potential at the top.

16. Here $2 \times (1/2) M\nu^2 = M\nu$.

17. Here power $= (10 \times 6)/3 = 20W$.

18. Velocity $= dx/dt = t^2$.

19. $P = F\nu$

20. ν(horizontal) $= \nu \cos 60^0 = \nu/2$.

21. $w = Fx. = K.E$

22. Power depends upon the time taken in doing the work.

23. As the ball rises, the initial kinetic energy is converted into potential energy. Also, the

potential is directly proportional to the height. When kinetic energy is reduced to 70%, the potential energy is 30%. It will happen at a height of 3m.

24. Kinetic energy on reaching the ground = mgh = mg x 10. kinetic energy after the impact = (0 /100) x mg x 10 = 6 mg.

    if the ball rises to a height h, hen : mgh = 6 mg, hence h = 6cm.

25. $P = f\nu = 5 \times 10^3 \times 2W = 10^4 W$.

26. $\frac{1}{2} m\nu^2 = \frac{1}{2} MV^2$.

    Hence $m^2\nu^2 / M^2V^2 = m/M$

That is $P_A/P_B = [m/M]^{1/2}$. since M>m.

Therefore $P_A<P_B$

27. $m\nu = MV$ hence $m^2\nu^2 = M^2V^2$

Therefore $[\frac{1}{2} m\nu^2 / \frac{1}{2} MV^2] = M/m$.

Since M>m therefore $E_A > E_B$.

28. Work done on the body is gain in the kinetic energy. Acceleration of the body is $a = V/T$

Velocity Acquired in time t is $\nu = (V/T)t$.

K.E. acquired $\propto \nu^2$. That is work done $\propto V^2t^2/T^2$.

Power = Work / time. Hence power $\propto [V^2t^2/T^2] / t$

That is power $\propto V^2t/T^2$.

29. See explanation for Q. No. 27

30. The effective mass to be lifted is (M/L) x L/4) = M/4. it will be lifted through a distance L/8. So work done will be (M/4)x g x (L/8) = MgL/32.

31. $W = (F \cos\theta)x = (\sqrt{3} \times 10^3) \cos 30^0 \times 10 = 15 \times 10^3$ J.

    Whole of the work id done against friction.

32. $\frac{1}{2} MV^2 = \frac{1}{2} m\nu^2$. Hence $M^2V^2/m^2\nu^2 = M/m$.

    Therefore $MN/m\nu = (2/8)^{1/2}$. = ½.

33. Velocity $\nu = dx/dt = 8t^3$. After one second

    $\nu = 8\ ms^{-1}$. K.E $(1/2) M\nu^2 = 64$ J

34. P.E + K.E = constant. Mass being constant gh + $v^2/2$ = constant

35 E + ΔE = ½ M (20)2. Also E = ½ M (10)2

Hence $\Delta E = (3/2)\ M\ (10)^2 = 3E$.

36 $E = K_1 = (1/2)\ mv^2$ and

$K_2 = (1/2)\ m\ (2v^2) = [(1/2)mv^2(4)]$

$\Delta K = K_2 - K_1 = 3\ [(1/2)\ mv^2] = 3E$.

37. Extension of spring under the force Mg sin θ is 10 cm. This gives the force = 250 Nm^{-1}. And $\omega = [k/M]^{1/2}$.

38. W = M [g- (g/2)] l = Mgl/2.

39. P = Fv = 4500 N x 2m = 9000 W = 9kW

40 if F be the breaking force, then stopping distance is given by

$x = mu^2/2F = K/F = p^2/2mF$

41. The mass of the particle remains constant So, when the momentum is increased by 100%, the momentum is doubled which means the velocity is doubled. This makes the kinetic energy four times.

42. $K = p^2/2m = \mu mgx$

Hence $x = P^2/2m^2\mu g$.

43. As kinetic energy becomes 4 times , the velocity is doubled. So, the momentum is also doubled.

COLLISION SOLUTIONS

1. knowledge based questions. **Ans. (B)**

2. knowledge based questions. **Ans. (D)**

3 Work energy theorem is always applicable. **Ans. (D)**

4. Apply the law of conservation of momentum. **Ans. (A)**

5. $\Delta p = M\nu - (-M\nu) = 2M\nu$ **Ans. (C)**

6. Linear momentum and angular momentum will be observed when the system includes the earth on which the rotation platform is placed. **Ans. (D)**

7. Apply conservation of momentum $MV = (M-m)\,\nu$.

   Ans. (A)

8. Let the velocity of the combination be V. then

   momentum of combination along north = momentum

of ball initially moving along north. That is 2 MV cos450

= $M\nu$. Which gives$V = \nu/\sqrt{2}$.

Ans. (D)

9. Here $MV = m\nu$. Here $(\frac{1}{2} MV^2)/(\frac{1}{2} m\nu^2)$ **Ans. (B)**

$= M^2V^2m / Mm^2\nu^2 = m/M$.

10. $[h_n / h] = e^{2n}$. **Ans. (D)**

That is $(h/2) / h = e^6$. This gives $e = (1/2)^6$.

11. Here $\hat{i}\, m\, \nu + \hat{j}\, m\, \nu = 2mV$ **Ans. (C)**

That is $\vec{V} = \nu/2\, [\hat{i} + \hat{j}]$

Hence $V = \nu/2 \times \sqrt{2} = \nu/\sqrt{2}$. Here $\nu = 5ms^{-1}$.

12. Velocity reduces to 50%. So the kinetic energy left with the bullet will be 25%of the initial value and it will travel further for 10 cm. **Ans. (C)**

13. Here $MV = m\nu$

Squaring both sides and simplifying we get

$[\frac{1}{2} MV^2] M = \frac{1}{2} (m\nu^2)m$.

That is $\frac{1}{2} m\nu^2 / \frac{1}{2} M\nu^2 = M/m$. **Ans. (B)**

14. $F\nu = P$. Or $M (d\nu/dt) \nu = P$

That is $\int \nu \, d\nu = \int (P/M) \, dt$.

Hence $\nu = [2Pt / M]^{1/2}$. **Ans. (B)**

15. $e = \nu_1/\nu_0 = \nu_2/\nu_1 = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \nu_n / \nu_{n-1}$. **Ans. (A)**

Since $\nu = \sqrt{2gh}$

Therefore $e^2 = h_1/h_0 = h_2/h_1 = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots h_n / h_{n-1}$.

Therefore e2n = h_1/h_0 x h_2/h_1 x ……h_n / h_{n-1}.= h_n/h_0.

That is $h_n = h_0 e^{2n}$.

16. Since collisions is perfectly inelastic , so the two balls stick together

$2mgh = 2m [\nu^2/4]^{½}$.

Hence $h = \nu^2/ 8g$. **Ans. (A)**

17. When he kinetic energy is halved, the potential energy s equal to the kinetic energy. That is mgh = (490/2)J = 245 J. this gives h =12.5 m. **Ans. (B)**

18. $W = \Delta E = ½ \times 0.01 [(1000)^2 – (500)^2] = 3750$ J

Ans. (B)

19. ma = (M+m)V. **Ans. (D)**

20. K.E = ½ $m\nu^2$, & $\nu^2 = 2ax = 2(F/m) x$. **Ans. (B)**

Hence K.E = Fx.

21. $w = \int_0^5 F dx$. **Ans. (D)**

22. Apply the conservation of momentum for inelastic collision **Ans. (B)**.

23. it is a case of inelastic collision.

Ans. (A)

24. it is a case of inelastic collision.

Ans. (B)

25. m x 3 = (m + 2m)V. Hence V = 1 km/h.

Ans. (C)

26. At the highest point $\nu = u \cos 45^0 = u/\sqrt{2}$.

Ans. (C)

Hence K (at top) = ½ m $(u/\sqrt{2})^2$.

= ½ [½ mu^2] = E/2.

27. K = ½ $M\nu^2$ = $p^2/2M$ That is P = $\sqrt{2kM}$.

Ans. (C)

hence P_1/P_2 = $\sqrt{[2KM / (2K \times 4 m)]}$ = $\sqrt{(1/4)}$ = ½.

28. ν = 36 km/h. = 10 m/s.

Applying conservation of momentum we find

2 x 10 = (2 + 3)V.

Hence V = 4 m/s.

Loss in K.E = ½ x 2 x $(10)^2$ - ½ x 5 x $(4)^2$.

= 100 – 40 = 60 J. **Ans. (B)**

29. K = p2/ 2m

K' = $[(1200/100) P]^2 / 2m$. = 1.44 $p^2/2m$ = 1.44 K

Ans. (A)

$\Delta K = K' - K = 0.44\ K = 44\ \%\ K$

30. $\Delta U_p = mgh = 0.2 \times 10 \times 200$

Ans. (B)

31. Velocity at the top = 200 cos 60 = 100 m/s.

Applying the law of conservation we find that the particles going upward and downward have equal moments. So the initial momentum of the composite particle is transferred to third particle.

That is $m \times 100 = (m/3) \times V$.

Hence $V = 300$ m/s.

32. Balls exchange velocity on collision

33. $K = ½\ m\nu^2$ and $\nu^2 - u^2 = 2as$.

34. $F = ½\ m\nu^2 = ½\ (m^2\nu^2/m) = p^2/2m$.

35. $p = \sqrt{2mK}$

36. $m_1v_1 = m_1v_2$ and $K_1/K_2 = m_2/m_1$.

37. $p = \sqrt{2mK}$. Here $p_1 = p_2$.

Hence $\sqrt{(2m_1K_1)} = \sqrt{(2m_2/K_2)}$

That is $m_1/m_2 = K_2/K_1 = ¼$.

38. Use conservation of momentum

$$25 \times 400 = 4.9 \times 1000 \times v$$

This gives $v \cong 2$ m/s.

39. Speed of bomb after 5 seconds

$$v = u\text{-}gt = 100 – 10 \times 5 = 50 \text{ m/s}.$$

Momentum of 400 g fragment

= (400 / 1000) x 25 (downwards)

Momentum of 600 g fragment

= 600/100)v (upward)

initial momentum of the bomb.

= 1 x 50 = 50

From conservation of momentum

50 = - (400 /1000) x 25 + (600 / 1000) ν

ν = 100 m/s. (upward)

40. The kinetic energy is conserved only in the elastic collisions.

41 Initial velocity u = 10/5 = 2 m/s.

Acceleration a = F/m = 0.2/5 = 0.04 m/s^2.

Using $\nu = u + at$

We get $\nu = 2 + 0.04 \times 10 = 2.4$ m/s.

Change in KE

$= \frac{1}{2} m\nu^2 - \frac{1}{2} mu^2$.

$= \frac{1}{2} \times 5 [(2.4)^2 - (2)^2]$

$= \frac{1}{2} \times 5 \times 1.76 = 4.4$ J

42. Masses of three fragments ate 1 kg, 1 kg & 3kg

According to the law of conservation of linear momentum.

$(3 \times V)^2 = (1 \times 39)^2 + (1 \times 39)^2$

That is $V = 13\sqrt{2}$ m/s.

43. Efficiency of pulley (η)

= Output / input = (75 x 10 x 3) / (250 x 12) = 0.75 = 75%

44. Kinetic energy 'E_k' is given by

$E_k = \frac{1}{2} mV^2 = p^2/2m$

(because momentum $p = mV$

$p = \sqrt{2mE_k}$)

Given change in kinetic energy, $E_k = 4E_k$.

Therefore, Momentum, $p' = \sqrt{2m}\,(4E_k)$

$= 2\sqrt{2mE_k}) = 2\ p.$

Hence, momentum becomes twice of the initial value.

45. Work done is stored as elastic potential energy of the spring , that is

$W = U_2 - U_1 = ½\ k\ (x_2^2 - x_1^2)$

$= ½\ k\ [\ (x_2 + x_1)\ (x_2 - x_1)]$

Substituting ,

$x_2 = 15\ cm = 15 \times 10^{-2}$;

x_1 5 cm = 5×10^{-2} m, and

$k = 800\ Nm^{-1}$, we get

$W = ½ \times 800\ [\ (15 + 5)\ (15 - 5)] \times 10^{-4}$.

$= ½ \times 800 \times 20 \times 10 \times 10^{-4}$.

Therefore W = 8J

46 Stopping distance is given by

x= Kinetic energy / stopping force = ½ $m\nu^2$ / μmg. = $\nu^2/2\mu g$.

$x \propto \nu^2$. (1)

According to question

For the Ist car, $x_1 \propto u^2$. (using 1)

For the IInd car, $x_2 \propto (4u)^2 = 16u^2$.

$x_1/x_2 = 1/16$.

47. Kinetic energy is given by

$E = p^2/2m \Rightarrow \sqrt{2mE}$ (1)

Now 300% of E = (300/100)E = 3E.

Hence, increased kinetic energy,

E' = E + 3E = 4E.

Therefore $p' = \sqrt{2mE'}$ (using 1)

Or $p' = \sqrt{2m\,(4E)} = 2\sqrt{2mE} = 2p$ from (1)

Hence change in momentum

$= \Delta p = p' - p = 2p - p = p$

Thus percentage change in momentum.

$= \Delta p/p \times 100\% = (p/p) \times 100\% = 100\%$

48. Magnitude of work done is given by

$$W = FS \qquad (1)$$

Now if $F' = 2F$ and $S' = 2S$, we get

$$W' = F'S' = (2F)(2S) = 4(FS) = 4W \qquad \text{using (1)}$$

49. Momentum = Kinetic energy

$$m\nu = \tfrac{1}{2} m\nu^2.$$

On solving , we get :

$$\nu = 2\ ms^{-1}.$$

50. Here ½ $m\nu^2 = Fx$., where m is the mass of the car, ν is its initial velocity, f is the force applied and x is the stopping distance. Hence

Since F and m are remaining unchanged therefore

$$x \propto \nu^2.$$

Hence $x_2/x_1 = \nu_2^2/\nu_1^2$.

Here ν_2 = 100 km/h, ν_1 = 50 km/h. and x_1 = 6m.

Hence $x_2 = (\nu_2/\nu_1) \times x_1 = (100 / 50)^2 \times 6 = 24$m.

51. Power , $P = F\nu$ = constant.

Or ma (at) = constant

Or a^2t = constant

$$a \propto 1/\sqrt{t} \qquad (1)$$

Now, $S = \sqrt{2}\, at^2$. (u= 0)

$$S \propto at^2.$$

$S = t^2/\sqrt{t}$. (using 1)

$S \propto t^{3/2}$.

52. In first case

$U = ½ kx_1^2$. (1)

In second case

$U' = ½ kx_2^2$. (3)

From 1 & 2

$W = U' – U – ½ k (x_2^2 – x_1^2)$

Substituting $k = 5 \times 10^3 Nm^{-1}$.

$x_1 = 5 cm = 5 \times 10^{-2} m$; $x_2 = 10 \times 10^{-2} m$.

we get

$W = 18.75 Nm$.

53. Kinetic energy, $E = p^2/2m$.

$\Rightarrow$ $E \propto 1/m$ [if P = constant]

$\Rightarrow \quad E_1/E_2 = m_2/m_1.$

54. For extension 'x' in spring we have

Potential energy, $U = ½ kx^2$. (1)

Similarly , for extension x' we have

$U' = ½ kx^2$. (2)

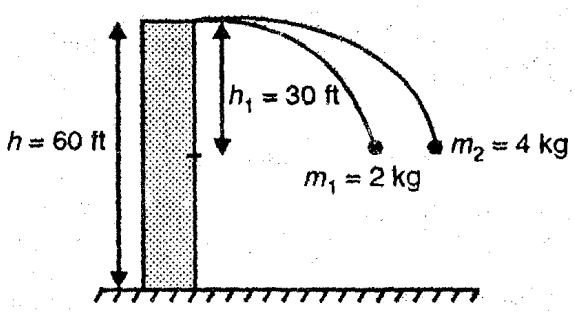
From 1 & 2

$U'/U = (x'/x)^2$.

Substituting x' = 10 cm , x = 2cm, we get

U' = 25 U.

55. When a body is thrown from a top of a building or tower, then velocity of the body at any instant 't' is given by :



$$v^2 - u^2 = 2gh.$$

Since, initial velocity u = 0, therefore we have :

$$v = \sqrt{2gh}$$

Hence the velocity of the body is independent of mass of the body..

This shows that, the velocity of both the balls will remain same at a fall of 30 feet towards the earth.

So, we have

Kinetic energy, $k = ½ mv^2$.

$\Rightarrow \quad k \propto m \quad \Rightarrow \quad k_1/k_2 = m_1/m_2$.

Substituting $m_1 = 2$ kg ; $m_2 = 4$kg, we get :

$k_1/k_2 = ½$.

56. Since, retardation is proportional to its displacement , so we have :

$$a \propto x. \qquad (1)$$

(negative sign of retardation is neglect)

Because, acceleration $a = \nu / t$

Therefore equation 1 becomes :

$$\nu/t \propto x.$$

$$\nu \propto xt.$$

If t remains same, then we have :

$$\nu \propto x. \qquad (1)$$

Now, kinetic energy is given by :

$$k = ½ m\nu^2.$$

If m = constant, then we have :

$$k \propto \nu^2.$$

Using 2 we get

$$K = x^2.$$

57. Stopping distance is given by :

S= kinetic energy/stopping force = K/F = ½ $m\nu^2$/ F

If m = constant ; F = constant the we have :

$S \propto \nu^2$.

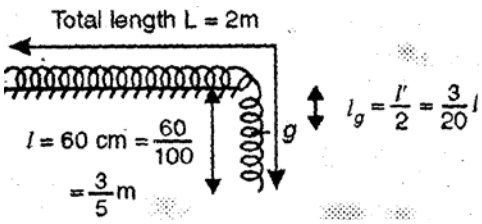
$S_2/S_1 = (\nu_2/\nu_1)^2$.

Substituting S_1 = 20 m; ν_2 = 120 kmh^{-1};

ν_1 = 60 kmh^{-1}, we get

S_2 = 80m.

58. Fraction of total length (L) hanging down the table is given by :



l' = (l/ L) x L = [(3/5) / 2] L = (3/10) L

Now the weight of the hanging chin acts at centre of gravity, that is at distance l'/ 2 from the edge of table.

Therefore the work done is given by

$$W = Fd = (3/10)\ (mg) \times (3/20)\ L$$

Substituting m -4 kg ; g = 10 ms^{-2} ; L =2m,

We get

$$W = 3.6\ J$$

59. From the law of conservation of momentum we have :

$$p_i = p_f$$

$$0 = 4\nu + (A - 4)\ V.$$

$$V = -\ [\ 4\nu\ /\ (A - 4)\ ]$$

Here '- ' sigh signifies that the daughter nucleus is moving in opposite direction of the given nucleus.

60. From law of conservation of momentum , we have

$$0 = m_1\nu_1 + m_1\nu_2\ .$$

Substituting m_1 = 2 kg ; m_2 = 1 kg ; ν_2 = 80 ms^{-1}. , we get

ν_1 = - 40 ms^{-1}.

Here negative sign shows the particle is moving to opposite direction of the direction of the other particle.

Now, total energy of the system gets disturbed in the fragments. Hence we have

$E = ½ m_1\nu_1^2 + ½ m_2 \nu_2^2$.

Substituting ν_1 = 40 ms^{-1}. ; m_1 = 2kg ; m_2 = 1kg ; $\nu 2$ = 80ms^{-1}. we get :

E = 4800 J = 4.8 k J

Questions from the competitive exams solutions.

1. $v_{min} = \sqrt{gr} = \sqrt{(10 \times 1.6)}m = 4m.$

   Ans. (A)

2. Applying the theorem of perpendicular axis

   $I_d = I_c/2 = 200g\ cm^2/2 = 100\ g\ cm^2.$

   Ans. (D)

3. $T = dL/dt = (4A_0 - A_0)/4 = 3A_0/4.$

   Ans. (A)

4. $a = [M / \{ M + (1/R^2)\}]\ g \sin\theta$. Here $\theta = 30^0$.

   And $I = (2/5)\ MR^2$.

$A = (5/7)\ g \times \sin 30^0 = (5/14)\ g.$

Ans. (D)

5. Translation kinetic energy $E_t = ½\ Mv^2$.

Rotational kinetic energy $E_r = ½\ I\omega^2$.

$= ½\ [2/5\ MR2]\omega^2 = 2/5\ [1/2\ MR^2\omega^2] = (2/5)E_t$.

Total kinetic energy $E = E_t + E_r = (7/5) \times E_t$.

Hence $E_r/ E = (2/5E_t) / (7/5\ E_t) = 2/7$.

Ans. B)

6. $Kr = ½\ I\omega^2$. here $Kr = 360$ J and $\omega = 30$ rad/s.

Ans. (D)

7. it is the moment of inertia about the tangential axis. It is given by $MR^2/2 + MR^2 = (3/2)MR^2$.

Ans. (B)

8. kinetic energy = ½ $I\omega^2$. and for ring $I = mr^2$.

Hence KE = ½ $mr^2\omega^2$.

Ans.(A)

9. $\nu = \sqrt{2gh} / \sqrt{[1+ (K^2/R^2)]}$ = here $K^2 = R^2/2$.

Ans. (B)

10. $a= g \sin\theta / \{ 1+(K^2/R^2) \}$. For the ring K= R.

Ans. (C)

11. Applying conservation of potential and kinetic energies

$Mgh = ½ m\nu^2 + ½ I\omega^2$.

Here $I = 2/5\ MR^2$ and $\nu = R\omega$.

This gives $\nu = [(10/7)\ gh]^{1/2}$.

Ans. (A)

12. Angular momentum about the point of contact with the surface includes the angular momentum about the centre. Total momentum is conserved. Ans. (B)

13. On the diametrically opposite points , the velocities have same magnitude but opposite directions. Therefore change in momentum is $MV - (-MV) = 2mV$. Ans. (C)

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change both in magnitude and direction.

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15. $Er/E = ½ I\omega^2/ (½ I\omega^2 + ½ M\omega^2)$

for sphere $I = 2/5 MR^2$. Also $\nu = R\omega$.

Hence $E_r/E = 2/7$ Ans.

(D)

$\rightarrow \rightarrow \rightarrow$

16. L = r x p. it is axial vector.

Ans. (A)

17. During sliding a = g isn θ

while rolling $a = g \sin\theta/ [1 + (K^2/R^2)$

Since $K^2 = R^2$, hence $a = g \sin\theta/2$.

Ans. (C)

18. M.I. = $MR^2 = M.(AD)^2 = m(\sqrt{3}/2\ b)^2$.

$= m.\ ¾\ b^2 = ¾\ mb^2$.

Ans. (C)

19. For ring K = R. hence $E_k = ½\ mv^2$ and

$E_r = ½\ I\omega^2 = ½\ MK^2\omega^2$.

Ans. (D)

20. Central force id directed along the line joining the particles. Hence it applies no torque. Ans. (C)

21. $I_{||} = (MR^2/4) + MR^2 = 5/4\ MR^2$.

$I_{\perp} = MR^2/2 + MR^2 = 3/2\ MR^2$.

Hence $I_{\perp} / I_{\parallel} = 6/5$.

Or $I_{\perp} = 6I/5$.

Ans. (A)

22. the angular momentum remains constant in the orbit of the earth. Ans. (A)

23. $I = ML^2/12 + M\ (L/2)^2 = ML^3/3$.

Ans. (A)

24. $\nu = r\omega = 20 \times 10$ cm/s. = 2 m/s.

Ans. (B)

25. $\tau = dL/dt = (4J-J)/4 = (3/4)J$

Ans. (A)

26. Couple consists of two equal and opposite forces, which cause rotational motion. Ans. (B)

27. $I = \frac{1}{2} MR^2 = 1/3 \times 0.5 \times (0.1)^2 = 2.5 \times 10^{-3}$ kg m^2. Ans. (A)

28. it exerts centripetal force + weight

Ans. (A)

29. Angular velocity is related to the rotating body.

Ans. (A)

30. knowledge based questions.

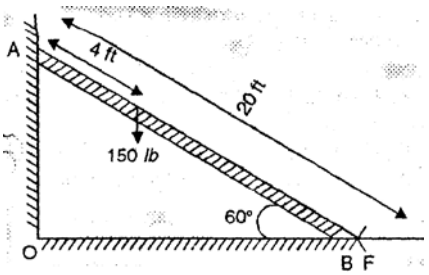
Ans. (A)

31. In rotational motion the centripetal force is always perpendicular to velocity. Ans. (D)

32. $\omega = 2\pi f = (2\pi \times 100) / 60$

Ans. (B)

33. Taking moment about O, we find :



$F = 20 \sin 60^0 = 150 \times 4 \times \sin 30^0 =$

This gives F = 1.5 lb.

Ans. (A)

34. $T = mv^2/r$. hence $v = \sqrt{(Tr/m)}$

$= \sqrt{(25 \times 1.96/0.25)} = 14$ m/s.

Ans. (A)

35. $Fc = mr\omega^2$.

Ans. (B)

36. The point of intersection of medians is equidistant from the three corners. Ans. (D)

37. $Fc = mv^2/r$. $\{500 \times (10)^2\} / 50 = 1000$ N

Ans. (C)

38. $\omega_1/\omega_2 = (2\pi/T_1) / (2\pi/T_2)$. Here $T_1 = T_2 = t$.

Ans. (A)

39. $I_{cm} = ½ MR^2$; $I_d = ¼ MR^2$.

$I_t = ¼ MR^2 + MR^2 = 5/4 MR^2$.

Ans. (C)

40. The tension in the string is largest and equal to

$mv^2/r + mg$ at the bottom. Ans. (A)

41 Acceleration down the inclined plane.

$$A = g\sin\theta / [\ 1+ (K^2/R^2)]$$

Since K for solid cylinder is smaller , therefore

a is larger. So, it will reach the bottom first.

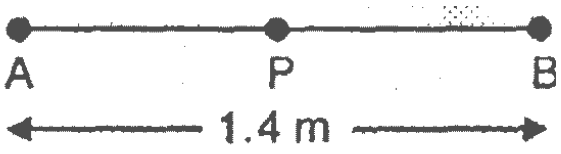
Ans. (B)

42. We have moment of inertia about an axis through

P as

$I = 0.3\ x\ \ x^2 + \ 0.7\ x$

$(1.4 - x)^2$.



$= 0.3x^2 + 0.7\,(1.96 + x^2 - 2.8x)$

$= x^2 - 1.96x + 1.372$

For minimum value of I , $dI/dx = 0$

$x - 1.96 = 0$

$x = 1.96/2 = 0.98$ m.

i.e 0.98 m from 0.3 kg.

Ans. (A)

43. for completion of the vertical circle, velocity at the bottom should be .

$\nu = \sqrt{5gr} = \sqrt{5g(D/2)}$

Therefore $\sqrt{2gh} = \sqrt{5g\,(D/2)}$

H = (5/4) D.

Ans. (B)

44. In circular motion the direction of body changes therefore both velocity and acceleration vary.Ans. (C)

45. Torque s the rotational analogue of force in linear motion. Ans. (D)

46. MI of solid sphere = (2/5) MR^2

MI of solid cylinder = $MR^2/2$.

MI is greater for solid cylinder.

Ans. (B)

47. Moment of inertia depends upon distribution of mass about the axis of rotation. Ans. (C)

48. The velocity of the bottom (B) is zero and that of top (T) is $2v_{cm}$. Ans. (A)

49. As angular velocity $\omega = 2\pi/T$. As T is same for both bodies, ω must also be same.

Hence $\omega_2/\omega_1 = t/T = 1$

Ans. (C)

50. According to law of conservation of angular momentum , we have

$$I_1\omega_1 = I_1\omega_2. \qquad ..1$$

Moment of inertia of the disc is given as

$$I_1 = \frac{1}{2} MR^2.$$

When two spheres of mass 'm' are attached to the disc, the moment of inertia is given as

$$I_2 = \frac{1}{2} (M + 2m)R^2.$$

Substituting the values of I_1 and I_2 in eqn. (1)

$$\frac{1}{2} MR^2\omega_1 = \frac{1}{2} (M + 2m) R^2\omega_2.$$

$$\Rightarrow \quad \omega_2 = [M/ (m+2m)]\omega_1.$$

Ans. (C)

51. Minimum velocity 'ν' required by a body in traversing flat curved path of radius 'r' is given by

$$\nu = \sqrt{\mu rg}.$$

Substituting $\mu = 0.6$, $r = 150$ m

And $g = 10\ ms^{-2}$. we get

$v = 30\ ms^{-1}$.

Ans. (C)

52. As the inclined plane is frictionless , hence neither sliding nor rolling friction would influence the motion of the bodies. So, acceleration down the plane of all would be same. Note that in his case, no rolling occurs.

Ans. (D)

53. knowledge based questions

Ans. (A)

54. Angular speed is given by :

$$\omega = 2\pi\nu$$

putting ν = 120 rev/min. = 2rev/s in relation (1) ,

we get $\omega = 4\pi$ Ans. (C)

55. knowledge based questions

Ans. (D)

56. According to the question , mass per unit length

$m \propto x \quad \Rightarrow \quad m = kx$

Now consider an elementary distance x of

thickness dx, in the rod , the moment of inertia

is given by :

$$I = \int dm \times x = \int (kx)\, dx \times (x)$$

$= \int kx^2\, dx.$ [$dm = kxdx$]

now if x varies from x = 0 to x =3 , then

$$I = \int_0^3 kx^2\, dx$$

Hence , centre of gravity $= \int_0^3 kx^2\, dx. / \int_0^3 kx\, dx$

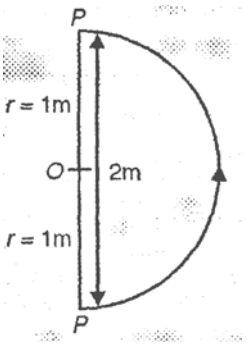
$= [x^2/3]_0^3 / [x2/2]_0^2$

= 2cm

Ans. (B)

57. knowledge based questions

Ans. (B)



58. when point P completes half of rotation , then the displacement is given by :

$\rightarrow$

S = r + r = 2m

Ans. (A)

59. knowledge based questions

Ans. (A)

60. knowledge based questions

Ans. (D)

61. Relation between linear (ν) and angular speed (ω) is given by

$$\nu = r\omega \Rightarrow \omega = \nu/r.$$

on putting $\nu = 10\ ms^{-1}$. ; r = 100m, we get

$$\omega = 0.1\ rad\ s^{-1}.$$

Ans. (B)

62. The total kinetic energy for solid sphere while rolling is given by :

$$E = ½\ I\omega^2 + ½\ m\nu^2.$$

Substituting $I_{sphere} = 2/5\ mr^2$; $\omega = \nu/r$, we get :

$$E = 1/5\ m\nu^2 + ½\ m\nu^2 = 7/10\ m\nu^2.$$

On putting $m = 500\ g = 5 \times 10^{-1} kg$; $\nu = 20\ cms^{-1}$ $= 2 \times 10^{-1}\ ms^{-1}$ we get

$$E = 0.014\ J$$

Ans. A)

63. From conservation of angular momentum we have

$$L = I\omega = \text{constant}$$

$$I_1\omega_1 = I_1\omega_2$$

$$\omega_2 = (I_1/I_2)\ \omega_1.$$

Substituting $I_1 = m(r_1)^2 = 2 \times (0.8)^2.$

$$= 1.28\ kg\ m^2.$$

$$I_2 = m\ (r_2)^2 = 2 \times (1)^2 = 2\ kgm^2.$$

$\omega_1 = 44$ rad s^{-1}, we get

$\omega_2 = 28.16$ rad s^{-1}.

Ans. (A)

64. In circular motion, kinetic energy

$E = (1/2) I\omega^2$.

$E = (1/2) L\omega$ ($L = I\omega$)

$L = 2E/\omega \Rightarrow L \propto E/\omega$ (1)

Similarly , $L' \propto E'/4\omega$

Substituting, $E' = E/2$; $\omega' = 2\omega$

$L' = E/4\omega$ (2)

Comparing 1 and 2 we get :

$L' = L/4$ Ans.

(B)

65. knowledge based questions.

Ans. (B)

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Rotational kinetic energy $E_r = ½ I\omega^2$.

$= ½ [2/5 MR2]\omega^2 = 2/5 [1/2 MR^2\omega^2] = (2/5)E_t$.

Total kinetic energy $E = E_t + E_r = (7/5) \times E_t$.

Hence $E_r/ E = (2/5E_t) / (7/5 E_t) = 2/7$.

Ans. B)

6. $Kr = ½ I\omega^2$. here Kr = 360 J and $\omega = 30$ rad/s.

Ans. (D)

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Ans. (D)

→ → →

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Ans. (C)

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$= m. \frac{3}{4} b^2 = \frac{3}{4} mb^2.$

Ans. (C)

19. For ring K = R. hence $E_k = \frac{1}{2} mv^2$ and

$E_r = \frac{1}{2} I\omega^2 = \frac{1}{2} MK^2\omega^2.$

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Ans. (A)

26. Couple consists of two equal and opposite forces, which cause rotational motion. Ans. (B)

27. $I = \frac{1}{2} MR^2 = 1/3 \times 0.5 \times (0.1)^2 = 2.5 \times 10^{-3}$ kg m^2. Ans. (A)

28. it exerts centripetal force + weight

Ans. (A)

29. Angular velocity is related to the rotating body. Ans. (A)

30. knowledge based questions.

Ans. (A)

31. In rotational motion the centripetal force is always perpendicular to velocity. Ans. (D)

32. $\omega = 2\pi f = (2\pi \times 100) / 60$

Ans. (B)

33. Taking moment about O, we find :

$F = 20 \sin 60^0 = 150 \times 4 \times \sin 30^0 =$

This gives F = 1.5 lb.

Ans. (A)

34. $T = mv^2/r$. hence $v = \sqrt{(Tr/m)}$

$= \sqrt{(25 \times 1.96/0.25)} = 14$ m/s.

Ans. (A)

35. $Fc = mr\omega^2$.

Ans. (B)

36. The point of intersection of medians is equidistant from the three corners. Ans. (D)

37. $Fc = mv^2/r$. $\{500 \times (10)^2\} / 50 = 1000$ N

Ans. (C)

38. $\omega_1/\omega_2 = (2\pi/T_1) / (2\pi/T_2)$. Here $T_1 = T_2 = t$.

Ans. (A)

39. $I_{cm} = ½ MR^2$; $I_d = ¼ MR^2$.

$I_t = ¼ MR^2 + MR^2 = 5/4 MR^2$.

Ans. (C)

40. The tension in the string is largest and equal to $mv^2/r + mg$ at the bottom. Ans. (A)

41 Acceleration down the inclined plane.

$A = g\sin\theta / [1+ (K^2/R^2)]$

Since K for solid cylinder is smaller , therefore a is larger. So, it will reach the bottom first.

Ans. (B)

42. We have moment of inertia about an axis through P as

$I = 0.3\ x\ \ x^2 + \ 0.7\ x\ (1.4 - x)^2.$

$= 0.3x^2 + 0.7\ (1.96 + x^2 - 2.8x)$

$= x^2 - 1.96x + 1.372$

For minimum value of I , $dI/dx = 0$

$x - 1.96 = 0$

$x = 1.96/2 = 0.98$ m.

i.e 0.98 m from 0.3 kg.

Ans. (A)

43. for completion of the vertical circle, velocity at the bottom should be .

$\nu = \sqrt{5gr} = \sqrt{5g(D/2)}$

Therefore $\sqrt{2gh} = \sqrt{5g}\ (D/2)$

$H = (5/4)\ D.$

Ans. (B)

44. In circular motion the direction of body changes therefore both velocity and acceleration vary.

Ans. (C)

45. Torque s the rotational analogue of force in linear motion. Ans. (D)

46. MI of solid sphere = (2/5) MR^2

MI of solid cylinder = $MR^2/2$.

MI is greater for solid cylinder.

Ans. (B)

47. Moment of inertia depends upon distribution of mass about the axis of rotation. Ans. (C)

48. The velocity of the bottom (B) is zero and that of top (T) is $2v_{cm}$. Ans. (A)

49. As angular velocity $\omega = 2\pi/T$. As T is same for both bodies, ω must also be same.

Hence $\omega_2/\omega_1 = t/T = 1$

Ans. (C)

50. According to law of conservation of angular momentum , we have

$$I_1\omega_1 = I_1\omega_2. \qquad ..1$$

Moment of inertia of the disc is given as

$$I_1 = ½ MR^2.$$

When two spheres of mass 'm' are attached to the disc, the moment of inertia is given as

$$I_2 = ½ (M + 2m)R^2.$$

Substituting the values of I_1 and I_2 in eqn. (1)

$$½ MR^2\omega_1 = ½ (M + 2m) R^2\omega_2.$$

$$\Rightarrow \quad \omega_2 = [M/ (m+2m)]\omega_1.$$

Ans. (C)

51. Minimum velocity ‘ν’ required by a body in traversing s flat curved path of radius r’r’ is given by

$$\nu = \sqrt{\mu r g}.$$

Substituting $\mu = 0.6$, $r = 150$ m

And $g = 10\ ms^{-2}$. we get

$$\nu = 30\ ms^{-1}.$$

Ans. (C)

52. As the inclined plane is frictionless , hence neither sliding nor rolling friction would influence the motion of the bodies. So, acceleration down the plane of all would be

same. Note that in his case, no rolling occurs.

Ans. (D)

53. knowledge based questions

Ans. (A)

54. Angular speed is given by :

$\omega = 2\pi\nu$

putting $\nu = 120$ rev/min. = 2rev/s in relation

(1) , we get $\omega = 4\pi$ Ans. (C)

55. knowledge based questions

Ans. (D)

56. According to the question , mass per unit length

$m \propto x \quad \Rightarrow \quad m = kx$

Now consider an elementary distance x of thickness dx, in the rod , the moment of inertia is given by :

$$I = \int dm \times x = \int (kx)\, dx \times (x)$$

$$= \int kx^2\, dx. \qquad [\, dm = kxdx]$$

now if x varies from x = 0 to x =3 , then

$$I = \int_0^3 kx^2\, dx$$

Hence , centre of gravity $= \int_0^3 kx^2\, dx. \Big/ \int_0^3 kx\, dx$

$$= \left[\frac{x^2}{3}\right]_0^3 \Big/ \left[\frac{x2}{2}\right]_0^2$$

= 2cm

Ans. (B)

57. knowledge based questions

Ans. (B)

58. when point P completes half of rotation , then the displacement is given by :

$\rightarrow$

S = r + r = 2m

Ans. (A)

59. knowledge based questions

Ans. (A)

60. knowledge based questions

Ans. (D)

61. Relation between linear (ν) and angular speed (ω) is given by

$$\nu = r\omega \Rightarrow \omega = \nu/r.$$

on putting $\nu = 10\ ms^{-1}$. ; r = 100m, we get

$$\omega = 0.1\ rad\ s^{-1}.$$

Ans. (B)

62. The total kinetic energy for solid sphere while rolling is given by :

$$E = ½\ I\omega^2 + ½\ m\nu^2.$$

Substituting $I_{sphere} = 2/5\ mr^2$; $\omega = \nu/r$, we get :

$$E = 1/5\ m\nu^2 + ½\ m\nu^2 = 7/10\ m\nu^2.$$

On putting $m = 500\ g = 5 \times 10^{-1} kg$; $\nu = 20\ cms^{-1} = 2 \times 10^{-1}\ ms^{-1}$ we get

$E = 0.014$ J

Ans. A)

63. From conservation of angular momentum we have

$L = I\omega = \text{constant}$

$I_1\omega_1 = I_1\omega_2$

$\omega_2 = (I_1/I_2)\ \omega_1.$

Substituting $I_1 = m(r_1)^2 = 2 \times (0.8)^2.$

$= 1.28$ kg m^2.

$I_2 = m\ (r_2)^2 = 2 \times (1)^2 = 2$ kgm^2.

$\omega_1 = 44$ rad s^{-1}, we get

$\omega_2 = 28.16$ rad s^{-1}.

Ans. (A)

64. In circular motion, kinetic energy

$E = (1/2)\, I\omega^2$.

$E = (1/2)\, L\omega$ $\qquad$ ($L = I\omega$)

$L = 2E/\omega \Rightarrow \quad L \propto E/\omega \qquad (1)$

Similarly , $\quad L' \propto E'/4\omega$

Substituting, $E' = E/2$; $\omega' = 2\omega$

$L' = E/4\omega \qquad (2)$

Comparing 1 and 2 we get :

$L' = L/4$

Ans. (B)

65. knowledge based questions.

Ans. (B)

GRAVITATION SOLUTIONS.

1. Ans. (C)

2. Ans. (D)

3. And. (C)

4. Ans. (B)

5. Ans. (A)

6. This is in accordance with Newton's third law of motion.

7. Gravitational mass does not change when we go from one place to another

8. $T = 2\pi \sqrt{(l/g)}$. When g is doubled, for T to be constant, l should be doubled.

9. Intensity of gravitational field of the earth is equal to the acceleration due to gravity.

10. The g decreases both we go below or above the surface of the earth.

11. The effective acceleration due to gravity inside the elevator is g + a

12. Weight is zero during the free fall.

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14. $gp = G (2M) / (2R)^2 = ½ GM^2/R^2 = ge/2$.

15. Divide the balls two lots of 16 each. Put theorem in two pans and identify the lot containing heavier ball. Then divide this two lots of 8 each and proceed as before. You will need weighings with 16,8,4,2 and 1 ball in each pan.

16. Both start with the same velocity and fall with the same acceleration.

17. $gh = g [1- (2h/R)] = g [1-(d/R)] = gd$

18. $W = \int G (Mme/x^2) dx. = ½ (GMe/R)M$

    $= ½ (GMe/R^2) MR = ½ MgR.$

19. $g = GM/R^2.$

Here $g' = G(2M) / (2R)^2 = g/2$.

20. $g' = GM/ (9/10\ R)^2 = (100/81)g$.

21. $F = GMM / (2R)^2 = G \times [(4/3\ \pi R^3)\rho]^2 / 2R^2$.

    $= G \times (4/9)\ \pi^2 \rho\ R^4$.

22. $P.E = GMm/ (R + h)$ here $h = R$. Therefore

    $P.E = GMm/ (R + R) = (GM/2R)m = (GM/R^2) \times (mR/2) = ½\ mgR$

SATELLITES.

23. Ans. (D)

24. Ans. (C)

25. Ans. (B)

26. Ans. (B)

27. Ans. (D)

28. On the satellite g = 0, hence T is infinity.

29. $T = (r^3/g)^{1/2}$.

30. To put the satellite in orbit it is first taken to the required height. Velocity of firing is not related to escape velocity.

31. $\nu_{es} = \sqrt{2}\nu_0$. kinetic energy in orbit is $M\nu_0^2/2$. Kinetic energy to escape is $M\nu_{es}^2/2$.

32. Escape velocity is independent of the mass of the body.

33. The velocity attained is equal to the escape velocity.

34. $\nu_0 = [GM / (R+h)]^{1/2}$.

35. PE = - GMm/R. and KE = GMm/2R.

36. U = GMm/r = (GM/r^2) x rm = grm = r (mg)

37. P.E = -GMMe [(1/R) – (1/2R)] = - (GMMe/2R)

= - MgR/2.

38. K.E = ½ | P. E | = MgR/4.

39. $\nu e = \sqrt{2}\ \nu_0 = 1.414\ \nu_0$.

Hence $(\nu e - \nu) / \nu_0 =$ 41.4 %

40. Period of revolution is independent of the

radius of the planet. $T = 2\pi\ [\ (R+h)^3 / GMe\ ]^{1/2}$.

Here

R + h does not change and T remains constant.

41. $E = G\,[Mm / R^{n-1}] = \frac{1}{2} m\nu^2$ and $T = 2\pi R / \nu$

$= 2\pi R / [2Gm / R^{n-1}]^{1/2}$. or $T \propto R^{n+1/2}$

42. $P.E = \int_{R}^{R+h} (GMm/r^2)\, dr = GMm\,[\,(1/R) - 1/(R+h)] = \frac{1}{2} m\nu^2$.

Find ν.

43. $U = GMm/r$. Hence $OM = Ur/m$. weight at a distance R will be

$$W = mg = m(GM/R^2) = m(Ur/mR^2) = Ur/R^2.$$

44. $T = 2\pi\,[\,r^3/GMe]^{1/2}$. That is $T \propto r^{3/2}$.

$T_2/T_1 = (4R)^{3/2} / R^{3/2} = 8$. here $T_1 = T$. hence $T_2 = 8T$.

45. KE = GMm/2R and PE = - GMm/R. Total energy = -GMm/2R = K.E. in magnitude.

46. $T = 2\pi \sqrt{(R^3/GM)} = 2\pi \sqrt{[R^3 / \{ G \times (4/3) \pi R^3 \rho \}]}$

i.e. $T \propto 1/\sqrt{\rho}$

47. $v_{es} = [2GM/R]^{1/2}$.

Initial KE. = $\frac{1}{2} \times m [1/3 (2GM/R)^{1/2}] = 1/9 (GMm/R)$

Let the maximum height attained = h.

Then gain in PW = (GMm/R) – (GMm/R+h) = Loss of KE

i.e. GMm/R – GMm / (R+h) = 1/2 (GMm/R)

On solving we find 9R/8 = R + h

That is h = R/8.

Competitive exams.

48. it is the property of ellipse.

That $2/R = 1/r_1 + 1/r_2$.

49. Total energy = -KE = PE/2

$KE = ½ mv^2$.

50. Escape velocity is same for all angles of projection

51. Time period does not depend on the mass.

Also $T^2 \propto r^3$.

52. Escape velocity does not depend on the angle of projection.

53. $T = 2\pi\sqrt{(l/g)}$. when the rocket accelerates upwards g increases to (g+ a)

54. $F = k/R = Mv^2/R$. hence $v \propto R^o$.

55. Due to rotation of the earth about its own axis , the weight decreases.

56. $gd = g [1 – (d/R)]$

Hence $\Delta gd/gd = \Delta d/d = 1/6400$

Since $T = 2\pi\sqrt{(l/g)}$

Hence $\Delta T/T = -1/2(\Delta gd/ga) = -\frac{1}{2} \times 1/6400$

This gives $\Delta T = 1/12800 \times T$

$= (1/12800) \times 24 \times 60 \times 60 = 7s.$

57. Mass does not vary from place to place.

58. $\nu es = \sqrt{(2gR)} = \sqrt{(2GM/R)}$

$\nu es' = \sqrt{[2 \times G \times 2M/(R/2)]} = 2\sqrt{(2GM/R)} = 2\nu_{es}.$

59. $T^2 \propto R^3.$

$T_1^2/T_2^2 = R_1^3/R_2^3$ or $R_1^3/R_2^3 = 64.$

$R_1 = 4R_2.$

60. Factual statement. Ans. (A)

61. $\nu_2/\nu_1 = \sqrt{(2gh2)} / \sqrt{(2gh1)} = \sqrt{(1.8/5)} =$

$(\nu_1 - \nu_2)/\nu_1 = 1 - (\nu_2/\nu_1) = 1 - \sqrt{(1.8/5)} = 0.4 = 2/5$

62. Ans. (D).

63. During the free fall the weight is zero.

64. Ans. (B)

65. Ans. (C)

66. $g = GM// R2 = G(Me/2) / (Re/2)^2 = 2$

$(GMe/Re^2) = 2 \times 9.8\ m/s^2$.

67. $W = mg = m(GM/R^2)$

Here $M = Me/7$ and $R = Re/2$.

Hence $W' = (W/7) \times 4$

68. $\nu es = \sqrt{(2GM/R)}$

hence $\nu es = 1/\sqrt{R}$.

69. We have $[G (M/81) \times M'] / x^2 = (GM \times M') / (60 R - x)^2$.

$1/ 81x^2 = 1/ (60R - x)^2$.

$9x = 60 R - x$ or $x = 6R$.

70. We know that $g = GM/R^2$. where R is maximum at equator and minimum at poles.

71. Use $g_h = (R + h)^2$.

72. Due to inertia, the satellite will move tangentially to the initial orbit and its velocity will continue to be same as before.

73. Escape velocity of a body from the gravitational field of any planet is given by

$$V_{es} = 2GMe/R = \sqrt{2gR}.$$

$\Rightarrow$`Ves is independent of mass of the body.

$\Rightarrow V_{es} \propto m^{o}$.

74. If ;Ves' is the escape velocity of a body to escape from earth's surface to infinity, then kinetic energy is given as

$$K.E = \frac{1}{2} mV2es. = \frac{1}{2} m \sqrt{(2gR)^2}$$

Because $V_{es} = \sqrt{(2gR)}$

$K.E = mgR.$

75. potential energy of a body of mass 'm' on earth's surface is given by

$$U_s = -GMm/R \qquad (1)$$

Now, if body is taken to height h = 3R, then potential energy is given by :

$$U_h = -GMm/h' = GMm/(h + R) = -GMm/4R \qquad (2)$$

Hence from 1 & 2 we have

$$\Delta U = U_h - U_s$$

$$= -GMm/4R - [-GMm/R]$$

on solving, we get

$$\Delta U = 3GMm/4R$$

substituting , $GM = gR^2$, we get

$$\Delta U = \tfrac{3}{4} mgR$$

76. Ans. (C) .

77. Escape velocity from the earth is given by

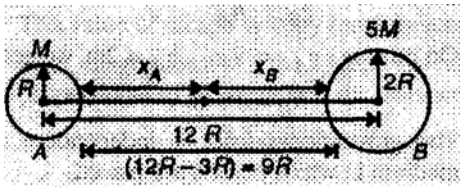
$$Ve = \sqrt{2gR} \qquad (1)$$

And the orbital velocity of a satellite orbiting close to the surface earth is given by :

$$V_0 = \sqrt{gR} \qquad (2)$$

From (1) and (2)

$$Ve = \sqrt{2}V_0. .$$



78. Gravitational force of attraction between two bodies is give by

$$F = G(M)(5M)/ (12R)^2 \qquad (1)$$

Also, acceleration of the body a is given by

$$a_A = G(5M)/ (12R)^2 \qquad (2)$$

Similarly , acceleration of body B is given by

$$a_B = G(M)/(12R^2) \qquad (3)$$

Now if x_A is the distance covered by body A and x_B by body B, then we have

$$9R = x_A + x_B.$$

or $$9R = 1/2a_At^2 + ½\ a_Bt2. \quad \text{(using 2 and 3)}$$

$$t^2 = 18R/(a_A+a_B)$$

Hence the distance moved by a body A before collision is :

$$x_A = ½\ aAt^2.$$

$$= ½\ [\ g(5m)/(12R)^2]\ [\ 18R\ /\ (a_A + a_B)]$$

(using 2 and 4)

or $x_A = ½ \times G (5M) / (12R)^2 \times (12R)^2$.

$= 15R/2 = 7.5 R$

79. From Kepler's law of periods, we have

$T^2 \propto R^3$.

$[T2/T1]^3 = [R_2 / R_1]^3$.

Substituting $R_2 = 4R_1$: $T_1 = 5$ hr. we get

$T_2 = 40$ hours.

80. The escape velocity of a body is independent of the angle of projection.

81. Acceleration due to gravity decreases with height

Hence, $g \propto 1/h$

$$gA/gB = hB/hA$$

on putting $g_A = 9\ g_B$; $h_A = 2m$, we get

$$h_B = 18m.$$

82. The gravitational force is independent of the medium in which the objects are placed.

83. Acceleration due to gravity on the surface of the earth is given by

$$g = GM/R^2. \quad (1)$$

Also, mass M = Volume x density.

$$= 4/3\ \pi R^3 \times \rho$$

Substituting the value in 1 , we get

$g = 4/3\ \pi G R \rho$

$g = R\rho$

$g/g' = R\rho/R'\rho'$

(2)

Since acceleration due to gravity on the planet = acceleration due to gravity on surface of earth is $g = g'$

So from 2 we have :

$g/g' = R\rho/R'\rho'$

of $R'/R = \rho/\rho'$

substituting $\rho' = 2\rho$ we get

$R' = R = 1/2R.$

84. Ans. (D)

85. Ans. (A)

86. change in gravitational potential energy is given by

$$\Delta U = GMm\ [\ (1/R_1) - (1/R_2)]$$

(1)

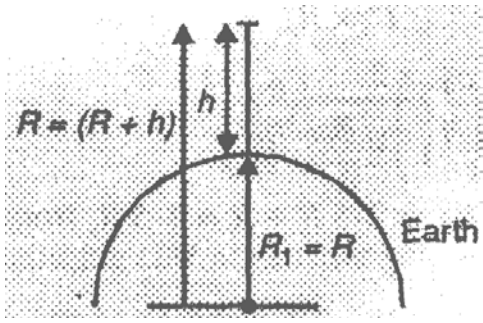
in case, body is initially on surface of earth, then we have

$$R_1 = R$$

And, when body is taken to a height h above the surface of earth , then we have

$$R_2 = R + h$$

Therefore equation 1 becomes :



$\Delta U = GMm\ [\ (1/R) - 1/(R + h)]$

given thath = R

$\Delta U = GMm\ [\ 1/R - 1/\ (R + R)]$

On solving we get :

$\Delta U = gMm/2R$ (2)

Further , acceleration due to gravity is given by

$G = GM/R^2.\beta$

$GM = gR^2.$

Substituting the value in equation (2), we get

$\Delta U = ½\ mgR$

87. When a planet revolves around the sun, then we have

Gravitational pull between the sun and the planet = Centripetal force acting on the planet that is

$$GMm/R^n = mv^2/R.$$

(1)

It is given that gravitational force varies inversely as the nth power of distance

Now, from relation (1), we get

$$v = \sqrt{[GM/(R^n - 1)]} = [GM/(R^n - 1)]^{1/2}.$$

(2)

Further, time period of the planet is given by :

$T = 2\pi R / [GM/ (R^n-1)]^{1/2}. = 2\pi [(R^n-1)/2\pi]^{1/2}.$

$T \propto R [(n+1) /2]$

88. Variation of acceleration due to gravity with latitude is given by

$g' = g - R\omega^2 \cos^2\theta$

At equator , $\theta = 0^0 = \cos 0 = 1$

Therefore we have

g' equator $= g-R\omega^2$. (1)

from 1 and 2 we have

g' poles > g' equator

As we move from equator to pole , the value of ‘g’ decreases

GRAVITATION

Acceleration due to gravity

1. Ans. (C)

2. Ans. (D)

3. And. (C)

4. Ans. (B)

5. Ans. (A)

6. This is in accordance with Newton's third law of motion.

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8. $T = 2\pi \sqrt{(l/g)}$. When g is doubled, for T to be constant, l should be doubled.

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18. $W = \int G\,(Mme/x^2)\,dx. = ½\,(GMe/R)M$

$= ½\,(GMe/R^2)\,MR = ½\,MgR$.

19. $g = GM/R^2$.

Here $g' = G(2M) / (2R)^2 = g/2$.

20. $g' = GM/(9/10\ R)^2 = (100/81)g$.

21. $F = GMM / (2R)^2 = G \times [(4/3\ \pi R^3)\rho]^2 / 2R^2$.

$= G \times (4/9)\ \pi^2 \rho\ R^4$.

22. P.E = GMm/ (R + h) here h = R. Therefore

P.E = GMm/ (R + R) = (GM/2R)m = $(GM/R^2) \times$

(mR/2) = ½ mgR

SATELLITES.

23. Ans. (D)

24. Ans. (C)

25. Ans. (B)

26. Ans. (B)

27. Ans. (D)

28. On the satellite $g = 0$, hence T is infinity.

29. $T = (r^3/g)^{1/2}$.

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(2)

Further, time period of the planet is given by :

$$T = 2\pi R / [GM/ (R^n-1)]^{1/2}. = 2\pi [(R^n-1)/2\pi]^{1/2}.$$

$$T \propto R^{[(n+1)/2]}$$

38 – 41

Comprehensive.

MECHANICS OF SOLIDS & FLUIDS.

ELASTICITY

1. Ans. (A)

2. Ans. (B)

3. Ans. (B)

4. Ans. (A)

5. Ans. (C)

6. E = Stress/Strain = 1/ slope

7. Young's modulus is a property of the material.

It is independent of length or radius of the wire.

8. Gases have no definite shape and extension of

length is meaningless in heir case.

9. Energy stored per unit volume is given by

W/(A x L) = ½ (F/A) x (l/L) = ½ stress x strain.

10. y = fl/Al or perfectly rigid body l is zero for all values of applied force. Hence Y is infinity.

11. The inter atomic binding energy decreases with temperature. So, more strain is produced at higher temperature . hence y decreases.

12. Strain = l/L. here L is doubled, hence l = L

13. l = FL/AY. For large l, A should be small and L large.

14. Note that the breaking stress will be different for wires of different cross section. But tensile strength is same. Tensile strength = breaking stress x area of cross section.

15. The stress developed will be such as to prevent the extension of length. Since extension is length due to heating as proportional to the initial length, therefore $S \propto L$. Note that $S = F/A$, so it is independent of A.

16. Modulus of elastic is a property of material it does not depend on length or area of cross section.

17. $F = YA\Delta l/l$ and $\Delta l = la\Delta\theta$

hence $F = YAa\Delta\theta$.

Stress = $F/A = Y\ a\ \Delta\theta$

It is independent of l and A.

18. $\delta = Wt^3/bd^3Y$. hence $\delta \propto 1/Y$.

19. $B = PV / \nu$. Here $\nu/V = 0.02/100$.

20. $B = \Delta P/(\Delta\nu/\nu) = h\rho g/ (0.1/100) = 10^9\ N/m^2$.

21. Energy stored per unit volume

$= ½\ Y\sigma^2$. here $\sigma = \alpha T$

because $\Delta L = L\alpha T$

22. Here $\Delta L = L\alpha\Delta T$.

23. $F = YA\ (\Delta l/l)$. here $\Delta l/l = 0.1$

24. if $\Delta l = l$, then $Y = \text{stress}/(\Delta L/L) = \text{stress}$

25. Since $l = FL/AY$. So, l will be minimum when

L/r^2 is minimum. Because $A = \pi r^2$.

26. Energy stored per unit volume.

$= \frac{1}{2}$ stress x strain

& stress = Young's modulus x strain

27. $\varepsilon = 0.06\% = 0.06 \times 10^{-2}$.

Energy density $= \frac{1}{2} Ye^2$.

28. $B = P(\Delta V/V)$

here $\Delta V/V = 0.01\% = 0.01 \times 10^{-2}$.

& $p = 100 \times 1.01 \times 10^5 \text{ Nm}^{-2}$.

$= 1.01 \times 10^8 \text{ dyn cm}^{-2}$.

Therefore $B = 1 \times 10^{12}$ dyn cm^{-2}.

29. The weight of the rope can be assumed to act at its mid point. Hence , extension will be produced in hair of the rope . that is

$$\Delta L = F(L/2) / AY = (AL\rho g)(L/2) / AY = \frac{1}{2} \rho g L^2/Y.$$

30. Hereu = ½ stress x strain

also Y = stress/strain

hence $u = \frac{1}{2} (\text{stress})^2/Y = \frac{1}{2} (S^2/Y)$

31. Net force = stretching force of the spring friction

$$= kx - \mu Mg.$$

PRESSURE

32. Ans. (C)

33. Pressure depends only on the height of he liquid column. Which is same in two cases.

34. Super fluid is a fluid with no viscosity

35. Up thrust = weight of the liquid displaced.

36. The fraction of the ball outside will depend will depend on the density of liquid and not on the value of effective weight

37. Archimedes up thrust is equal to the weight of the liquid displaced. In the absence of gravity , the weight is zero.

38. The up thrust due to air will be replaced water vapours. Water vapours are lighter than air , so up thrust decreases and ball sinks a little.

39. A part of the ice cube remains outside. How wever weight of the ice is equal to the weight of the water displaced So, when the ice melts the volume of the water produced is equal to the volume of the water displaced by the ice cube.

40. Decrease in volume = Volume of ice - Volume of water in same mass.

41. Let volume of sphere be V. Weight of the ball

$\rho = V\rho g$ and up thrust = $V\sigma g$.

42. The water will lie above the mercury.. The steel ball will continue to float above the mercury and will be covered by water. The up thrust due to water displaced will make the ball move up.

43. The weight of the water displaced = weight of ice cube + weight of air. Since , the weight of the air is negligible., so the volume of the water produced due to melting of ice will be same as the volume of the water displaced.

44. The weight of the water displaced = weight of the ice + weight of glass ball. When the ice melts

, the glass will be immersed in water. The water displaced due to the immersion of glass ball will be equal to its volume which will be less than the volume of the water having weight equal to the weigh of balls hence the water level will fall.

45. The load carried = weight of bucket + weight of the fish.

46. There will be increase in the load. This will displace the water. But water displaced will be equal to the water drunk by the passengers. So, water level will not change

47. If centre of buoyancy is at the centre of gravity, the torque due to the weight and up thrust is zero.

48. The air pushed down by the wigs of the bird will go out of the wires.

49. The weight decreases due to up thrust and the up thrust is equal to the weight of air displaced, which is more in case of losely packed feathers.

50. The weight of the body is equal to the up thrust. It will sink due to the downward push.

51. Pressure is independent of area & thrust = pressure x area.

52. Pressure at the bottom is maximum. To with stand it, the bottom is made thick.

53. Fall in pressure means air will rush to that place from the places where pressure is more.

54. Pa = 1 Nm^{-2}.

55. The flow of air around the wings provides the lift.

56. Since the body is completely immersed , he weight of the body = wt. of water having having volume

$120\ cm^3 = 120\ g.$

57. Let l be the length of the cube out side. Then

$$(L - 1)\ L^2 \times 3 = L^3 \text{ .hence } l = (2/3)L.$$

58. Suppose, the mass of te ball is M grams then volume of water displaced $V = M\ cm^3$. Actual volume of cavity $= V - \nu = M - (M/2) = M/2 = V/2$.

59. Velocity outflow $= \sqrt{2gh}$. Maximum value of h $= 50\ cm = 0.5\ m$ hence maximum velocity $= (2 \times 10 \times 0.50)^{1/2}. = \sqrt{10}\ ms^{-1}$.

60. volume of the raft = 120/600= 0.200 m^3. weight of the water displaced when it sinks is 200 kgt. Its mass =200 kg. So additional weight = 80 kg.

61. V x (40/100) x 1000 = 4 and V = 4/ 1000

where ρ = specific gravity

62. Let the mass of ice be M. Then mass of water displaced will also be M. Volume of water displaced will be V_1 = M/1. Volume of ice V_2 = M/0.9 hence % age of the volume outside

$$= [(M/0.9) - (M/1) / (M/0.9)] \times 100 = 10\%$$

63. Volume of water displaced = 500 cm^3. its mass is 0.5 kg and weight is 5N. hence loss of weight is also 5N.

64. Mass of ice berg = Mass of water displaced

= M (say)

Volume of ice berg V_1 = M/ (0.92)

Volume of water displaced V_2 = M/ 1.03

Percentage of iceberg below the water surface

= (V_2 / V_1) x 100 = 89.3%

65. For solid - I

[V x (3/4)] x 1 x g = Vρ1g. That is ρ_1 = ¾.

For solid – II

[V x (1/4)] x 1 x g = $V\rho_2 g$.. That is $\rho_2 = ¼$.

66. Fraction of the body inside water does not depend on the value of g.

67. Same volume of water will continue to be inside water as in the beginning

VISCOSITY

68. Ans. (B)

69. Ans. (C)

70. Ans. (B)

71. Ans. (C)

72. Ans. (C)

73. Ans. (A)

74. Ans. (B)

75. Ans. (B)

76. Ans. (A)

77. Ans. (C)

78. Ans. (C)

79. Ans. (C)

80. Ans. (C)

81. Radius of the sphere of mass 8π will be double of that of mass M. also $\nu_1 \propto r^2$. Ans. (B)

82. it is caused by the difference of pressure on the opposite sides due to different relative speeds

of the air.

Ans. (D)

83. Viscous drag = η A ($d\nu/dx$). It depends on velocity gradient and NOT on velocity Ans. (B)

84. The velocity of low increases as we go away from the part, when the liquid is in contact with the containing vessel.

Ans. (A)

85. Angle between viscous drag and direction of flow is π. Ans. (D)

86. The $\nu_1 = 2/9\ (r^2\rho g / \eta)$

Ans. (C)

87. Only in the laminar flow , the velocity of the flow of liquid in contact with the walls of the containing vessel is zero.

Ans. (C)

88. Falls with terminal velocity

Ans. (C)

89. Poiseuille ‘s equation $V = \pi Pr^4/8\eta l$.. here v is he volume of liquid flowing per second . hence V = R. and so $\eta \propto 1/R$.

90. A part of the pressure energy is used to overcome the viscous drag.

91. According to the equation if continuity $A_1\nu_1 = A_2\nu_2$. Since $R = A\nu$, hence the rate of flow is independent of diameter. Remember , the rate of flow is the amount of liquid flowing per second.

92. it is applicable to non compressible , isotropic and non viscous liquid.

93. As viscosity increases, the resistance to flow also increases.

94. Power = $F\nu = (PA)\nu = P(A\nu)$. where ν is the velocity of flow. Here $A\nu$ is the volume of the liquid flowing per second

95. Due to high velocity of the air above the roof, the pressure above the roof is less than that below it

96. Velocity of efflux = $\sqrt{(2gh)}$. Also it is decreased by the viscosity

97. velocity of outflow is $\sqrt{(2gh)}$. It does not involve density of the liquid.

98. The net force = weight – up thrust - viscous drag. As the velocity increases, viscous drag increases so the net force also decreases, till it becomes zero.

99. The Poiseuille = Nsm^{-2}.

$= 10^5$ dyn s x ($100\ cm^{-2}$)

$= 10$ dyn s cm^{-2} = 10 poise.

100. $\nu_1 \propto r^2$.

101-104

(i) according to Bernoulli's theorem :

$p_1/p + gh_1 + ½\ \nu_1^2 = p_2/p + gh_2 + ½\ \nu_2^2$

here $p_1 = p_2$, $h_1 = H$, $h_2 = H-h$, $\nu_1 = 0$

hence $gH = g\ (H-h) + ½\ p_1/p + gh_1 + ½\ \nu_2^2$

hence $\nu_2 = \sqrt{(2gh)}$

(ii) Range R = $\nu 2$ x t, where t is the same taken by the water to fall through height H- h, that is

$H-h = ½\ gt^2$. hece $t = [2\ (H-h)\ /g]^{1/2}$.

Therefore $R = [2(H-h) / g]^{1/2}$.

(iii) For maximum range $dR/dh = 0$. that is

$2 \times ½ [h(H-h)]^{-1/2}[H-2h] = 0$

that is possible when $H – 2h = 0$ or $H = 2h$.

105. The average velocity pf efflux.

$$\nu = [\sqrt{2gh_1} + \sqrt{2gh_2}.] / 2$$

let a be the area of cross section of the hole and

A be the area of of cross section of the tank. If t

be the time taken to empty the tank from level

h_1 to h_2 then

$[\sqrt{2gh_1} + \sqrt{2gh_2}.] / 2 \times a \times t = A [h_1 – h_2]$

this gives $t = (\sqrt{R_1} – \sqrt{R_2})$

106. As describe earlier in the explanation to the Q. no. 101 to 104.

$R = 2\ (h\ (H\text{-}h)]^{1/2}$.

Here we have

$R = 2\ [h_1\ (\ H\text{-}h_1)]^{1/2}. = 1\ [h_2\ (H\text{-}h_2)]^{1/2}$.

This on simplification gives $h_2 = H - h_1$.

In Q. no 105, we have $h_1 = h$

Therefore $h_2 = H - h$, and the distance of second hole from the top is

$H - h_2 = H - (\ H\text{-}h) = h$.

Question from competitive exams :

107. V = pr2/8ηl .when the length is doubled and radius is halved, the flow becomes.

$= V (½)^2/2 = V/32$

108. Weight of the rope =W = 8 x A x 1.5 x 103 x 10 N. Where A is the area of cross section. The weight can be assumed to act at half the length of the rope. That is L = 4m.

Hence $\Delta L = (W/A) \times (L/Y)$

$= 8 \times 1.5 \times 10^3 \times 10 \times (4/5) \times 10^{-6} = 9.6 \times 10^{-3}$ m.

109. According to the gas equation p V = nkT. For the gas A, we have pV = n1kT. For the gas B we have

$(2P)\ (V/4) = n_2kT\ (2T)$. this gives $n_1/n_2 = 4$.

110. $p = 4T/r = 4 \times 25 \times 10^{-3} / 0.005 = 20pa$

110. $(h\rho g + H \times 1 \times g)\ 4/3\pi r^3 = h\rho g \times 4/3\ \pi(2r)^3$.

This gives $H = 7h\rho$.

111. Weight of the whole sphere = Up thrust

$4/3\pi(R^3 - r^3)\rho_1 + 4/3\ \pi\ r^3\rho_2 = 4/3\pi R^3 \times 1$

where ρ_1 and ρ_2 are specific gravities of concrete and sawdust respectively.

$\rho_1R^3 - r^3\rho_1 + r^3\rho_2 = R^3$

$R^3/r^3 = (\rho_1-\rho_2) / (\rho_1-\rho_2)$.

$(R^3-r^3) / r^3 = (\rho_1-\rho_2-\rho_1+1) / (\rho_1-1)$

$(R^3-r^3)\rho_3 / r^3\ \rho_2 = [(1-\rho_2) / (\rho_1-1)] \times (\rho_1/\rho_2)$

Mass of concrete / Mass of sawdust = [(1- 0.3) / (2.4 – 1)] x (2.4/0.3) = 4.

112. Otherwise they will be attracted towards each other according to the Bernoulli's theorem

113. Up = ½ Stress x Strain

Also Y = Stress/Strain = S/Strain

114. $B = \Delta p / (\Delta V/V) = h\rho g / (0.1 / 100) = (200 \times 10^3 \times 9.8) / (1/1000)$

$= 200 \times 10^3 \times 9.8 \times 10^3 = 19.6 \times 10^8$.

115. When the bird flies it pushes air down to balance its weight . So, then weight of the bird and cage assembly remains unchanged.

116. $\eta = F/a\nu$ - $MLT^{-2}/ \{(L)\ LT^{-1}\} = ML^{-1}T^{-1}$.

117. $4/3\ \pi R^3 = 1000 \times 4/3\pi r^3$. $\Rightarrow$ $r = R/10$

119. knowledge based questions.

120. use the ascent formula for capillary rise.

121. surface tension tends to have minimum surface area of the drop.

122. knowledge bases questions.

123. On the common surface , the pressure us equal to the sum of pressure due to both surfaces. That is

$$4\sigma/r = 4\sigma/r_1 - (-4\sigma/r_2)$$

124. $\nu \propto r^2$. When radius ® is half, ν becomes one fourth.

125. Let length of the side be l cm

then l^2 x 2 x 1 = 200

This gives l = 10 cm

126. According to Pascal's law , pressure of a liquid

is transmitted equally in all directions.

127. In this case, H – h = 20m

hence, velocity of efflux is given by ,

$\nu = \sqrt{(2gh)}$

substitution h = 20m, g = $10ms^{-2}$, we ge

$\nu = = 20\ ms^{-1}$.

128. knowledge based questions.

129- 132 knowledge based questions.

133. Energy, $E = \frac{1}{2} \times F \times \Delta x$

On putting $F = 200N$;

$\Delta x = 1mm = 10^{-3}$ m we get

$E = 0.1$ J

134. Velocity first increases and then becomes constant which is termed as terminal velocity

135-136 knowledge based questions

137. Excess pressure in a soap bubble is given by

$p = 2T/R$

$P \propto 1/R$

$P_{\text{bigger bubble}} < P_{\text{smaller bubble}}$

Air flows from the smaller bubble to bugger bubble

138.-141 knowledge based questions.

THERMODYNAMICS SOLUTIONS

1. **Ans. (D)**

2. **Ans. (B)**

3. **Ans. (C)**

4. **Ans. (A)**

5. **Ans. (B)**

6. **Ans. (D)**

7. **Ans. (D)**

8. **Ans. (B)**

9. $\mathbf{W_{iso}} = RT \log_e(V_2/V_1)$ **Ans. (C)**

10. Ans. (B)

11. After the complete cycle , there is no change in temperature. The internal energy will not change as it depends upon temperature.

Ans. (C)

12. For adiabatic change , $dp/p = -\gamma\, dV/V$.

Ans. (D)

13. The work done in a thermodynamic process is equal to the area under the P-V diagram.

The P-V diagram are as shown in figure.

Ans. (B)

14. Using $\Delta Q = \Delta U + \Delta W$ & $\Delta Q = 0$.

Hence $\Delta W = -\Delta U$, since there is decrease in internal energy, therefore

$$\Delta U = -75J$$

Hence $\Delta W = +75J$

Ans. (B)

15. $\Delta Q = \Delta U + \Delta W$

$= U_2 - U_1 + \Delta W$.

here $\Delta Q = -30J$. $\Delta W = -22$ J

$U_1 = 20$ J

Hence $U_2 = \Delta Q - \Delta W + U_1$.

$= -30J - (-22\ J) + 20\ J$

$= 12$ J

Ans. (D)

16. Use $PV^{\gamma} = K$.

Ans. (A)

17. C_v for mono atomic gas is 3R/2 and that for diatomic gas is 5R/2. hence the ratio is 5/3.**Ans. (D)**

18. it is a case of adiabatic expansion. So, cooling takes place. **Ans. (B)**

19. For adiabatic compression, PV^{γ} = Constant.

Hence $dp = -\gamma p dV/V$. For isothermal compression pV = constant , hence $dp = pdV/V$.

Ans. (A)

20. Bulk modulus of elasticity is given by $V\, dp/dV$.

For isothermal process, $PV = k$

Hence, $Vdp/dV = p$.

Ans. (D)

21. knowledge based question.

Ans. (B)

22. $B_a = (-dp/dV)\, V = \gamma P$. Hence it depends upon atomicity and pressure. **Ans. (C)**

23. knowledge based question.

Ans. (A)

24. knowledge based question.

Ans. (A)

25. At zero Kelvin all the process are equivalent because the molecular motion ceases at zero Kelvin.

Ans. (B)

26. Work done = area under P – V graph & V axis.

Therefore

$W_1 < W_2 < W_3$.

Ans. (B)

27. Heat at constant pressure is

$Q_1 = nC_pdT.$

Heat energy supplied to increase internal energy

$Q_2 = nCvdT$

$Q_2/Q_1 = C_v/C_p = 1/\gamma = 1/(5/3) = 3/5.$

$Cp/Cv = \gamma = (5R/2) / (3R/2)$

Ans. (B)

28. Entropy is constant when work is converted into heat at constant temperature. **Ans. (D)**

29. knowledge based question.

Ans. (B)

30. Work done in isobaric process is given by

$$W = p\Delta V = P\,(V_2 - V_1) \qquad (1)$$

Work done in isothermal process

$$W_{iso} = RT \log_e(V_2/V_1) \qquad (2)$$

Work done in adiabatic process

$$W_a = P\Delta V/\,(\gamma - 1) \qquad (3)$$

From 1,2 & 3 it is clear that work done in isobaric process is maximum. **Ans. (B)**

31. No heat goes out, the work done on the system increases the internal energy, hence temperature of the gas increases.

Ans. (B)

32. Internal energy is path independent and depends on initial and final positions. Change in internet energy is zero for cyclic and isothermal processes **Ans. (B)**

33. knowledge based question.

Ans. (D)

34. in isothermal process, $\Delta T = 0$

$\Rightarrow \quad \Delta U = 0$

$\Rightarrow \quad U = \text{constant.}$

Ans. (D)

35. knowledge based question.

Ans. (B)

36. knowledge based question.

Ans. (D)

37. The isothermal bulk modulus of a gas is equal to 1 atm., that is

$$1 \text{ atm} = 1.013 \times 10^5 \text{ Nm}^{-2}.$$

Ans. (B)

38. knowledge based question.

Ans. (B)

39. In isothermal process no change in internal energy takes place. **Ans.(A)**

40. Note that ab is isothermal and bc is isobaric. System returns to original state from c to a.

Ans.

(D)

41. Here $\Delta Q = \Delta U = MC\Delta T$. Since $\Delta Q = 200$ J, $\Delta T = 20K$ and M = 5 mole, hence c = 2 $Jmol^{-1}K^{-1}$,.note that specific heat capacity = specific heat. Note that specific heat capacity = specific heat. **Ans. (C)**

42. Cp = (5/2)R for mono atomic gas. We know that

$$\theta = n \times Cp \times dT$$

$$\theta = 2 \times (5/2)R \times 100 = 500R.$$

Ans. (D)

43. Here $V = aT + b$.

Hence $p = nRT/(aT+b) = nR/[a+(b/T)]$

Since $T_2 > T_1$, therefore $p_2 > p_1$.

Ans. (C)

44. $W = \int pdV = \int (RT/V)\, dV$.

Since $V = kT^{2/3}$.

Hence $dV = (2/3)\, kT^{-1/3} dT$.

Eliminating K, we find $dV/V = (2/3)\, dT/T$.

Hence $W = \int_{T2} 2/3\, (RT/T)\, dT = (2/3)R\,(T_2 - T_1)$

$= (2/3)\, R(30) = 20R$

Ans. (B)

45. For adiabatic process $\Delta Q = 0$.

Hence $\Delta W = -\Delta U$

$\Delta W = -(-200J) = 200$ J.

Ans. (C)

46. $\Delta Q = \Delta U + \Delta W$.

here $\Delta Q = 2k$ cal = 2000 cal = 2000 x 4.2 J = 8400 J.

Therefore $\Delta U = 8400 – 500 = 7900$ J.

Ans. (A)

47. For adiabatic process

$PV^{\gamma} = \text{constant}$

$P\rho^{\gamma} = \text{constant}$.

$p\rho^{\gamma} = p'\rho^{\gamma}$.

$p/p' = (\rho'/\rho)^{\gamma}$.

$p/p' = (1/32)^{7/5}. = 1/128.$

$p' = 128p$ **Ans. (C)**

48. Work done = Area enclosed by indicator diagram (triangle)

$= ½ \times (4p_1 - p_1) \times (3V_1 \times V_1) = 3p_1V_1.$

Ans. (C)

49. The process is isothermal, hence

$\Delta U = 0.$ $(\Delta T = 0)$

As the gas expands, heat is supplied

$\Delta Q = +VE.$

Ans. (B)

50. $\Delta Q = \Delta U + \Delta W$

$\Rightarrow \quad \Delta W = \Delta Q - \Delta U$

$= 110 - 40 = 70$ J

Ans. (B)

51. for adiabatic change

$PV^{\gamma} =$ constant.

$T^{\gamma} / P^{(\gamma-1)} =$ constant

$P \propto T^{\gamma / (\gamma-1)}$ where $\gamma = 7/5$.

$\Rightarrow \quad p \propto T^{7/2}$.

$C = 7/2$. **Ans. (D)**

52. Heat energy absorbed = area of loop.

$= \pi r^2 = \pi \times (10)^2 = 10^2\pi$joules.

Ans. (C)

53. $T_1V_1^{-1} = T_2V_2^{\gamma-1}$. here $\gamma = 1.4$ for diatomic gas

$$T_2 = (V_1/V_2)^{\gamma-1} T_1.$$

On solving, we get

$$T_2 = 891^oC$$

Ans. (C)

54. $T_1/T_2 = (p_1/p_2)^{(1-\gamma)/\gamma}$.

For air $\gamma = 1.4 = 7/5$.

Hence $T_2 = 300(4/1)^{(1-7/5)/(7/5)} = 300(4)^{-2/7}$.

Ans. (D)

55. $\Delta W = p\Delta V = 10^3 \times 0.25 = 250$ J

Ans. (B)

56. $\Delta Q = \Delta U + \Delta W$

$= 167 + 333 = 500$ cal.

Ans. (C)

57. We know that

$PV^{\gamma} =$ constant.

$TV^{\gamma-1} =$ constant

$T_2 = (27/8)^{5/3} . . 300$

$T_2 = 648$ K $= 375^{o}$C.

Ans. (D)

58. $P_1V_1^{\gamma} = P_2V_2^{\gamma}$.

$P_1V^{5/3} = P_2(V/64)^{5/3}$.

$P_1 = 1024P$.

Ans. (D)

59. Both assertion and reason are true and explanation is correct. **Ans. (A)**

60. From first law of thermodynamics, we have :

External work done, $\Delta W = \Delta Q - \Delta U$

Where ΔQ = heat added to the system.

ΔU = internal energy.

Substituting $\Delta Q = 100$ J ; $\Delta U = 40$ J, we get

$\Delta W = 70$ J **Ans. (B)**

61. From first law of thermodynamics, we have :

$\Delta Q = \Delta U + \Delta W$

$\Delta U = \Delta Q - \Delta W$

Substituting $\Delta Q = 200$ cal $= 20 \times 4.2$ J

$= 840$ J ; $\Delta W = 40$ J, we get

$\Delta U = 800$ J.

Ans. (C)

62. V/T = Constant

Hence $\Delta V/V = \Delta T/T$ or $\delta = \Delta V/V\Delta T = -1/T$

Ans. (C)

63. The magnitude of the slope of the P-V diagram

for an adiabatic process equals to adiabatic

constant γ. The slope of plot 2 is steeper than the slope of plot 1.

$\gamma_2 > \gamma_1$.

Now $\gamma_{\text{mono atomic}} > \gamma_{\text{Diamotic}} > \gamma_{\text{poly atomic}}$.

We can conclude that alternative (B) is the correct choice. **Ans. (B)**

64. For an ideal gas, dQ = dU + dW = nCvd/t + pdv

dW= 0

$\Rightarrow$ dV = 0, alternative (B) is incorrect.

$dQ < 0 \Rightarrow dT < 0$.

Temperature decreases, alternative (A) is correct.

Ans. (A)

65. For isobaric process, indicator diagram is a line parallel to p-axis, Slope of adiabatic process, is larger than the slope of isothermal curve. This is the case with (C) **Ans. (C)**

66. In a cyclic process, the net change in internal energy is zero. **Ans. (D)**

67. From ideal gas equation, we have :

$PV = nRT$

From figure we have :

At A, $P_0V_0 = nRT$ (1)

At B, $2P_0V_0 = nRT$ (2)

From 1 & 2 we have

$$T = 2T_0.$$

Now, thermodynamic efficiency of the reversible engine of this Carnot's cycle is given by :

$$\eta = 1 - (T_0/T)$$

Substituting $T = 2T_0$, we get

$$\eta = ½$$

$\Rightarrow$ efficiency of cycle. = 50%.

Ans. (B)

THERMOMETRY, CALORIMETRY & HYGROMETRY.

1. Temperature is proportional to the average molecular kinetic energy. **Ans. (B)**

2. Heat required to raise the temperature of 1 gram of water through $1^{o}C$ is 1 cal = 0.001 kcal.

Ans. (A)

3. it is determined by the difference in the average kinetic energy of the molecules in random motion.

Ans. (D)

4. In SI, both heat and energy are measured in joules and so the joule's mechanical equivalent of heat, which is a conversion factor is 1.

Ans. (D)

5. Joule's mechanical equivalent of heat = work/heat = 4.2H/ 1cal = 4.2 x 10^3J($kcal^{-1}$) A**ns. (C)**

6. Mechanical equivalent relates heat in calories to the equivalent amount of work in joules. **Ans. (B)**

7. Melting point falls due o pressure, So the ice at the joint melts . when pressure to removed. It

again freezes and one block is formed.

Ans. (B)

8. knowledge based question.

Ans. (A)

9. knowledge based question.

Ans. (D)

10. knowledge based question.

Ans. (A)

11. The atmospheric pressure on the moon is very small. Due to this water in bottle will start boiling as soon as lid is opened. It is because a liquid starts boiling when its vapour pressure

becomes equal to atmospheric pressure.

Ans. (C)

12. knowledge based question.

Ans. (B)

13. Volume in constant Gay Lussac's law

Ans. (C)

14. knowledge based question.

Ans.(A)

15. The latent heat of steam is very high and so the body receives larger amount of heat per unit of mass of substance in case of steam.

Ans. (C)

16. When ice melts the heat energy used to weaken the molecular bonds which results in the gain of potential energy.

Ans. (C)

17. Due to high thermal capacity, water absorbs large amount of heat and ice cooling is faster **Ans. (B)**.

18. R.H = [Actual amount of vapours / Vapours required foe saturation] x 100 **Ans. (C)**

19. Maximum value of relative humidity is 100%.

Ans. (D)

20. When the relative humidity is high, less evaporation occurs from our body and so we feel hotter **Ans. (A)**

21. Saturation vapour pressure is higher at higher temperatures. **Ans. (B)**

22. Human beings feels comfortable when R.H. is between 50 -60% **Ans. (C)**

23. The dew point is the temperature at which amount of water vapour is sufficient to saturate the air in the room.

Ans. (B)

24. Heat supplied is 2 kcal. 2 kcal = 2000 x 4.2 = 8400 joules.

Energy consumed in doing work = 500 joules.

Increase I internal energy = 8400 – 500 = 7900 joules. **Ans. (A)**

25. Rate of loss heat decreases with the fall of temperature. **Ans. (C)**

26. We know that

$Q = MC\Delta T$ $C = Q/M\Delta T$ since $\Delta T = 0$

$\Rightarrow$ $C = \infty$ **Ans. (C)**

27. knowledge based questions.

Ans. (A)

28. $Cp = (5/2)R$ and $C_v = (3/2)R$ We know that

$Q_v = nC_v\Delta T$ & $Q_p = nC_p\Delta T$

$Q_v/Q_p = (3/5)$.

Hence $Q_p = 207$ J $\Rightarrow$ $Q_v \cong 124$. **Ans. (D)**

29. We know that : Speed = Frequency x wavelength **Ans. (D)**

30. Due to low boiling point, alcohol vaporizes eve at low temperature as compared to water which has 100^oC as the boiling point.

Ans. (A)

31. $\Delta q = MC\Delta\theta$ $\Rightarrow$ $\Delta\theta = \Delta Q/MC$.

Since C is infinite, therefore $\Delta\theta = 0$.

Ans. (C)

32. knowledge based questions.

Ans. (A)

33. knowledge based questions.

Ans. (C)

34. We know that C/5 = (F-32) / 9.

Let C = F = x $\Rightarrow$ x/5 = (x-32) / 9.

$\Rightarrow$ x = -40°C = -40°F

Ans. (C)

35. knowledge based questions.

Ans. (C)

36. Specific heat is maximum for steel.

Ans. (B)

37. knowledge based questions

Ans. (B)

38. knowledge based questions

Ans. (C)

39. knowledge based questions

Ans. (B) .

40. knowledge based questions.

Ans. (B)

41. Heat capacity = mass x specific heat.

= $V\rho$x specific heat.

(Because = volume x density)

Ans. (A)

42. Heat gained by 20 g of water = 20θ

Heat lost by 40g of water = $40(10-\theta)$

Heat lost = Heat gained

$40(10-\theta) = 20\theta \quad \Rightarrow \quad \theta = 6.67^{o}C$

Ans. (B)

43. Heat supplied = 420 J = 100cal.

Temperature raised = 100/10 = $10^{o}C$

Ans. (C)

44. knowledge based questions.

Ans. (C)

45. knowledge based questions.

Ans. (D)

46. knowledge based questions.

Ans. (D)

47 knowledge based questions.

Ans. (B)

48. Total heat energy gets converted into work

Hence W = 200 cal.

= 200 x 4.2 J = 840 J

Ans. (D)

49. knowledge based question.

Ans. (B)

Concept plus :

50. On change of state the potential energy increases, which is much larger in case of boiling because of larger change in volume.

Ans. (A)

51. Latent heat of ice = 80 cal/g.

Heat required by ice to converted to water = x x 80

Heat lost by water = 240 x 40

Heat gained = Heat lost

x x 0 = 240 x 40

$x = (240 \times 40) / 80 = 120$ g.

Ans. (A)

52. knowledge based questions.

Ans. (C)

53. Thermal capacity = m.C = $V\rho C$

Ratio of thermal capacity = $V_1\rho_1C_1 / V_2\rho_2C_2$

$= (V/V) \times (2/3) \times (3/2) = 1:1$

Ans. (D)

54. Latent heat of steam is 540 cal. 5g of ice at 0^oC will be converted into 5g of water at 100^oC by absorbing heat $= 5 \times 80 + 5 \times 100 = 900$ cal.

Thus less than 2g of steam will condense. So

that final temperature will be 100^oC

Ans. (A)

55. $R \propto (\theta-\theta_0)$. Hence $R_1 \propto (50-20)$ and $R_2 \propto (40-20)$. Therefore $R_1/R_2 = 3/2$.. since same amount of heat is lost in both the cases. Therefore $R_1t_1 = R_2t_2$. This gives

$$t_2 = (3/2) \times 8 = 12 \text{ minutes.}$$

Ans. (B)

56. Dew point is that at which the relative humidity is 100%. Hence dew point at 15^oC **Ans. (A)**

57. Let the final temperature be T

$= 10 \times 80 + 10 \times 1 \times T$

Heat lost by water = 55 x (40-T)

$\Rightarrow$ T = 21.54^{o}C = 22°C

Ans. (B)

58. Let the final temperature be t. then 100 x 80 + 100 (t-0) = 100 (100-t)

This gives 200t = 2000 nd t = 10°C

Ans. (A)

59. C/100 = (F – LFP) / (UFP – LFP)

where C is the actual temperature . F is the reading on faulty thermometer . LFP is lower fixed point ; UFP is upper fixed point.

Ans. (B)

60. (Temp. on scale – LFP) / (UFP – LFP) = (Temp. on scale – LFP) / (UFP – LFP)

$\Rightarrow$ (x-20) / (150 – 20) = (60 – 0) / (100– 0)

$\Rightarrow$ x = 98°C **Ans.**

(B)

61. let the mass of steam condensed = mg.

Heat lost by ,g of steam to attain temp. of 90°C = m x 540 + m x S x (100-90)

Heat required by water to change from 20°C to 90°C = 22 (90-20)

$\Rightarrow$ m x 540 + mx10 = 22 x 70

$\Rightarrow \quad m = 24.8$ g.

Ans. (A)

62. $Mgh = MC\Delta\theta$

$\Delta\theta = gh/C$ (in SI, C = 4.2 kcal/kg)

$\Delta\theta = 1.16^{o}C$

Ans. (C)

63. R.H. = (Actual pressure/SVP)x 100

$(0.012 \times 10^5 \times 100) / (0.016 \times 10^5) = 75\%$

Ans. (D)

64. Heat available with steam is much larger than heat required by ice to melt and raise its

temperature to 100^oC . hence final temp. will be

100^oC **Ans. (C)**

65. Heat required by ice to change to θ^oC

$= 1 \times 80 + 1 \times (\theta - \theta)$

Heat lost by water at $100^oC = 1 \times 1 \times (100 - \theta)$

By using principle of Calorimetry , we get

$80 + \theta = 100 - \theta$

$2\theta = 20$

$\theta = 10^oC$ **Ans. (B)**

66. Let n small drops of water coalesce to form a big drop of radius R. Then

$4/3\pi R^3 = (4\pi r^3/3) \times n \quad \Rightarrow \quad r^2 n = R^3/r.$

Now $W = T\Delta A$

Then $W = T\,[4\pi r^2 n - 4\pi R^2]$

$W = 4\pi T\,[\,(R^3/r) - R^2)$

$W = 4\pi T R^3 = [(1/r) - (1/R)]$

Now, $ms\Delta\theta = W/J$

Or $4/3\pi R^3 \times 1 \times \Delta\theta = (4\pi R T^3/J)\,[\,1/r - 1/R]$

$\Rightarrow \quad \Delta\theta = 3T/J\,[\,1/r - 1/R]$

Ans. (C)

67. Heat given by 50 g of water in cooling from 80^oC to 0^oC is

$$Q = mC\Delta T$$

$$Q = 50 \times 1 \times 80 = 4000 \text{ cal.}$$

Heat required by 50 g to melt is given by

$$Q' = mL$$

$$Q' = 50 \times 80 = 4000 \text{ cal.} \qquad (L = \text{cal/g})$$

Since Q =Q' , thus there is no further transfer of heat is possible, the final temperature of the mixture will be zero.

Ans. (A)

68. We know that, heat added to a system is given by

$$\Delta Q = \Delta U + \Delta W$$

where ΔU = increase in internal energy

ΔW = work done by system

here Q = 22407 J, ΔW = 168J

$\Rightarrow$ ΔU = 2072 J.

Ans. (C)

69. Length of open end column above Hg = 8cm

Pressure = 76 cm of Hg.

Let the mercury rise in tube = x cm

$\Rightarrow$ Final length = 8 +44 –x = 52- x

Pressure = 76 – x

$\Rightarrow$ 76 x 8 = (76 –x) (52-x)

That is , x = 36.4 cm

Therefore length of air column

= 52- 36.4 =15.6 cm.

Ans. (A)

70. knowledge based questions.

Ans. (C)

71. Whenever mechanical work is done, heat is produced , So, by joules mechanical equivalent of heat is given by :

$$J = W/Q$$

$$\Rightarrow \quad JQ = W \qquad (1)$$

Now when water falls from height h, then work done is given by :

$W = mgh$

And , heat generated is given by :

$Q = mc\Delta T$

Here, $c =$ specific heat of water.

Hence, equation 1 becomes :

$J (mc\Delta T) = mgh.$

$\Delta T = gh/cJ$

Substituting $g = 9.8\ ms^{-2}$. ; $h = 210m$; $c = 1\ cal\ g^{-1}\ {}^{o}C^{-1}$. $= 103\ cal\ kg^{-1}\ {}^{o}C^{-1}$. ; $J = 4.3\ J\ cal^{-1}$, we get

$$\Delta T = (9.8 \times 210) / (4.2 \times 10^{3}) = 0.49^{o}C$$

Ans. (C)

72. From the equation of heat balance, we have :

Heat given by water at 40^oC = heat taken by ice.

Or $m_2C_2Q_2 = m_1L + m_1C_1Q_1$

Or $m_2C_2 (40 - \theta) = m_1L + m_1C_1(\theta - 0)$

Where, L = latent value of fusion of ice.

$= 80 \text{ cal } g^{-1}$.

θ = final temperature.

Now substituting $m_1 = 5g$

$C_1 = C_2 = 1 \text{ cal } g^{-1o}C^{-1}$.; $L = 80 \text{ cal } g^{-1}$.

$m_2 = 20$ g, we get

$800 - 20\theta = 400 + 5\theta$ or 25θ

$= 400$

$\theta = 16^oC$ **Ans. (B)**

73. In order to calculate temperature on a new scale of thermometer, following relation is used :

(t –LFP of t –scale) / (UFP – LFP of t scale)

= (x –LFP of x –scale) / (UFP – LFP of x scale)

(1)

Heret = true value

LFP = lower fixed point

UFP = upper fixed point

X = reading of the new scale.

Now, for true value we have :

$T = 60^oC$

LFP = Freezing point of water $=0^oC$

UFP = Boiling point of water = 10^oC

For new scale , we have :

LFP = 20^oC

UFP = 150^oC

Substituting the value of both true scale (f) as well as new scale (x) in eqn (1)., we get

$$(60-0) / (100-0) = (x-20) / (150 - 20)$$

On solving, we get; x = 98^oC **Ans. (A)**

74. Kinetic energy $\propto$ increase in temperature. When velocity is doubled, then kinetic energy becomes

our times. Hence temperature is also increases four times. **Ans. (D)**

75. (Temp. of one scale – LFP) / (UFP – LFP)

Ans. (B)

76. Smaller the difference between the temperature of the dry bulb and wet bulb reading, higher the value of relative humidity

Ans. (B)

77. We know that

$$R_t = R_0(1 + \alpha t) \qquad \ldots\ldots\ldots\ldots..(1)$$

Therefore, $R_{10} = R_0(1 + \alpha \times 10)$ ……..(2)

$R_{100} = R_0(1 + \alpha \times 100)$ ……..(3)

From 1 and 2

$t - 10 = [(R_t - R_{10}) / (R_{100} - R_{10})] \times 90 = [(3.26 - 2.71) / (3.71 - 2.71)] \times 90$

$t - 10 = 0.55 \times 90 = 49.5$

$\Rightarrow \quad t = 60^oC$ **Ans. (C)**

78. Use principle of calorimetry.

Ans. (A)

79. R.H = [S VP at the dew point / SVP at given temperature.] x 100

= (15.5 / 23.7) x 100

R.H = 65.4% **Ans. (A)**

80. The temperature of boiling water = $100^oC = 212$

F

Temperature of lowered reading of 'F scale =

140^oF

We know that

$C/5 = (F-32) / 9$

$\Rightarrow \quad \Delta F = (9/5)\Delta^oC$

$\Rightarrow \quad 212 - 140 = (9/5)\Delta^oC$

$\Rightarrow \quad \Delta^oC = (5/9) \times 72 = 40^oC$ **Ans.**

(B)

81. We know that $dQ = \mu C_p dT$

$\Rightarrow \quad 70 - 2 \times C_p \times 5$

We know that $C_v = C_p - R$

$C_v = 5$ cal mol^{-1} K^{-1}.

Heat required = nC_vdT.

= 2 x 5 x 5 = 50 cal.

Ans. (B)

82. At first, there is a linear variation in temperature and time when liquid oxygen is heated from 50 K onwards. In between, at a particular temperature , phase change in liquid oxygen takes place. Since phase change is an isothermal process, therefore temperature remains constant. After phase change ,

again the temperature shows linear variation with time. Hence option C is correct.

KINETIC THEORY OF GASES SOLUTIONS.

1. knowledge based question.

   Ans. (B)

2. knowledge based question.

   Ans. (A)

3. knowledge based question.

   Ans. (D)

4. knowledge based question.

   Ans. (B)

5. knowledge based question.

   Ans. (A)

6. knowledge based question.

Ans. (D)

7. it is a case, as if volume is halved , So the pressure is doubled. **Ans. (B)**

8. knowledge based question.

Ans. (C)

9. PV = RT, but V = M/d. Hence P/M = RTd. Therefore at constant temperature, **$P \propto d$.**

10. PV = RT Or PM = RTd. If P is constant, then $T \propto 1/d$. But $T \propto Q^2$. Hence **$C \propto 1/\sqrt{d}$**.

11. $C_1/C_2 = [T_1/T_2]^{1/2}$. here $C_1 = 0.5\ kms^{-1}$., $T_1 = 0^oC = 273\ K$, $T_2 = 819^oC = 1092\ K$

Hence $\mathbf{C_2 = 1\ kms^{-1}}$.

12. it is a case as if volume is halved. So, the pressure is doubled. **Ans. (C)**

13. knowledge based question.

Ans. (B)

14. Collision is assumed to be elastic

Ans. (C)

15.. it is in accordance with the graham's law of diffusion. **Ans. (C)**

16. knowledge based questions.

Ans. (D)

17. knowledge based question.

Ans. (D)

18. knowledge based question.

Ans. (B)

19. The term hot refers to higher temperature and temperature depends on kinetic energy.

20. knowledge based question.

Ans. (A)

21. knowledge based question.

Ans. (C)

22. knowledge based question.

Ans. (B)

23. knowledge based question.

Ans. (B)

24. knowledge based question.

Ans. (D)

25. Each relation decreases the degrees of freedom by 1. **Ans. (A)**

26. $C_p = C_v + R = (dU/dT) + R$.

Ans. (C)

27. knowledge based question.

Ans. (B)

28. knowledge based question.

Ans. (B)

29. knowledge based question.

Ans. (C)

30. knowledge based question.

Ans. (D)

31. $P_1V_1/T_1 = P_2V_2/T_2$. hence $P_2 = 2P_1$ and $V_2 = 2V_1$.

Therefore $T_2 = 4T_1 = [27+273]K = 1200$ K. **Ans. (D)**

32. PV = k = nRT. Hence k depends on n, the number of moles of the gas. **Ans. (C)**

33. PV = RT. Hence pV/T = R = 2 cal $mol^{-1}K^{-1}$.

Ans. (C)

34. The internal energy of perfect gas consists of only translation KE, therefore it depends on temperature alone.

Ans. (B)

35. There is no inter molecular force for perfect gas. So, intermolecular potential energy does not exist.

Ans. (A)

36. Gases have Cp and Cv.

Ans. (B)

37. We know that

$C_{rms.} \propto 1/\sqrt{M}$.

Ans. (D)

38. Cp –Cv = R and R = 2 cl/mol K. This is true only for (B).

39. For a gas the average energy per mole is (3/2)p. Hence average energy per molecule is (3/2) p/N.

Ans. (B)

40. Cp/Cv = 3/2 = (Cν + R) / cν = 3/2

Ans. (C)

41. pV = RT, therefore pV/T = R = 8.4 J $mol^{-1}K^{-1}$. = 2 cal $mol^{-1}K^{-1}$. **Ans. (C)**

42. The atoms cannot oscillate . So, the degrees of freedom will be 5.

Therefore Cv = (5/2)R.

43. Motion of gas molecules is random.

Ans. (D)

44. We know that $C_{rms} \propto \sqrt{T}$

Ans. (A)

As temperature increases four times, therefore root mean square velocity become twice.

45. The molecules have to travel less distance between the walls. So, the rate of collision

is faster.

Ans. (D)

46. For perfect gas, there is no intermolecular force and therefore internal energy depends on the temperature alone.

Ans. (A)

48. $1/3\ Nmc^2 = (2/3) \times [1/2\ Nm]\ c^2 = 2/3$ K.E

Ans. (A)

49. Number of translational degrees of freedom are same for all types of gases.

Ans. (B)

50. Work done is not a thermo dynamic function. **Ans. (B)**

51. Cv = R/ 0.67 = 1.5T = (3/2)R

Ans. (C)

52. According to law of equi partition of energy, the energy per degree of freedom is ½ kT.

Ans. (C)

53. 8g of oxygen is equivalent to (1/4) mole.

Ans. (B)

54. Absolute temperature $\propto$ average KE $\propto$ (rms speed)^2. **Ans. (A)**

55. For Boyle's law , temperature should be constant. **Ans. (B)**

56. $C_{rms} \propto 1/\sqrt{M}$, where M is molecular mass.

Ans. (A)

57. $C = \sqrt{(3p/\rho)} = \sqrt{[(3 \times 10^3) / 2.6]} = 40$ m/s.

Ans. (D)

58. Maximum density of water is at 4^oC, which corresponds to 39.2^oF. **Ans. (B)**

59. RMS speed depends on temperature. As temperature is constant , So RMS speed

does not change.

Ans. (D)

60. As the gas is a real gas, so work has to be done in separating the molecules. Hence heat is taken from the gas and so the temperature fails. **Ans. (A)**

61. K.E$\propto$ T.

Ans. (A)

62. knowledge based question.

Ans. (A)

63. Use $V_1/T_1 = V_2/T_2$.

Ans. (D)

64. $\Delta U = nC_v\Delta T$

Also, $C_p/C_v = \gamma$. Hence $(C_p-C_v) / C_v = \gamma-1$

That is, $C_v = R / (\gamma-1)$. This gives

$\Delta U = [nR / (\gamma-1)] \Delta T = p\Delta V / (\gamma-1) = \{p (2V - V)\} / \gamma-1 = pV/ (\gamma-1)$ **Ans. (C)**

65. $C_p - C_v = R$.

Ans. (D)

66. Mono atomic molecules have only three degrees of freedom for translatory motion.

A

n

s

.

(

D

)

67. knowledge based questions.

Ans. (C)

68. Neon is a mono atomic gas.

Hence, Cv = (3/2)R.

Ans. (B)

69. Since $C_v = n \times (R/2)$ &

$$C_p = (nR/2) + R = [(n+2)/2]\,R$$

Therefore,

$$\gamma = C_p/C_v = (n+2)/n \Rightarrow n = [2/(\gamma-1)]$$

Ans. (C)

70. In this process, Volume (V) remains constant though other variables may change.

Ans.

(

C

)

71. knowledge based questions.

Ans. (B)

72. Rate of diffusion $\propto$ $1/\sqrt{\text{density}}$

Ans. (D)

73. $C_{rms} = \sqrt{(3RT/M)}$

Ans. (B)

74. Average kinetic energy of molecules in gas is given by

$E \propto T \Rightarrow E_1/E_2 = T_1/T_2$.

Substituting $T_1 = 300$ kJ ;

$T_2 = 350$ K , we get

$E_1/E_2 = 6/7$.

Ans. (B)

75. knowledge based questions.

Ans. (D)

76. For first sample pV = nRT

For second sample, 2p x (V/4) = n'R(2T)

Therefore n/n' = 4.

Ans. (B)

77. pV = constant

That is p $[4/3\pi r^3]N$ = constant.

Now when r is doubled] p becomes $1/8^{th}$.

Ans. (C)

78. pV = nRT

$\Rightarrow$ $n_0T_0 = n_HT_H$.

$\Rightarrow$ $T_0/T_H = n_H/n_0$.Sincs mass is same for both gases, hence $n_H = 16n_0$. **Ans. (C)**

79. Given equation

$[p+(a/V^2)(V-b) = RT$

We know that like quantities are added or subtracted. Hence a/V^2 has dimensions of

pressure b has dimensions of volume

Ans. (B)

80. For jar A, $PV = n_1RT$

for jar B] $2p. (V/4) = n_2R(2T)$

Dividing both] we get

$2 = n_1/n_2(1/2)$

$\Rightarrow \quad n_1:n_2 = 4 : 1$

Ans. (D)

81. knowledge based questions.

Ans. (C)

82. For adiabatic equation of an ideal gas , we have

$T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$

$T_2 = T_1(V_1/V_2)^{\gamma-1}$.

Substituting $T_1 = 27^oC = 27 + 273 = 300$ K ;

$V_1 = 8$ liter.

$V_2 = 1$ liter ; we get

$T_2 = 1200$ K

$T_2 = 1200 - 273 = 927\ ^oC$

Ans. (D)

83. Rms velocity of a gas molecule is given by

$$C = \sqrt{(3RT/M)}$$

If M = constant, then we have

$C \propto \sqrt{T}$.

$\Rightarrow$ $C'/C = \sqrt{T'/T}$

on putting $C' = 2C$, we get : $T' = 4T$

Now according to Charle's law at constant pressure we have

$\Rightarrow$ if temp. becomes 4 times, then volume becomes 4 times. **Ans. (D)**

84. knowledge based question.

Ans. (C)

85. knowledge based questions.

Ans. (C)

86 PV = constant , when volume is halved , pressure is doubled. However volume is

reduced to V/2 from 2V. Therefore, pressure becomes 4p.

87. $P_1V_1 / T_1 = P_2V_2 / T_2$, That is $T_2 = P_2V_2 / p_1V_1 \times T_1$.

88. The moving thermometer will impart velocity v t the molecules . so, increased in the temperature = 2/3 (increase in kinetic energy)

89. $T_1\gamma / (P_1^{\gamma-1}) = T_2\gamma / (P_2^{\gamma-1})$ Therefore T2γ = (P2/P1) γ-1 . Tγ1

$$T_2^{1.5} = (1/8)^{0.5} (300)^{1.5}.$$

Or $T_2 = (1/8)^{0.5/1.5} (300) = (1/8)^{1/3} \times 300$

$= 150$ K $= 123^{o}C$

90. Since pV = nRT, therefore x = nR. Here R is a constant and n is number of moles. Which depends on the number of molecules in the sample.

91. C rms = $\sqrt{(3kT/m)}$ and $c_{average} = \sqrt{(8kT/\pi m)}$

92. $c_p = \sqrt{(23/)}\ c_{rms}$.

93. For isothermal process , PV = constant . So pV curve is hyper bola with p decreasing as V increases.

94

SIMPLE HARMONIC MOTION (SOLUTIONS)

1. When the displacement of one will be zero that of the other will be zero that of the other will be amplitude /4. that is when one is at the mean position the other wil be at the extreme position. So, the phase difference between them is $\pi/2$.

2. Maximum velocity if ω A. here

   $\omega = 2\pi/T. = 2\pi/2 = \pi.$

   Hence $\omega A = \pi \times 5 = 5\pi$.

3. increase in displacement produces corresponding increase in acceleration .

4. $T = 1/\nu = (1/100)s = 0.01s$.

5. $E = ½ M\omega^2A^2$.

6. The acceleration is either parallel or anti parallel to velocity.

7. $F = kx$. Hence $k = f/x = Nm^{-1}$.

8. $(M/k) = (ML^0T^0) / (ML^0T^{-2}) = M^0L^0T^2$.

9. Maximum velocity of the oscillator is called velocity amplitude. Since velocity of SHM.

$$\omega [A^2 – x^2]^{1/2}. \text{ hence } \nu (max) =\omega A.$$

10 Acceleration of SHM is ω^2x. hence maximum acceleration $a(max) = \omega^2A$.

11. $T = 2\pi \sqrt{(\Delta l/g)}$

12. $\omega 2y = \omega[A^2 - y^2]^{1/2}$., here A = 2xm, y =1 cm ;

hence $\omega = \sqrt{3}$.

13. for series combination of springs.

$1/k = (1/k_1) + (1/k_2)$

14. for parallel combination of spring

$k = k_1+k_2$.

15. $T = 2\pi (l/g)^{1/2}$. hence $I = (g/4\pi^2) T^2$. the graph

between l & T is a parabola.

16. the acceleration due to gravity at a depth d is g_d =

g [1-(d/R)] = g [(R-d) /R]. but R-d = y is the

distance of the point from the centre of the earth.

Then g_d = (g/R) y. so, the acceleration of the

body in the tunnel is proportional to y. and the motion is SHM with time period $T = 2\pi\ [R/g]^{1/2}$.

17. The pendulum comes under two accelerations (g and a) in mutually perpendicular directions hence resultant acceleration increases because of which T decreases.

18. Acceleration due to gravity on the planet is twice that on the earth .

19. $\frac{1}{2} M\omega^2 (A^2 - x^2) = \frac{1}{2} M\omega^2 x^2$.

    That is $2x^2 = A^2$.

    Hence $x = \pm A/\sqrt{2}$.

20. $Up = \frac{1}{2} M\omega^2 x^2 = \frac{1}{2} M\omega^2 A^2 \sin 2\omega t$

` $= \frac{1}{4} M\omega^2 A^2 [1 - \cos 2\omega t]$

21. For SHM acceleration = $\omega^2 x$. here $\omega^2 = p$.

22 in series combination of springs

$$1/k = (1/k_1) + (1/k_2)$$

in parallel combination $k = k_1 + k_2$. here (i) , (iii) & (iv) are behaving as parallel combination.

23. Since phase difference is constant, time periods must be equal.

24. Max. velocity ωA. since phase difference is constant therefore ω is same for both.

25, 26. Knowledge based questions.

27. the positions of the particle at t_1 ot t_2 may be the extreme positions of the simple harmonic motion.

28. let $y = A \sin \omega t$

hence $A/2 = A \sin (2\pi/T)t = a \sin (2\pi/4)\ t$.

that is $\sin^{-1}(1/2) = (\pi/2).t$ or $(\pi/2)t = \pi/6$

29. here $y = A \sin \omega t$

$\nu = A\omega \cos \omega t$.

since $\omega = 2\pi/16$, therefore

$\nu = A\ (2\pi/16) \cos (2\pi/16) \times 2 = \pi$

hence $A = \pi \times 16/\pi \times \sqrt{2}$.

30. let $y = A \sin \omega t$, then

$k = ½\ MA^2\omega^2\cos^2\omega t$ and

$U = ½ MA^2\omega^2 \sin^2\omega t$

Therefore $K/U = \cos^2\omega t / \sin^2\omega t = (1- \sin^2\omega t) / \sin^2\omega t$

$= [(1 –y^2) / A^2] / (y^2/A^2) = (A^2 –y^2) /y^2$.

31. Force on the mass m along the tunnel will be :

$F = - [(GMm /R^3) y]\sin\theta$.

$= - [(GMm /R^3) y] (x/ y) = - (GMm /R^3) x$

or $F = -(mg/R)x$. it is an SHM with k

$= mg/R$. hence $T = 2\pi (m/k) = 2\pi \sqrt{(R/g)}$, where g is the acceleration on the surface on the earth .

Note : same is the time period in the tunnel passing through the centre of the earth as in that case

$$F = -(GMm/R^3)\,y = -(mg/R)\,y$$

32. We know that $T = 2\pi\sqrt{(l/g)}$

when l is made four times , the time period is doubled.

33. Potential energy of SHM $Up = E\,(y^2/A^2)$

here $y = A/2$, hence

$$Up = E/4.$$

34. the relation between y and a is

$$a = -\omega^2 y.$$

it is the equation of the straight line .

35. the time period of oscillation of a spring does not depend on gravity.

36. P.E. = ½ $M\omega^2x^2$.. total energy E = /2 $M\omega^2A^2$.

37 $d^2x/dt^2 + \omega^2x = 0$ $\omega = 2\pi/\mu$.

$\omega^2 = b$;$\omega = \sqrt{b}$; $2\pi/T = \sqrt{b}$ $\Rightarrow$ $T = 2\pi/\sqrt{6}$.

38. here y = A cos ωt. when y = A/2. we find cos ωt

= ½ = sin π /6. hence ωt = π/3.

Or $t = \pi/3\omega = \pi / [3x(2\pi/T)] = T/6$.

39. when he jumps out, he pushes the platform downwards which increases the reading. Then the reading decreases as the spring tries to return to the original state.

40. $K = 1/2m\omega^2 [A^2 - y^2]^{1/2}$.

$= (1/2)m\omega^2 A^2 [1- (y^2/A^2)]^{1/2}$ E.

$= [\ 1 - (y^2/A^2)\ ]^{1/2} \cdot E$

41. Effective acceleration is $\sqrt{(g^2+a^2)}$

42. According to the Hooke's law , stress $\propto$ stain.

    Or $F/A \propto 1/L$ or $F = (YA/L)\ l = Kl$

    Where $k = YA/L$ = a constant

43. Factual statement.

44. A resonance $\omega L = 1/\omega C$.

    hence $\omega = 1/\sqrt{LC} = 2\pi f$.

    hence $f = 1/(2\pi\ \sqrt{LC})$

45. $T = 2\pi\ \sqrt{(l/g)}$

46. Use $f = 1/2\pi\ \sqrt{k/M}$

47. in SHM the PE is maximum at extreme position and kinetic energy is maximum at the mean position.

48. here KE = PE

$\frac{1}{2} m\omega^2 (A^2 - y^2) = \frac{1}{2} m\omega^2 A^2$.

$Y = A/\sqrt{2} \Rightarrow \quad y = 2\sqrt{2}$.

49. complete spring is equivalent to two springs in series. Therefore :

$1/k = (1/k_1) + (1/k_1)$

$\Rightarrow \quad k_1 = 2k$

50. $T = 2\pi \sqrt{(m/k)}$. since $T = 1/n$.

therefore $n \propto \sqrt{k}$

also for a spring $k \propto 1/x$.. thus $k_2/k_1 = x_1/x_2 = 2$.

Therefore new frequency

$n_2 = n_1 \times \sqrt{(k_2/k_1)} = n\sqrt{2}$.

51. Comparing with

$$y = A \sin(\omega t + \phi)$$

we find $\omega = 2\pi f = 4\pi$.

Therefore $f = 2$.

52. As total energy of SHM, $E = \frac{1}{2} mA^2\omega^2$.

53. Using $v^2 - u^2 = 2as$., we get

$$v = \sqrt{(2gh)} = \sqrt{[2 \times 10 (2 - 0.75)]}$$

$$= \sqrt{(2 \times 10 \times 1.25)} = \sqrt{25} = 5 \text{ m/s}.$$

54. if a spring is cut into n pieces then the force constant K' of each spring become n times

$\Rightarrow$ K' = nk. (1)

Now, time period of a spring is given by

$T = 2\pi \sqrt{(m/k)}$ (2)

For n equal parts of spring we have

$T' = 2\pi\sqrt{(m/k')}$

$= 2\pi \sqrt{(m/nk)}$ from 1

$\Rightarrow$ $T' = 1/\sqrt{n}$ using 2

55. Total energy of S.H.M is $E = ½ m\omega^2A^2$.

$= ½ KA^2$.

Kinetic energy of particle executing S.H.M. is

$$K.E. = \frac{1}{2} m\omega^2 (A^2 - y^2)$$

Here $y = A/2$.

$$K.E. = \frac{1}{2} m\omega^2 [A^2 - (A^2/4)] = \frac{3}{4} E.$$

56. P.E. in S.H.M. is given by

$$U = \frac{1}{2} m\omega^2 y^2.$$

$\Rightarrow$ $U_{max} = \frac{1}{2} m\omega^2 A^2.$ (when $y = A$)

Substituting , $y = A/2$, we get

$$U = \frac{1}{2} m\omega^2 (A^2/4) = \frac{1}{4} U_{max}.$$

57. we are given :

$$y = A \sin pt + B \cos pt$$

Since $v = dy/dt$.

Therefore $\nu = d/dt\ (A \sin pt + B \cos pt)$

$= Ap \cos pt - B\ p \sin pt$

$\Rightarrow \quad \nu = Ap \cos pt - Bp \sin pt$

we know that acceleration is given by

$a = d3/dt$

therefore $a = d/dt\ (Ap \cos pt - Bp \sin pt)$

$= Ap^2 \sin pt - Bp^2 \cos pt$

$a = -\ p^2\ (A \sin pt - B \cos pt)$

or $a = -p^2 y.$

That is $a \propto -y$

Hence motion is simple harmonic .

58. frequency of spring mass system is given by :

$\nu = 1/2\pi \sqrt{(K/M)}$

$\Rightarrow$ ν is independent of g.

therefore , when the elevator acceleration upwards , g will change, but ν will remain the unchanged.

59. Time period of a simple pendulum is given by :

$T = 2\pi \sqrt{(l/g)}$

$\Rightarrow$ $T \propto \sqrt{l}$

$\Rightarrow$ $T_1/T_2 = \sqrt{(l_1/l_2)}$

substituting $T_2 = 2T_1$., we get

$l_1 = 4l_1$.

Hence time period. of the pendulum will be double, if length will decrease four times.

60. Total energy of a simple harmonic motion is given by

$$E = \frac{1}{2} m\omega^2 a^2.$$

$$E \propto a^2.$$

61. kinetic energy of a simple harmonic motion is given by

$$K = 1/2\ m\omega^2(A^2 - y^2) \qquad (1)$$

Here , y is the displacement of the bdoy executing S.H.M. and is given by

$$Y = A \sin \omega t.$$

$$K = \frac{1}{2} m\omega^2 (A^2 - A^2 \sin^2\omega t)$$

$$K = \frac{1}{2} m\omega^2 A^2 (1 - \sin^2\omega t)$$

Since $1 - \sin^2\omega t = \cos^2 \omega t$.

Therefore we have

$$K = \frac{1}{2} m\omega^2 A^2 \cos^2\omega t.$$

Now, $\cos^2\omega t = (1 + \cos 2\omega t) /2$.

So, we have

$$K = \frac{1}{2} m\omega^2 A^2 [(1+\cos 2\omega t) /2)]$$

Or $K = 1/1 [1/2\ m\omega^2 A^2] [1+\cos 2\omega t]$

(2)

Further total energy of S.H.M. is given by

$$E = \frac{1}{2} m\omega^2 A^2$$

Hence equation 2 becomes

$$K = \frac{1}{2} E (1+ \cos 2\omega t)$$

$$= \frac{1}{2} E (1+ \cos \omega' t)$$

$$\Rightarrow \quad \omega' = 2\omega$$

$$\Rightarrow \quad \omega/\omega' = \frac{1}{2}.$$

The ratio of frequency of oscillations to the frequency of kinetic energy is 1:2.

62. for a spring mass system executing S.H.M. time period is given by

$$T = 2\pi \sqrt{(m/k)}$$

$$\Rightarrow \quad T \propto \sqrt{m}. \quad \Rightarrow \quad T'/T = \sqrt{(m'/m)}$$

substituting m' =4m ; T = 1s we get :

$T' = 2s.$

63. The general equation of S.H.M. is given by

$$y = a \sin(\omega t+\phi)$$

given equation is

$$y = 3 \sin [100t+(\pi/6)]$$

comparing both the equations, we get

$a = 3$; $\omega = 100$

now in S.H.M. maximum velocity is given by

$$\nu_{max} = \omega a. = 100 \times 3 = 300 \text{ ms}^{-1}.$$

64. here $x = 4\cos\pi t + 4 \sin \pi t.$

comparing with $x = = A_1 \cos \pi t + A_2 \sin \pi t.$

which is the equation of SHM., we find the amplitude is .

$A = \sqrt{(A^2_1 + A^2_2)}$

Here $A_1 = A_2 = 4$. hence $A = 4\sqrt{2}$.

65. time period of a spring, $T = 2\pi \sqrt{m/k}$

$\Rightarrow \quad T \propto \sqrt{(1/k)}$ (1)

now in S.H.M. maximum velocity is given by

$\nu_{max} = \omega A$.

for particle A, $\nu_1 = \omega_1 A_1$.

for particle B, $\nu_2 = \omega_2 A_2$.

Given $\nu_1 = \nu_2 \Rightarrow \omega_1 A_1. \Rightarrow \omega_2 A_2$.

$\Rightarrow \quad A_1/A_2 = \omega_2/\omega_1 = T_1/T_2$. [$\omega = 2\pi/T \Rightarrow \omega \propto 1/T$]

$\Rightarrow \quad A_1/A_2 = \sqrt{(k_2/k_1)}$ using 1

66 given equation is

$$x = a \cos (\omega t - \theta)$$

velocity is given by

$$\nu = dx/dt = d/dt [a \cos (\omega t-\theta)] .$$

on differentiating we get

$$\nu = -a\omega \sin (\omega t -\theta)$$

for maximum velocity , we have

$\sin (\omega t -\theta) = \sin 90 = 1$

Therefore $\nu_{max} = |\nu| = a\omega$.

67. the standard equation of S.H.M. is given by

$$y = A \sin(\omega t+\phi) \qquad (1)$$

Given equation is :

$$Y = 2 \sin[(\pi/2)\, t + \phi] \qquad (2)$$

Comparing equation 2 with 1

$\omega = \pi/2$; $A = 2$

Now, maximum acceleration is given by

$a_{max} = \omega^2 A = (\pi/2)^2 \times 2 = \pi^2/2.$

68. The general equation of S.H.M. is given by

$$y = A \sin(\omega t+\phi) \qquad (1)$$

given equation is

$y = 0.2 \sin(10\pi t + 1.5\,\pi) \cos(10\pi t + 1.5\,\pi)$

using $2 \sin\theta \cos\theta = \sin 2\theta$, we get

$y = 0.1 \times \sin 2(10\pi t + 1.5\pi)$

$y = 0.1 \sin (20\pi t + 3\pi)$ (2)

from 1 and 2 , it is clear that the given equation is of SHM.also on comparing equation 2 with equation 1 we get :

$\omega = 20\pi$.

$2\pi/T = 20\pi$.

$T = 0.1$ s.

69. The effective spring constant of two springs of spring constants k_1 & k_2 joined in series is given by

$1/k = (1/k_1) + (1/k_2)$

$1/k = (k_1+k_2) / (k_1k_2)$

or $k = (k_1k_2) / (k_1+k_2)$

70. in forced oscillations , both amplitudes as well as energy become maximum when frequency is equal to natural frequency which is the condition of resonance.

Hence $\omega_1 = \omega_2$.

71. In SHM maximum acceleration is given by

$a_{max} = \omega 2A.$ (1)

Also maximum velocity is given by

$\nu_{max} = \omega A.$ (2)

from (1) & (2)we get.

$a_{max}/\nu_{max} = \omega$.

Substituting $a_{max} = 24\ ms^{-2}$. , $\nu_{max} = 16\ ms^{-1}$.

We get

$\omega = (3/2)\ S^{-1}$.

Substituting $\omega = (3/2)\ s^{-1}$; $\nu max = 16\ ms^{-1}$ in eqn. 2 we get

$A = (32/3)m$.

72. Time period of a pendulum is independent of mass . hence time periods of the seconds pendulum will remain same , that is :

$T = 2s$.

CONCEPT PLUS (C+)

1. The net acceleration acting on the bob is

$$[g^2 + a^2] = (10^2+10^2)^{1/2}. = \sqrt{2} \times 10$$

Because a is perpendicular to g.

Hence $T = 2\pi [2/ (\sqrt{2} \times 10)]^{1/2}$. But it is given that $2\pi [I/10]^{1/2} = 2s$. therefore $T = 2 / 2^{1/4}$.

2. The magnitude of the resultant acceleration remains unchanged. Only their direction changes. So, time period remains unchanged..

3. Maximum potential energy = total energy of the oscillator.

4. The pendulum executes half oscillation.

5. For damped oscillator $A = A_0 e^{-bt}$.

Here $A_0/27 = A_0 e^{-6b}$ that is $e^{-6b} = 1/27$

$A_2 = A_0 e^{-2b}. = A_0 [e^{-6b}]^{1/3}$.

$= A_0 (1/27)^{1/3} = A_0 /3$.

6. $A = (1/2) \times (1/2) \times (1/2) = 1/8 = 1/n$. hence $n = 8$.

7. Let $I = I_1 + I_2$. then for spring of length l_1.

We have $k_1 = (1/l_1)k = [(l_1+l_2) / l_1] k$.

$[1+ (l_2/l_1)] k. = [1+ (1/n)] k$.

8. This is possible if one particle is at mean position when the other is at the extreme position. Hence $\phi = \pi/2$.

9. The gain in P.E at P will be

$mg \times OQ = mg\, l\, (1-\cos\theta)$

K>E at mean position = PE at extreme position.

10. Here $y = 3 \sin 4\pi t + 4 \cos 4 \pi t$

    therefore $\nu = dy/dt = 12 \pi \cos \pi t - 16 \pi \sin \pi t$

    At t= 0, we find

    $\nu = 12\pi \cos 0 + 16 \pi \sin 0 = 12\pi$.

11. here $mg = -kx$.

    Therefore $| m/k| = | x/g |$

    Hence $T = 2\pi \sqrt{(m/k)} = 2\pi \sqrt{(x/g)}$

12. The rod behaves as a compound pendulum. Its time period is given by

$$T = 2\pi\sqrt{(2L/3g)}$$

Here $L = 2l$, therefore

$$T = 2\pi \sqrt{[(2 \times 2l) / 3g]} = 4\pi \sqrt{(l/3g)}$$

13. The relation between y and a is

$$a = -\omega^2 y.$$

therefore slope of the graph between y and a is

$$\tan\theta = \omega^2.$$

Here $\theta = 45^0$, hence

$$\omega^2 = \tan 45 = 1$$

or $\omega = 1$

or $T = 2\pi/\omega = 2\pi.$

14. if the extensions produced in the spring by m_1 and m_2 are l_1 and l_2 respectively, then :

$$m_1 g = kl_1.$$

$$m_2 g = kl_2.$$

Therefore $\omega = \sqrt{(k/m_2)}$

And amplitude $l_1 = m_1 g/k$.

15. here $y_1 = 10 \sin(\omega t - \phi)$

$y_2 = 10 \cos(\omega t - \phi)$

$= 10 \sin(\omega t - \phi + \pi/2)$

hence $\Delta\phi = \pi/2 = 90^0$.

16. here $\omega_1 = \sqrt{(k_1/m_1)}$ and $\omega_2 = \sqrt{(k_2/m_2)}$

hence $a_{01}/a_{02} = \omega^2{}_1 A_1 / \omega^2{}_2 A_2$.

Since $A_1 = A_2$., therefore

$a_{01}/a_{02} = \omega^2{}_1 / \omega^2{}_2 = (k_2/m_2)(m_2/k_2)$

17. The bob describes an arc of a circle of radius l. therefore the tension in the string in the sum of centripetal force and weight . That is :

$$T\ max = (m\nu^2 max / l) + mg$$

But $\nu_{max} = \omega A$ and $\omega = \sqrt{(g/l)}$

Hence $T_{max} = (m\omega^2 A^2 / l) + mg =$

$(mgA^2/l^2) + mg.$

$$= mg\ [\ (A^2/l^2) + 1]$$

18. here Mg = kl. When the mass is suspended the string extends by l . so energy stored = ½ kl^2 = ½ (kl)l = ½ Mgl. .when the spring oscillates at the maximum displacement additional potential

energy = ½ kl^2 is stored. So total potential energy

= ½ kl^2 + ½ kl^2 = kl^2 = Mgl

19. T = 2π (l/g) ½.. Hence ΔT/T = ½ (Δl/l)

20. $K_p = K_1 + K_1$ & & $1/Ks = 1/2K_1 + 1/K_2$.

21. here ω = 2πt = 4π. Hence f = 2Hz.

22. f = ω/2π = (220 /2π) Hz.

23. ν = ωA = (2π/T)A.

24. W_1 = ½ k x (1 x 10^{-3}) ^{2} = 10 x 1 x 10^{-3}.

= 10^{-2} J

⇒ K = 2 x 10^{-2} x 10^6

W_2 = ½ k (40 x 10 $^{-3}$) ^{2}.

= 1/2k x 1600 x 10^{-6}.

$= ½ \times 2 \times 10^{-2} \times 10^{+6} \times 1600 \times 10^{-6}$

$= 16J$

25. $F_{max} = m\omega^2 A.$ $m \times 4\pi^2 t^2 \times A.$

$(10/1000) \times 4\pi^2 \times (5/\pi) \times (5/\pi) \times 0.5 = 0.5$

N.

26. The weight can be resolved into two components as follows (i) Mg sin α along the plane (ii) Mg cosα perpendicular to the plane. The restoring force for oscillation will be provided by the component Mg cos α. (Due to the component Mg sin α the vehicle will move along the plane).

Hence, the expression for time period will change from

$$T = 2\pi \sqrt{(L/g)} \text{ to } T = 2\pi \sqrt{(L/ g \cos \alpha)}$$

27. For SHM P.E. = $\frac{1}{2} MA^2\omega^2 \sin^2\omega t$.

K.E = $\frac{1}{2} MA^2\omega^2 \cos^2\omega t$.

Total energy = $\frac{1}{2} MA^2\omega^2$

In this case , $\frac{1}{2} MA^2\omega^2 \cos^2\omega t$.

$= (1/4) \times \frac{1}{2} MA^2\omega^2$

$\Rightarrow \quad \cos \omega t = \frac{1}{2}$ or $\omega t = \pi/3$

$y = A \sin \omega t = A \sin (\pi/3) = A(\sqrt{3}/2)$

28. For series combination of Springs.

$1/k_s = 1/k_1 + 1/k_2$.

$\Rightarrow \qquad k_s = k_1k_2 / (k_1+k_2)$

Elongation $l = F/k = Mg / k_s = Mg (k_1+k_2) / k_1k_2$

29. The angular momentum should be conserved

that is :

$m/\nu = m \times (l/2) \times \nu'$

$\nu' = 2\nu$

Also $T = 2\pi l/\nu$ and $T' = 2\pi(½) / \nu'$

$= 2\pi l / (2 \times 2\nu) = T/4.$

30.. Let the equation of SHM be $y = A \sin \omega t$

Then in the first case $A/2 = A \sin \omega T_1$.

That is $\omega T_1 = \sin^{-1} (1/2) = \pi/6$.

Therefore $T_1 = \pi/6\omega$.

Also $T_2 = (T/4) - T_1 = 2\pi/4\omega - \pi/6\omega = \pi/3\omega$

Therefore $T_1 < T_2$.

31. Simple pendulum

$$T = 2\pi \sqrt{(l/g)} = 2\pi \sqrt{[\, l/(GM/r^2)\,]} =$$

$2\pi r \sqrt{(l/GM)}$

Hence $T_1 = 2\pi R \sqrt{(l/GM)}$

And $T_2 = 2\pi (2R) \sqrt{(l/GM)}$

Therefore $T_2/T_1 = 2$

32. Time period on earth is given by

$$T = 2\pi \sqrt{(l/g)} \qquad (1)$$

Similarly time period on moon is given by

$$T' = 2\pi\sqrt{(l/g)} \qquad (2)$$

Since $g = GM/r^2 \Rightarrow g' = G\,(M/r^2)$

Substituting $M' = 2M$ and $r' = 2r$, we get

$$G' = ½\,(GM/r^2) = ½\,g$$

Substituting the value of g in eqn. 2 we get

$$T' = 2\pi\,\sqrt{[l/(g/2)]} = \sqrt{2}\,T. \qquad \text{(Using 1)}$$

33. Time period of spring mass system is

$$T = 2\pi\,\sqrt{(M/k)}$$

` $\Rightarrow$ T is independent of g.

Therefore at moon T will remain unchanged, however g at the moon will be different than that on earth.

34. The displacement of a particle executing SHM is :

$$y = a \sin \omega t \qquad \text{(i)}$$

we are given , $y = 5 \sin 20 \pi t$ (ii)

on comparing (i) & (ii)

$\omega = 20\pi$

as $= 2\pi\nu$.

Therefore , $2\pi\nu = 20\pi$ or $\nu = 10$ Hz.

35. The time period of a simple pendulum is :

$$T = 2\pi \sqrt{(l/g)}$$

Which means to record proper time, time period 'T' should remain constant.

Or $l/g = \text{constant} \quad \Rightarrow \quad l \propto g.$

We are given that g has decreased by 0.1 %

therefore , l should also decreased by the same amount that is by 0.1%.

36. The time period of simple pendulum in a lift which is at rest is given by

$$T = 2\pi \sqrt{(l./g)}$$

However when the lift falls freely time period of pendulum changes to T'

Where $T' = 2\pi \sqrt{(l/g_{eff})}$

As during the free cell of the lift ' $g_{eff} = 0$' due to condition of weightlessness.

Therefore $T' = 2\pi \sqrt{(l/0)} = \alpha$

Or T' = infinite.

37. The frequency of an oscillator is given by :

$$\nu = 1/2\pi \sqrt{(k/M)}$$

we are given , k= M

therefore $\nu = 1/2\pi$ Hz.

38. time period of a spring is given by

$$T = 2\pi \sqrt{(M/k)}$$

When spring is cut into n equal parts , then

spring constant of each part will become nk. .

And time period of the spring changes to

$$T' = 2\pi \sqrt{(M/nk)}$$

We are given that spring is cut into 9 equal parts.

$N = 9$

Therefore, $T' = 2\pi \sqrt{(M/9k)} = 1/3\ [2\pi \sqrt{(M/k)}]$

$T' = T/3$.

39. We know that when a block is about to slip

frictional force = maximum external force (i)

As frictional force = μ mg (ii)

& external force = ky

where k is spring constant & $k = \omega^2 m$.

Since external force is maximum when displacement is equal to amplitude

Or $y = A$.

Therefore

Maximum external force = $kA = m\omega^2 A$ (iii)

Putting (i) (ii) & (iii) we get

$\mu mg = m\omega^2 A$.

$\omega^2 = \mu g$.

or $\omega = (\mu g/A)^{1/2}$.

Also $\omega = 2\pi\nu$

Therefore $2\pi\nu = (\mu g/A)^{1/2}$ or $\nu = 1/2\pi \sqrt{\mu g/A}$

40. We are given that time period of the spring is

$$T = 2\pi \sqrt{(M/k)}$$

When spring is divided into two equal pars then , K = 2K and time period is given by

$$T' = 2\pi \sqrt{(M/2k)} = 2\pi/\sqrt{2} \sqrt{(M/k)}$$

$\Rightarrow \quad T = T/\sqrt{2}$

41. Force in case of spring is F = kx.

Where k is the spring constant and x is the extension in the spring

We are given, F = Mg.

$\Rightarrow \quad Mg = kx \qquad$ or $x = Mg/k$

therefore , extension of the Ist spring = Mg/k_1.

Extension of the 2nd spring = Mg/k_2.

Hence total stretch or extension of springs .

$= Mg/k_1 + Mg/k_2$

or total stretch $= Mg\,[(k_1+k_2)/k_1k_2]$

42. The time period of a spring is $T = 2\pi\sqrt{(M/k)}$

if mass of 500 g is removed , then spring will oscillate with a mass of 400 g.

$\Rightarrow$ $M = 400$ g.

Hence time period will be $T_1 = 2\pi\sqrt{(400/k)}$

We are given that $T_1 = 2$s.

$\Rightarrow 2\pi\sqrt{(400/K)} = 2.$

If mass of 300 g . is also removed along with mass of 500 g then spring will oscillate with a mass of 100 g. That is M = 100g.

Therefore, time period of the pendulum will be

$T_2 = 2\pi \sqrt{(200/k)}$ (ii)

Dividing equations 2 by 1

$T_2/2 = 2\pi \sqrt{(100/k)} \times \sqrt{(k/400)} \times 1/2\pi = \sqrt{(1/4)}$

$\Rightarrow \quad T_2 = 2 \times (1/2) = 1s.$

43. $T = 2\pi \sqrt{(m/k)} = 2\pi \sqrt{(0.98/2)}$

$T = 2\pi \times 0.7$

That is $T = 4.4s.$

44. We know that

$T \propto \sqrt{l}$

45. Suppose pendulum make n oscillations on the earth in 1 minute.

$\Rightarrow \quad 60/n = 2\pi\ (l/g)$

now on moon

$T/n = 2\pi\ \sqrt{[l/(g/6)]}$

$T = \sqrt{6} \times 60$

Time period on the moon will increase by $\sqrt{6}$.hence it will move slower than earth. Therefore time on moon measured by pendulum $= 60\sqrt{6} = 25s$.

46. Knowledge based questions.

47. As $T = 2\pi\ (m/K)$ or $\omega = \sqrt{(K/m)}$

$\omega_1 A_1/\omega_2 A_2 = 1$

$A_1/A_2 = \sqrt{(K_2/K_1)}$

48. We know that

$$K = mg/x.$$

Therefore $T = 2\pi \sqrt{\{(m+M) / k\}}$

$T = 2\pi \sqrt{\{(m+M)\ x\}} / mg$

49. the general equation of a wave is

$$Y = A \sin (\omega t - kx) \qquad (1)$$

Given equation is

$$Y = 0.3 \sin (314\ t - 1.57x) \qquad (2)$$

Comparing equations 1 & 2 we get

$$\omega = 314 \ ; \ k = 1.57$$

Now, wave velocity is given by

$C = \omega/k = 314 / 1.57 = 200\ ms^{-1}$.

50. The equation of S.H.M. is

$y = y_0 \sin \omega t$

Time period = 2s.

$\omega = 2\pi/T = 2\pi/2 = \pi$

when displacement is half of amplitude we find

$y_0 / 2 = y_0 \sin \pi t$

$\sin \pi t = ½$

$\pi t = \pi/6$

$t = 1/6$ seconds .

51. in simple harmonic motion , the speed is maximum at the mean position and is given by :

$\nu \max = A\omega$

$\omega = \nu \max / A$

Substituting $\nu \max = 16$m s+.

$A = 4$ cm , we get :

$\omega = 4$ rad s^{-1}.

Now, velocity in terms of amplitude and displacement is given by :

$\nu = \omega\sqrt{(A^2-y^2)}$

Substituting $\nu = 8\sqrt{3}$ cm s^{-1} ; $\omega = 4$ rad s^{-1}.

$A = 4$ cm, y can be calculated

On solving we get y =2 cm

52. Height of the bob at maximum angular displacement is given by

$$h = l - l\cos\theta = l(1 - \cos\theta) \qquad (1)$$

Also at the end of the displacement , that is at extreme position , we have :

Kinetic energy of the bob = potential energy of the bob that is

$$Mgh = mg\,[l\,(1-\cos 0)] \qquad \text{using (1)}$$

Or maximum K.E. = $mgl\,(1-\cos\theta)$

53. the total energy of simple harmonic motion is given by

$$E = \tfrac{1}{2}\, m\omega^2 A^2.$$

Where A = amplitude of S.H.M.

In S.H.M. as a particle is displaced from its mean position, its kinetic energy is converted to potential energy and vice-versa as a result the total energy of S.H.M> remains constant.

Hence the total energy of S.H.M is independent of displacement x.

54. The frequency of oscillation of a vibrating spring is given by

$$\nu = 1/2\pi \sqrt{(k/m)} \qquad (1)$$

Since the spring are attached in series , each having spring constants, so we have

$$1/keff = 1/k + 1/k = 2/k$$

$k_{eff.} = k/2$

hence using relation (1) we have

$\nu = 1/2\pi \sqrt{(k_{eff}/m)} = 1/2\pi \sqrt{(k/2m)}$

BEATS , STATIONARY WAVES ORGAN PIPES

1. The first overtone of closed organ pipe is third harmonic. Hence its frequency = 3 x frequency of fundamental note. The first overtone of the open organ pipe is the second harmonic. Its frequency = 2 x frequency of fundamental note. But the frequency of fundamental note of open organ pipe is always twice that for closed organ pipe. Suppose, the fundamental frequency of closed organ pipe is f. then that of open organ pipe is 2f. and the frequency of first overtone of closed organ pipe is 3f. and that of open organ pipe will be 4f.

2. Wavelength (λ) = 2 x distance between consecutive nodes =2 x 10 cm = 20 cm.

   Hence $c = f\lambda = 256 \times 20\ cms^{-1} = 51.20\ ms^{-1}$.

3. Lengths of the two parts are l_1 = 49.9 cm and the

   l_2 = 50.1 cm. hence

   $f_1/f_2 = l_2/l_1 = 50.1 / 49.9 = 501/499$. hence

   frequencies should be 501 and 499 Hz.

4. When the tube is dipped in water. It becomes a closed organ pipe of length L/2. hence frequency of fundamental note = $f_1 = c/(4L/2) = c/2L$.

   fundamental frequency of the open organ pipe will also be c/2L.

   Hence f_1 = 256 Hz.

5. Suppose the frequency of the tuning fork is f .

Then $f_2 / f_1 = 40 / 44 = (f-5) / (f+5) = 10 / 11$.

This gives

$F = 105$ Hz.

6. $f_2/f_1 = 16.0 / 16.2 = (16 \times 25) / (16.2 \times 25) = 400 / 405$

7. The tube does nor resonate and produces negligible sound. So no beats are heard.

8. Difference of frequencies = beat frequency = number of beats produced per second.

   $= 1 / 0.2 = 5$.

9. $f_0 = c/2l$. for closed pipe $\lambda/4 = l/2$

   hence $\lambda \backslash 2l$

   therefore $f_c = c/2l = f_0$.

10. knowledge based questions

11. $\lambda = c/f = 340/340 = 1$m.

first resonance occurs at $\lambda/4 = 25$ cm.

second resonance occurs at $3\lambda/4 = 75$ cm.

Third resonance occurs at $5\lambda/4 = 125$ cm.

12. $\nu = 2n$ [difference of resonance difference]

or $\nu = 2n$ [52 – 17]

$\nu = 2 \times 500$ [52 – 17] = 350 m/s.

13. Frequency of vibrating string is given by :

$\nu = n/2l \sqrt{T/\mu}$

$\Rightarrow \quad \nu \propto \sqrt{T}$.

Hence before increasing the tension frequency of the piano was

$\nu = 256 - 5 = 251$ Hz.

14. $n_A = 256 \pm 6$

On loading A, its frequency decreases. It will produce 6 beats with 256 Hz only when its frequency is 262 Hz.

15. When m and T are constant, then

$n_1/n_2 = l_2/l_1$.

According to question. $n_1 = x + 4$, $n_2 = x - 4$.

$(x + 4) / (x-4) = 50/49 \Rightarrow 49(x+40) = 50 (x-4)$

$x = 396$ Hz.

16-17-18 knowledge based questions.

19. $n = 100 \pm 2 = 102$ Hz or 98 Hz.

On loading unknown fork, beat frequency of 1 is possible only with 102 Hz.

PROPAGATION OF WAVES SOLUTIONS

1. Surface wave are transverse

2. Sound waves in the air are longitudinal and so they cannot be polarized.

3. Knowledge based questions.

4. Distance between nearest nodes $= \lambda/2$. Hence next node will be at $x = 3m + (2m/2) = 4m$.

5. Wavelength frequency and velocity are related as

$$c = \nu\lambda.$$

6. Generally about 0.2 is taken to produce each of the syllabic sound.

7. knowledge based questions.

8. There is a vacuum between the earth and the moon. So the sound will never reach the earth.

9 knowledge based questions.

10. knowledge based questions.

11. Maximum particle velocity $\nu_m = A \times 2\pi \times t$.

    Wave length is $c = f\lambda$.

    Therefore $\nu_m = (A2\pi c) / \lambda$.

    If $\nu_m = 4c$, then $\lambda = \pi A/2$.

12. For $y = A \cos(\omega t \pm kx)$, the frequency is

$\nu = \omega/2\pi$. Hence $\omega = 60$. therefore $\nu = 60/2\pi$ Hz.

Also $\lambda = 2\pi/k = 2\pi/2 = \pi$. The wave velocity $c = \omega/k = 60/2 = 30\ s^{-1}$. here amplitude A =3m.

13. Knowledge based questions.

14 -15. intensity $\propto$ (amplitude)^2 . hence the amplitude of the waves are $\sqrt{l}$ and $2\sqrt{l}$.

Maximum amplitude = $\sqrt{l} + 2\sqrt{l} = 3\sqrt{l}$.

Minimum amplitude = $2\sqrt{l} - \sqrt{l} = \sqrt{l}$.

Hence maximum and minimum intensities are 9l and l.

16. knowledge based questions.

17. $y = A \cos \gamma\omega t - kx)$

$= A \sin [(\omega t - kx) + (\pi/2)]$

18. Two waves propagate through the pipe. One through the steel and the other through the air. The wave through the air of less intensity and propagate slower. That through the steel is of more intensity and propagates faster.

19. Intensity of the wave = Energy crossing per unit area per second = $\frac{1}{2} \rho c \omega^2 A^2$. This energy in contained in volume c x 1. hence energy density $= \frac{1}{2} \rho c \omega^2 A^2 / c = \frac{1}{2} \rho \omega^2 A^2$.

20. Frequency does not change on refraction.

21. Constant phase difference is the essential condition for coherence of sources.

22. Compare with the equation $\xi = A \cos (2\pi \nu t + \phi)$

23. The amplitude ratio = 10/5 = 2.

    $l_1/l_2 = (2)^2 = 4$.

24. knowledge based question.

25. Strain is more if displacement is more.

26. $c \propto \sqrt{T}$.

    $c_2/c_1 = 2 = \sqrt{[T_2 / (273+27)]}$

27. knowledge based questions.

28. $y = a\cos (\omega t - kx) = a \sin [\omega t - kx + (\pi/2)]$.

    Hence the phase difference is $\pi/2$.

29. Here $\omega = 2\pi f = 2\pi$.

    Hence $f = 1$

30. $c \propto \sqrt{T}$.

31. Knowledge based questions .

32. In open organ pipe all harmonic are present.

33. In the open organ pipe the first overtone is the second harmonic. Its frequency is twice the frequency of the fundamental note. Wavelength for fundamental note is equal tot twice the length of the pipe. Hence that for second harmonic or first overtone is equal to the length of pipe.

34. Knowledge based questions.

35. In closed organ pipe only odd harmonics are present. Suppose fundamental frequency is f. Then frequency of Ist , 2nd …… pth overtone will be

3f, 5f ……..(2p+1)f.

36. In open organ pipe all the harmonics are present. Suppose fundamental frequency is f. Then frequency of Ist , 2nd …… pth overtone will be

2f, 3f ……..(p+1)f.

37. Diameter has no effect on frequency

38. $f_1 = c/ 2L = 320\ ms^{-1}./2 \times 0.40m = 400$ Hz.

First overtone is 800 Hz and the second overtone is 1200 Hz.

39. $f_1 = c/ 4L = 320\ ms^{-1}./4 \times 0.20\ m = 400$ Hz.

Sine in closed organ pipe only odd harmonics are present, therefore 1200 Hz is the first overtone.

40. end correction $= (l_2 - 3l_1) / 2$.

$= (49\ cm - 3 \times 16\ m) / 2 = 0.5$ cm.

41. Distance between consecutive nodes = length of each segment = 2m/4 = 0.5 m.

42. $l_1 : l_2 : l_3 :: (1/f_1) : (1/f_2) : (1/f_3) :: (1/1) : (1/2) : (1/3)$

Doppler's Effect, Musical Sounds and Acoustics of buildings Solutions

1. $\nu' = [(c-u_L) / (c - u_S)]\ \nu$

   where +ve sign is taken with UL and US if they are in the same direction as c, otherwise – ve sign is taken. Here U_L and $U_S = c/2$. Positive sign is to be taken with both. Hence $\nu' = \nu$. So, there is no change in frequency.

2. $\nu' = 1.5\nu$. Hence $[\ c / (c - u_S)\ ]\ v = 1.5\nu$.

   This gives $u_S = c/3$.

3. $\nu' = [\ c / (c - u_S)\ ]\ v = [320 / (320 - 32)\nu$.

$= (10/9)\nu$.

Hence $\lambda' = c/\nu' = (c/\nu) \times (\nu/\nu') = \lambda (\nu/\nu') = 0.8$ m x (9/10) = 0.72 m.

4. $f' = [c/ (c-f)]f =[c / \{ c - (c/2) \}] f = 2f$.

hence $\Delta f = 2f - f = f$.

5. $\Delta\nu = (2u/c) \nu$. Here $\Delta\nu = 2.5$ kHz, $\nu = 750$ MHz and $c = 3 \times 10^8$ ms^{-1}. Hence $u = (2.5 \times 10^3) / (2 \times 7.5 \times 10^6) \times 3 \times 10^8$ ms^{-1} = 500 ms^{-1}.

6,7,8,9,10,11. knowledge based questions.

12.,13,14,15,16 knowledge based questions.

17. $\frac{1}{2} M\omega^2 x^2 = \frac{1}{2} M\omega^2 (A^2 - x^2)$. Hence $x = A\sqrt{2}$.

18. $\nu' = [c / (c - u_S)] \nu = [\upsilon /(\upsilon + u)] \nu$.

$\Rightarrow$ Here $\nu' = \nu/2$,

Hence $\frac{1}{2} = [\upsilon / (\upsilon + u)]$

$\Rightarrow$ Hence $u = \nu$.

19,20. knowledge based questions.

21. According to Doppler's effect, the expression for the apparent frequency heard by the stationary observer when source moves towards observer is given by

$$\nu' = [\upsilon + (\upsilon + \upsilon_S)] \ \nu$$

$\Rightarrow$ Substituting $\nu = n$, $\upsilon_S = \upsilon_1$.

We get $\nu' = n/2$.

22. According to Sabine law :

Reverberation time, $T_R = K [V/\alpha S)$

$\Rightarrow \quad T_R \propto V$.

23. We know that the apparent change in frequency

$\Delta\nu = (2\upsilon s / c)\nu \quad \Rightarrow \quad 3 \times 10^3 = [2\upsilon s / (3 \times 10^8)] \times 9 \times 10^9$.

υs (velocity of jet) = 50 m/s.

24. knowledge based question.

25. Relative velocity of the sound w.r.t. the obstacles is c + v. hence frequency $= (c + v) / \lambda$.

26. Relative velocity of the source and observer is zero. So, there is no change in frequency.

27. $\Delta\nu = 2cus\nu / (c^2 - u^2_S)$

$= 2 \times [(300 \times 200 \times 400) / (90000 - 40000)]$

$[(2 \times 300 \times 200 \times 400) / 50000] = 960$ Hz.

28. $\nu' = [c / (c - u_s)]\nu$

here $\nu' = (102.5/100)\nu = 320\ ms^{-1}$.

Hence $102.5 / 100 = [320 / (320 - u_s)]$

This gives us $u_s = 7.8\ ms^{-1}. = 8\ ms^{-1}$.

29. $f' =[(c + \omega - u_0) / (c + \omega - u_S)] f$

here both u_0 as well as u_s are zero, because thee is no relative motion between the source and the observer. Hence

$$f' = [(c + \omega) / (c + \omega)] f = f.$$

that is there is no change in the frequency.

30. knowledge based question

Doppler's Effect, Musical Sounds and Accoustics of buildings Solutions

1. $\nu' = [(c-U_L) / (c - U_S)]\ \nu$

   where +ve sign is taken with UL and US if they are in the same direction as c, otherwise – ve sign is taken. Here U_L and $U_S = c/2$. Positive sign is to be taken with both. Hence $\nu' = \nu$. So, there sis no change in frequency.

2. $\nu' = 1.5\nu$. Hence $[\ c / (c - u_S)\ ]\ \nu = 1.5\nu$. This gives $u_S = c/3$.

3. $\nu' = [\, c / (c - u_S)\,]\, \nu = [320 / (320 - 32)\nu. = (10/9)\nu.$

Hence $\lambda' = c/\nu' = (c/\nu) \times (\nu/\nu') = \lambda\, (\nu/\nu') = 0.8$ m x (9/10) = 0.72 m.

4. $f' = [\, c/ (c-f)\,]f = [c / \{ c - (c/2) \}\,]\, f = 2f.$

hence $\Delta f = 2f - f = f.$

5. $\Delta\nu = (2u/c)\, \nu$. Here $\Delta\nu = 2.5$ kHz, $\nu = 750$ MHz and $c = 3 \times 10^8$ ms^{-1}.

Hence $u = (2.5 \times 10^3) / (2 \times 7.5 \times 10^6) \times 3 \times 10^8$ $ms^{-1} = 500$ ms^{-1}.

6. knowledge based questions.

7. knowledge based questions.

8. knowledge based questions.

9. knowledge based questions.

10. knowledge based questions.

11. knowledge based questions.

12.,13,14,15,16 knowledge based questions.

17. $\frac{1}{2} M\omega^2 x^2 = \frac{1}{2} M\omega^2 (A^2 - x^2)$. Hence $x = A\sqrt{2}$.

18. $\nu' = [c / (c - u_S)]\, \nu = [\upsilon / (\upsilon + u)]\, \nu$.

Here $\nu' = \nu/2$,

Hence $\frac{1}{2} = [\upsilon / (\upsilon + u)]$

Hence $u = \nu$.

19,20. knowledge based questions.

21. According to Doppler's effect, the expression for the apparent frequency heard by the stationary observer when source moves towards observer is given by

$$\nu' = [\upsilon + (\upsilon + \upsilon_S)]\ \nu$$

Substituting $\nu = n$, $\upsilon_S = \upsilon_1$.

We get $\nu' = n/2$.

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Reverberation time, $T_R = K\ [\ V/\alpha S)$

$\Rightarrow \quad T_R \propto V$.

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$$\Delta\nu = (2\upsilon s / c)\nu$$

$3 \times 10^3 = [\, 2\upsilon s / (3 \times 10^8)\,] \times 9 \times 10^9$.

υs (velocity of jet) = 50 m/s.

24. knowledge based question.

25. Relative velocity of the sound w.r.t. the obstacles is c + v. hence frequency $= (c + v) / \lambda$.

26. Relative velocity of the source and observer is zero. So, there is no change in frequency.

27. $\Delta\nu = 2cus\nu / (c^2 - u^2_S) = 2 \times [\, (300 \times 200 \times 400) / (90000 - 40000)\,]$

$[\, (2 \times 300 \times 200 \times 400) / 50000\,] = 960$ Hz.

28. $\nu' = [c / (c - u_s)\,]\nu$

here $\nu' = (102.5/100)\nu = 320\ ms^{-1}$.

Hence 102.5 / 100 = [320 / (320 – u_s)]

This gives us u_s = 7.8 ms^{-1}. = 8 ms^{-1}.

29. f' =[(c + ω -u_0) / (c + ω -u_S)] f

here both u_0 as well as u_s are zero, because thee is no relative motion between the source and the observer. Hence

f' = [(c + ω) / (c + ω)] f = f.

that is there is no change in the frequency.

30. knowledge based question.

30. For approaching source

n' = [ν / (ν- νs)] n

1200 = (350/300)n.

for receding source

$n_{recede} = [\ \nu / (\nu + \nu s)\ ]\ n.$

$n_{recede} = (350/400) \times (300 / 350) \times 1200$

$n_{recede} = 3600 / 4 = 900$ Hz.

31. $f_0 = c/ 2l$. for closed pipe $\lambda/4 = l/2$.

Hence $\lambda = 2l$.

Therefore $f_c = c/2l = f_0$.

32. $\Delta\lambda / \lambda = \upsilon /c$.

hence $\nu = (\Delta\lambda/\lambda)c = (0.1 / 6000) \times 3 \times 105$ km/s = 5 m/s.

33. $f_1 = 200 = [(c + u_2) / c]\ f = [(c + 40) /c\ ]f$.

$f_2 = 160 = [(c - 40\ ) / c\ ]\ f$.

hence 200/160 = (c+40) / (c -40)

this gives c = 360.

34. in case of circular motion $\nu = n\omega$, hence we have

$$\upsilon = r\omega.$$

Substituting $\omega = 20$ rad/s ; $r = 50$ cm.

= 0.5 m , we get

$\upsilon s = 10 ms^{-1}$.

Now frequency will be min. at B as it is moving away from observer , therefore, from

$$\nu' = \nu [c / (c \pm \upsilon s)] \text{ , we have}$$

$(c + \omega - u_0)$ ‘ min = $\nu [c/(c + \upsilon s)]$

Substituting $\nu = 385$ Hz ;

$C = \upsilon_{sound} = 340\ ms^{-1}$.

$\upsilon s = 10\ ms^{-1}$, we get ν' min.

$= 374$ Hz.

35 According to Doppler's effect , when source moves away from the observer , then apparent frequency is given by

$$\nu' = \nu\ [\ c / (c - \upsilon_s)\ ]$$

Substituting $\nu = 800$ Hz ; $c = 330\ ms^{-1}$.

$\upsilon s = 30\ ms^{-1}$.

We get $\nu' = 733.3$ Hz.

36. According to Doppler's effect,, the expression for the apparent frequency heard by the observer,

when the source and observer both move

towards each other, is given by

$$n' = [(\upsilon + \upsilon_0) /(\upsilon - \upsilon s)]\, n$$

Substituting $v = 340\ ms^{-1}$. $\upsilon_0 = 20\ ms^{-1}$. ; $\upsilon s = 20$

ms^{-1}n. = 240 Hz.

We get : n' = 270 Hz.

37. Doppler's shift is given by

$$\Delta\lambda = (\upsilon /c)\lambda.$$

Substituting $\Delta\lambda = 0.05\%\ \lambda = (0.05 /100)\ \lambda$;

$c = 3 \times 10^8\ ms^{-1}$., we get :

$(0.05 /100)\lambda = [\upsilon / (3 \times 10^8)]\lambda.$

On solving we get :

$\upsilon = 1.5 \times 105\ ms^{-1}$.

Since λ decreases, hence the star is coming closer to an observer on earth.

38. According to Doppler's effect, the apparent frequency heard by a stationary listener when source is moving away from the listener is given by :

$$\nu' = [\ c / (\ c + \upsilon s\ )\ ]\ \nu$$

Substituting $c = 330\ ms^{-1}$; $\upsilon_s = 50\ ms^{-1}$.

$\nu = 500$ Hz, we get

$\nu' = 434.2$ Hz.

39. According to Doppler's effect, the apparent frequency heard by a stationary observer when source of sound is moving towards the observer is given by :

$$\nu' = [\, c/ (\, c - vs)]\, \nu.$$

Substituting $\upsilon s = 0.5c$; $\nu = 3$ kHz, we get

$$\nu' = 6 \text{ kHz}.$$

40. Since the sound gets reflected from the cliff, hence it appears to be coming from the source towards the racing car which is moving towards cliff.

Now, from Doppler's effect ,apparent frequency of the sound heard by the driver of the car moves towards cliff is given by :

$$f = [(\upsilon + \upsilon_0) / (\upsilon - \upsilon_s)]f.$$

hence $\upsilon_0 = \upsilon s = u$

Therefore, we have :

$F' = [(\upsilon + u) / (\upsilon - u)] f.$

Substituting $f' = 2f$, we get

$U = \upsilon/3.$

ELECTROSTATICS SOLUTIONS.

COULOMB'S LAW

1. Knowledge based questions.

2. Charged on each electron is 1.66×10^{-19} C. so, he

charge added = 1.6×10^{-19}C $\times 10^{6} = 1.6 \times 10^{-13}$ C

3. Minimum charge is that on the electron.

4. knowledge based questions. Ans. (A)

5. The net force on the third charge is zero. However , when disturbed , the middle charge cannot return to the state of equilibrium. Because, the net force will not be zero any where except the midpoint.

6. The electrostatic force varies inversely as the dielectric constant.. The dielectric constant of the

metals is very large. So, the electrostatic force will decrease.

7. Coulomb's interaction is in accordance with the Newton's third law of motion.

8. Dielectric constant of conductor is infinite.

9. $F_{vacuum} / f_{medium} = \varepsilon_r = \varepsilon/\varepsilon_0$.

10 The electrostatic repulsion causes increase in the radius.

11. The Coulomb's law obeys Newton's third law of motion.

12. When a body gets charged after rubbing, then either it becomes positively charged by loss of electrons or it becomes negatively charged by gain of electrons. Hence, its weight may increase when it gains

electrons or weight may decreases due to loss of electrons.

13. The glass rod acquires positive charge on rubbing . when the rod is brought near the disc of the electroscope , the disc will acquire negative charge and there will be positive charge on the far end. That is, on the leaves.

14. due to conduction, positive charges of the glass rod are passed on the disc and leaves.

15. Coulomb's force obeys Newton's third law of motion. That is it is equal and opposite between two charges. Hence, the ratio of forces is 1 : 1

16. $F_m = (1/k)F_0$.

17. Due to mutual repulsion, the value will increase.

18. $F \propto 1/k$.

$F = (1/4\pi\varepsilon_0 k)(q_1 q_2/r^2)$ for air k = 1

19. Electrons carry negative charge

20. $F \propto 1/k$. The dielectric constant of medium is more than that of air.

21. $F = (1/4\pi\varepsilon_0)(q_1 q_2/r^2)$ Here q_1, q_2 as well as r are doubled. Hence F remains unchanged.

22. Gravitation force between two electrons is

$F_g = (Gm_e \times me) / r^2$.

$F_g = (6.67 \times 10^{-11} \times 9.1 \times 10^{-31} \times 9.1 \times 10^{-31}) / r^2$.

Electrostatic force between two electrons is

$F_e = (1/4\pi\varepsilon_0)(q_e \times q_e / r^2)$

$F_e = (9 \times 10^9 \times 1.6 \times 10^{-19} \times 1.6 \times 10^{-19}) / r^2$.

$F_g/F_e = 10^{-43}$.

23. $F_{air} = (1/4\pi\varepsilon_0)(q_1q_2/r^2)$

$F_{medium} = (1/4\pi\varepsilon_0 k)(q_1q_2/r^2)$

So, $F_{air} / F_{medium} = k/1$.

24. Relative permittivity , ε_r is given by

$\varepsilon r = F_{vac.} / F_{med.} \Rightarrow F_{med.} = F_{vac} / \varepsilon_r$.

on putting $F_{vac.} = 40$ N and $\varepsilon_r = 8$; we get

$F_{med.} = 5$ N.

25. Electrostatic force between the charges q_1, q_2 placed in a medium of dielectric constant k is given by :

$F = (1/4\pi\varepsilon_0)(q_1q_2/r^2)$ (1)

Electrostatic force between the charges q_1, q_2 placed in a medium of dielectric constant k is given by :

$F' = (1/4\pi\varepsilon_0 k)(q_1q_2/r^2)$ (2)

From 1 & 2, we have

$F/F' = K$

$\Rightarrow \quad F' = F/K$

26. When two charges are placed in a medium of dielectric constant K, then we have

$$F_{medium} = F_{vacuum} / K$$

Substituting $F_{vacuum} = F$; $K = 4$, we get :

$$F_{medium} = F/4.$$

27. knowledge based questions.

Ans.(D)

Concept plus (C+)

28. Calculate electrostatic force and gravitational force taking mass of electron $= 9.1 \times 10^{-31}$ kg .that of proton $= 1.6 \times 10^{-27}$ kg and the charges on them as 1.6×10^{-19}C.

29. From coulomb's law, $F = (1/4\pi\varepsilon_0)\ (q_1q_2/r^2)$

here $q_1 = q_2 = q$ then

$F \propto q^2$. (1)

Now, $q' = 25\%$ of q.

i.e. $q' = (25/100)q = (¼\ )q$

$q1 = q - (1/4)q = ¾\ q$

So $F' = (q')^2 = (\ ¾\ q)^2 = (9/16)\ q^2. = (9/16)\ F$

Using 1

30. Here $\sigma_1 = \sigma_2$

$q_1 / 4\pi r_1^2 = q_1 / 4\pi r_2^2$ So $q_1/q_2 = r_1^2/r_2^2$.

31. $F = (1/4\pi\varepsilon_0)\ (q_1q_2/r^2)$

for maximum value of F

$dF/dq = 0$

or $d/dq\ [\ q(Q-q)] = 0$

$[Q - 2q] = 0$

$q = Q/2.$

32. Figure below shows the configuration of the three charges.

The two forces experienced by q_1 are :

$F_1 = F_2 = (1/4\pi\varepsilon_0)\, q_1q_2 / [\,(d/2) + (x^2)\,]$

The horizontal components of F1 and F2 will cancel each other

Hence net vertical force on q_1 will be

$F = F_1\cos\theta + F_2 \cos\theta.$

$= (2/4\pi\varepsilon_0)\, q_1q_2 / [\,(d/2) + (x^2)\,] \;\; x \;\; x / [\,(d/2) + (x^2)\,]^{½.}$

$= (2qq_1 /4\pi\varepsilon_0)\, [\,(d/2)^2 + (x^2)\,]^{-3/2}.$

For F to be maximum , we have $dF/dx = 0$. This gives

$= d/2\sqrt{2}.$

33. According to Coulomb's law of electrostatic we know that force is given as

$$F = (1/4\pi\varepsilon_0)\ (q_1 q_2/r^2)$$

Since the charges are equal, $q_1 = q_2 = Q$.

Given $F = 40N$ and $r = (3/100)m$

Substituting these values and solving the equation, we get

$$Q = 2\mu C$$

35. Force between similar charges each of magnitudes Q placed at a distance r apart is given by :

$$F_2 = (1/4\pi\varepsilon_0)\ (Q^2 / r^2) \qquad (1)$$

Also, force between either charge Q and charge (q) placed at C at a distance r2 apart is given by :

$$F_2 = (1/4\pi\varepsilon_0)\ \{Qq/(r/2)^2\} = 4\ (1/4\pi\varepsilon_0)\ (Qq/r^2) \qquad (2)$$

Now condition for equilibrium is:

$F_1 + F_2 = 0.$

From 1 and 2 ,w e get

$(1/4\pi\varepsilon_0)\ (Q^2/r^2) + 4\ (1/4\pi\varepsilon_0)\ (Qq/r^2) = 0$

on solving we get :

$q = -Q/4.$

Concept plus (C+)

34. $1/4\pi\varepsilon_0\ \{(qxq) / (2r)^2\} = -1/4\pi\varepsilon_0\ (Qq / r^2)$

hence $Q/q = -\ ¼$

37. Only in case (D), the electrostatic force is directed opposite to the weight.

38. For net force on q placed B to be zero, we have

$F_{BA} + F_{BD} + F_{BC} = 0$

$\Rightarrow$ $qQ/4\pi\varepsilon_0 a^2 + q^2/4\pi\varepsilon_0 (2a^2) \cos 45 + qQ/4\pi\varepsilon_0 a^2 +$

$\cos 90$

on solving , we get

$q = -2\sqrt{2}\, Q$

39. Net force on each of the charge due to the other charges is zero. However disturbance in any direction other than along the line on which the charges lie, will not make the charge sreturn.

40. Force between similar charges Q, $F3 = k(Q^2/r^2)$

and force between q and Q, $F_1 = 4kQq/r^2$.

For equilibrium

$F_1 + F_3 = 0 \Rightarrow 4kQq/r^2 = -(kQ^2/r^2)$

$\Rightarrow$ $q = -Q/4$.

41. Two forces on C are

$F_1 = F_2 = (1 \times 10^{-6} \times 2 \times 10^{-6}) / \{4\pi\varepsilon_0 (0.1)^2\}$

$= (9 \times 10^9 \times 2 \times 10^{-12}) / (0.1)^2 = 1.8$ N

horizontal components of F_1 and F_2 will cancel out.

Hence net force on the charge at C is 2 x 1.8

cos 30^0.

42. From figure , it is clear that the force on the charged acting upwards due to electric field is balanced by the weight of the charged particle acting vertically downwards.

So, we have

$$F = mg$$

So $qE = mg$

$\Rightarrow$ $q = mg/E$

Substituting $m = 9.6 \times 10^{-16}$ kg ; $g = 10$ ms^{-1} ;

$E = 20{,}000\ Vm^{-1}$, we get :

$Q = 4.3 \times 10^{-19}\ C$

Now by quantization of charge , we have :

$Q = ne$

$N = q/e$

Substituting $q = 4.8 \times 10^{-19}\ C$; $e = 1.6 \times 10^{-19}\ C$, we get number of excess electrons , $n = 3$

43. From fig (i) we have :

Force, $F = (1/4\pi\varepsilon_0)\ (q^2/r^2)$ (1)

Further, from figure (iv) , we have

$F' = (1/4\pi\varepsilon_0)\ \{(q/2)\ (3q/4)\}\ /r^2\ ]$

$F' = 3/8\ [(1/4\pi\varepsilon_0)\ (q^2/r^2)]$

Using 1 we have

$F' = 3F/8.$

Electric Field & Gauss Law

44. Ans. (D)

45. Since, the drop moves upwards , the viscous drag is downwards. Resultant of weight and up thrust , that is $4/3\ \pi r^3 (\rho-\rho_0)g$ also acts downwards. So, the upward motion is due to the up ward electric force qE.

46. Density of lines of force is proportional to E.

$\rightarrow \rightarrow$

47. Up = - P. E.

48. Ans. (B)

49. Ans. (C)

50. Ans. (C)

51. Ans. (C)

52. Ans. (D)

53. Electric field decreases as we move from surface of the sphere to its centre.

54. Ans. (A)

55. E = F/q. = N/C

56. if we consider the cube as the Gaussian surface then flux through it is q/ε_0.

Since each of the cube is symmetrical so flux associated with each side is same. Hence flux through one of the side is $q/6\varepsilon_0$.

57. Ans. (A)

58. Ans. (A)

59. As we know , $\phi = q/\in_0$. or $q = \phi \in_0$.

If $\phi 1$ is the electric flux entering and $\phi 2$ is the electric flux leaving an enclosed surface, then electric charge is given by

$$Q = (\phi_2 - \phi_1)\in 0.$$

60. Ans. (A)

concept plus.

61. Electric field is perpendicular to area vector.. hence the total flux

$$\phi = 0$$

62. From Gauss's theorem

$$\phi = \text{net charge enclosed by the surface} / \varepsilon_0.$$

63. The net energy of charged particle in uniform E is

$$K = ½\, q^2E^2t^2/m.$$

$\Rightarrow$ $K \propto q^2/m$. $K_1 = (2q)^2/m$.

$K_2 = (2q)^2/2m.$

So $K_2/K_1 = 2/1.$

64. Dipole consists of equal and opposite charges . here the net charge enclosed is zero

65. Electric field at the centre due to charge at the opposite corners will cancel each other.

66. The electric dipole moment varies inversely as the cube of the distance

67. According to Gauss's theorem , total electric flux through any closed surface is equal to $1/\in_0$ times. the total charge enclosed by the surface i.e.

$$\phi = q/\in_0 = (+q-q) / \in_0 = 0$$

note the charge situated outside the closed surface are not considered to total electric flux.

Concept plus plus

68. Electric field inside the shell is zero. It varies inversely as the distance from the centre.

69. A charged conducting sphere behaves for all points on its surface as well as outside , as if which of the charge is concentrated at its centre when distance becomes 2R. then E becomes one fourth.

70. Electric intensity due to a sheet of charge having surface density σ is $\sigma / 2\varepsilon_0$. that due to $-\sigma$ is $\sigma / 2\varepsilon_0$.

total intensity $\sigma / 2\varepsilon_0. - (- \sigma / 2\varepsilon_0.) = \sigma / \varepsilon_0.$

& Outside will be $-\sigma / 2\varepsilon_0. + \sigma / 2\varepsilon_0. = 0.$

71. Conductor behaves as if whole charge is concentrated at the centre. Distance between the charge will be (R + x)

72. Electric field on the surface of the sphere should not exceed 2.0×10^6 N/C. Therefore

$9 \times 10^9 \times q / (3 \times 10^{-3})^2 = 2.0 \times 10^6$.. this gives $q = 2 \times 10^{-9}$ C.

73. The electric flux is given by :

$$\phi = \int E ds$$

Substituting $E = \alpha x$, er get

$$\phi = \int (\alpha x) 2\pi x \, dx.$$

$$\Rightarrow \quad \phi = 2\pi\alpha \int_0^R x^2 \, dx.$$

$$\phi = 2\pi\alpha \left[x2/3 \right]_0^R$$

$$\phi = 2/3 \, \pi R^3.$$

74. Electric field at the centre of a hollow charged sphere is zero.

ELECTRIC POTENTIAL

75. Work done in displacing the charge = q x ΔV. On the equi potential surface $\Delta V = 0$. hence work done is also zero.

76. knowledge based questions. Ans. (D)

77. Electric potential inside a a charged sphere is everywhere same as that on the surface.

78. knowledge based question. Ans. (D)

79. maximum value of potential gradient gives electric intensity

80. Both points are on equi potential surface.

81. $E = 1/4\pi\varepsilon_0 (Q/R^2) = 1/4\pi\varepsilon_0 (4\pi R^2 / R^2) = \sigma / \varepsilon_0$.

It is independent of radius and depends on σ

82. $V = 1/4\pi\varepsilon_0 (Q/R) = 1/4\pi\varepsilon_0 (4\pi R^2 \sigma/ R) = (\sigma / \varepsilon_0)R$

83. The breakdown or sparking occurs when the electric field becomes more than a particular value. Since $V = 1/4\pi\varepsilon_0 (qR)$

$= 1/4\pi\varepsilon_0 (q/R^2) = ER.$

Hence $V \propto R$, because E is constant.

84. $\sigma \propto 1/r.$

85. $V_1 = V_2$.

$1/4\pi\varepsilon_0 (q_1/r_1) = 1/4\pi\varepsilon_0 (q_2/r_2)$

$q_1/q_2 = r_1/r_2.$

86. Potential inside the sphere is same as on its surface.

87. Here, $q_1 = q_2.$

$(4\pi\varepsilon_0) V_1r_1 = (4\pi\varepsilon_0) V_2r_2.$ $[1/(4\pi\varepsilon_0) (q/r)]$

$V_1/V_2 = r_2/r_1$.

88. $V = -\int E dx$.

89. The electric potential inside is same as that at the surface . that outside , it is inversely proportional to r. hence

$V = 1/(4\pi\varepsilon_0)\ (Q/10)$

$V = 1/(4\pi\varepsilon_0)\ (Q/15) = 2/3\ V$

$Up = 1/(4\pi\varepsilon_0)\ (q_1q_2/r^2)$

90. $F = qE$

$E = F/q. = (3000/3)\ NC^{-1} = 1000\ NC^{-1}$.

91. Potential difference between two points is given by

$V = \text{Work} / \text{Charge} = W/q$.

Substituting $W = 2\ J$; $q = 20C$, we get

$V = 0.1\ V$

92. $V_c = 1/4\pi\varepsilon_0 (q/R)$, $V = 1/4\pi\varepsilon_0 [Q/ (r^2 + R^2)^{1/2}]$

$\Delta V = V_c - V$

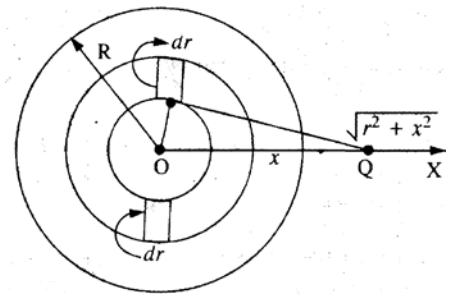
$= q / 4\pi\varepsilon_0 [(1/R) - (1/ (r^2 + R^2)^{1/2})]$

$= (10 \times 10^{-6}) (9 \times 10^9) [(1/6) + (1/10)]$

$= 9 \times (14/60) \times 10^4$ V.

hence $W = (\Delta V)q_0$,,

where $q_0 = 6\mu C$.



93. The potential due to small element dr of the disc having charge dq at a point Q distant x from the centre of the disc is given by

$dV = 1/4\pi\varepsilon_0[dq / \sqrt{(r^2 + x^2)}]$

or $dV = 1/4\pi\varepsilon_0[(2\pi r dr)\sigma / \sqrt{(r^2 + x^2)}]$ [in this case, charge density = $\sigma = dq / 2\pi r dr$]

R

$\Rightarrow dq = (2\pi r dr)\,\sigma$

$$V = 1/4\pi\varepsilon_0\, \pi\sigma \int_0 [2rdr / \sqrt{(r^2 + x^2)}\,]$$

$$V = \sigma/4\varepsilon_0[(r^2 + x^2)^{-½+1} / (-1/2 + 1)\,]$$

$$V = \sigma / 2\varepsilon_0\, [\sqrt{(R^2 + x^2)} - R]$$

At $x = \sqrt{3}\,R$, we have

$$V = \sigma / 2\varepsilon_0\, (R) \Rightarrow \sigma R/2\varepsilon_0.$$

94. From principle of conservation of energy, we have :

kinetic energy = Electrostatic potential energy

$$½\, m\nu^2 = KqQ / r \qquad (1)$$

when the speed of charge q is doubled, then we have

:

$$½\, m\,(2\nu^2) = KqQ/r' \qquad (2)$$

Dividing eqn. 1 by 2 , we get

¼ = r' / r

r' = r/4

CAPACITANCE

95. When radius is doubled , the capacitance is also doubled. Since the charge remains unchanged . therefore V = q/C is halved.

96. Capacitance in a medium = dielectric constant x capacitance in vacuum.

97. when n drops coalesce radius of the single drop so formed becomes $n^{1/3}r$. So the capacitance also becomes $n^{1/3}$. times. Potential is $n^{2/3}$ times. The potential energy which is given by ½ n^2q^2 $Cn^{1/3}$ becomes $n^{5/3}$ times.

98. See explanation to Q. no. 97

99. when the plates are moves apart , charge cannot change. But capacitance will decrease . So V = q/C will increase. That is , the potential difference will increase

100. knowledge based question.

101. All are conductors with very high dielectric constant. Presence of material increases capacitance in proportion to the dielectric constant.

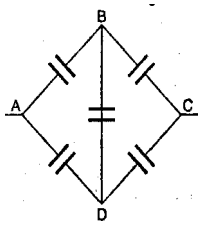
102. The plates of the capacitor acquire equal and so the electric field due to inner cylindrical charged conductor varies inversely as the distance from the axis.

103. Electric field due to outer plate is zero and so the electric field due to inner cylindrical charged

conductor varies inversely as the distance from the axis.

104. Electric field is inversely proportional to the dielectric constant.

105. when dielectric is introduced, capacitance increases. Since charge on the plates remains unchanged. Therefore potential difference as well as potential energy



106. $C = \varepsilon_0 A/d$.

CONCEPT PLUS.

107. Three equivalent circuits in the fig.

The bridge is balanced. Hence the capacitor between B and d is not in operation. As the potential at B is equal to the potential at D.

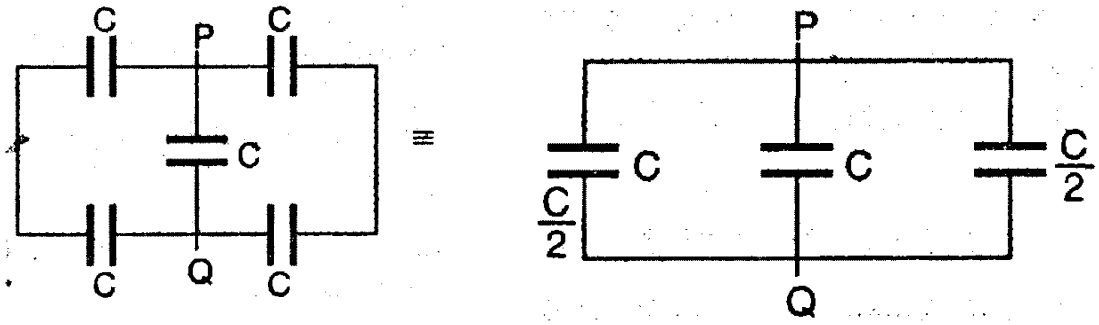
108. they constitute three capacitors in parallel.

109. They constitute two capacitors in parallel.

110. Apply the laws of in series and parallel.

111. Apply the laws of in series and parallel.

112. Hence $C_{eff} = C/2 + C + C/2 = 2C$



113. When a dielectric substance of dielectric constant k is introduced in the plates of capacitor , then , capacity is given y :

$$C = k (\varepsilon_0 A/d)$$

$\Rightarrow$ capacitance C increases on introduction of dielectric slab.

114. The equivalent diagram can be drawn as follows :

from fig (ii) C1 and C5 are in series . hence the equivalent capacitance ,

$$1/C' = 1/C^1 + 1/C^5 = ½.$$

$\Rightarrow$ $C' = 2\mu F$.

Similarly $C'' = 2\mu F$

Now from fig (iii)

C' & C" are in parallel combination.

$\Rightarrow$ equivalent capacitance $C = C' + C = 4\mu F$.

115. the given circuit diagram can be simplified as follows

it is clear from figure (i) that first three capacitors are in series.

Hence, equivalent capacitance of series combination is given by

$1/CS = 1/C + 1/C + 1/C = 3/C$

$Cs = C/3$.

Now from fig (ii), it is clear that Cs and C both are in parallel.

Hence, the circuit can be simplified as shown in fig. (iii)

Further, equivalent capacitance of parallel combination is given by

$C_{AB} = C/3 + C = 4C/3.$

116. $W = ½ q^2/C$

by substituting the values for q and C , we get the work done = 32×10^{-32} J.

117. The energy stored in a capacitor is given by

$E = ½ CV^2.$

Substituting $C = 40\ \mu F = 40 \times 10^{-6}$ F ; V = 3000 V, we get

$E = 180$ J

Now, power delivered is given by : $P = E/t$

Substituting E = 180 J and T = 2 ms = 2×10^{-3} s, we get :

P = 90 kW.

118. The distribution of charge at various plates is as shown. From the following we can determine the ratio by multiplying with 4.

119. The equivalent arrangement is shown in the fig.

Capacitance between A and B is

$1/C_{AB} = 1/C + 1/C = 2/C$

or $C_{AB} = C/2 = \varepsilon_0 A/2d.$

$C_{ab} = C + \varepsilon_0 A/2d. = \varepsilon_0 A/d. + \varepsilon_0 A/2d = 3/2\ \varepsilon_0 A/2d.$

120. the equivalent circuit is as follows :

$C_{RS} = .C + C = 2C.$

$C_{PQ} = (C_{RS} \times C_S) / (C_{RS} + Cs) = (2C \times C) / 3C$

$= 2/3\ C$

Substituting $C = \in_0 A/d.$

$C_{PQ} = 2/3 \in A/d.$

121. $Q = VC$

122. Capacitance due to a parallel plate capacitor is give by

$$C = \in_0 (A/ d)$$

Now when thin aluminium sheet is placed between the capacitors, then two capacitors connected in series are obtained. The new capacitance of each capacitor is given by

$$C = \in_0 \{ A/ (d/2)\}$$

$$C' = 2 (\in_0 A/ d)$$

Using 1 we have

$$C' = 2C.$$

Further equivalent capacitance of the combination is given by

$$1/C' = 1/C' + 1/C' = 2/ C'$$

$C' = C'/2 = 2C/2 = C$

123.

124. The equivalent circuit of given network of capacitors is given as This is work done by reducing the equi potential points in the network .

ELECTROMAGENTISM

QUESTIONS FROM THE COMPETITIVE EXAMS.

1. Factual statement

   Ans. (C)

2. Magnetic flux $\phi = BA$.

   Hence $B = \phi/A = Wb/m^2 = tesla$

   Ans. (C)

3. knowledge based questions

   Ans. (B)

4. knowledge based question

   Ans. (A)

5. Induced emf ,

$$e = -L\,(dI/dt) = -5 \times 2 = -10 \text{ volt}$$

here negative sign shows that induced emf has got opposing nature. Ans. (B)

6. Capacitive reactance $Xc = 1/\omega C = 1/(C \times 2\pi f)$

$$Xc = 1/(2C \times 2\pi \times 2f) = 1/\,4(2\pi f \times C) = \tfrac{1}{4}\,Xc.$$

Ans. (C)

7. knowledge based questions

Ans. (A)

8. According to faraday's law of electromagnetic induction, induced emf in the coil is given by

$$|\,e\,| = L\,(dI/dt)$$

Given that $dI = 3 - 2 = 1A$,

$dt = 1 \times 10^{-3}$ s.

$|e| = 5V.$

substituting these values we get

$L = 5 \times 10^{-3} H = 5$ m H.

Ans. (B)

9. knowledge based questions

Ans. (B)

10. We know that magnetic flux is give by

$\phi s = MI_P$

where ϕs = Magnetic flux linked with the secondary coil.

I_P = current flowing through primary coil

M = Mutual inductance

Here $\phi s = 2 \times 10^{-2}$ Wb and $I_P = 0.01$ A.

Substituting these values in above equation, we get

$$M = (2 \times 10^{-2}) / (1 \times 10^{-2}) = 2H$$

Ans. (A)

11. From faradays law of electromagnetic the induced emf is given by

$$E = -L\,(dI/dt)$$

Or $E = -L\,(I_1 - I_2)/dt.$

$L = -Edt / (I_1 - I_2)$

Substituting $E = 8V$; $t = 0.05$ s ; $I_1 = 2A$

$I_2 = 4a$ we get

$= 0.2$ H

Ans. (C)

12. Power is given by

$P = E^2/R$

$P \propto E^2$. (1)

Since $E\, d\phi/st = d/dt\, (NBA) = NA\, dB/dt$,

therefore we have

$E \propto NA$

Therefore equation 1 can be written as

$P \propto (NA)^2$.

$P_2/P_1 = N_2^2A_2^2 / N_1^2A_1^2$.

Since $A = \pi r^2$, therefore we have :

$P_2/P_1 = (N_2^2 / N_1^2) \times (r_2^4/ r_1^4)$

Substituting $N_2 = 4N_1$; $r_2 = r_1/2$.; we get

$P_2/P_1 = 1$.

Ans. (B)

13. knowledge based questions.

Ans. (C)

14. $e = - L(dI/dt)$

$L = -e / (dI / dt)$

Substituting the values of $e = 8V$,

$dI = -2-2 = -4A$ and $dt = 0.05s$,

we get $L = 0.1$ H.

Ans. (A)

15. Ans. (D)

16. knowledge based questions.

Ans. (B)

17. knowledge based questions.

Ans. (C)

19 $Vc = IX_c = 1/\omega c = 1/2\pi fC$.

Ans. (A)

20. knowledge based questions.

Ans. (B)

21 motion of charged particle is a circle in yz plane

Ans. (C)

22. knowledge based question

Ans. (A)

23. The maximum of induced emf is given by

$E = nBA\,\omega$

Substituting $\pi = 3.14$; $\nu = 8.3 \times 10^5$ Hz,

$C = 1.20\ \mu F = 1.20 \times 10^{-6}$ F, we get

$L = 3.07 \times 10^{-8} H$

Ans. (B)

24. The r. m. s. value of current in an a.c. circuit is given by

I r.m.s. $= I_0/\sqrt{2}$.

Substituting $I_0 = 5\sqrt{2}$ A, we get

I rms = 5A.

Ans. (A)

25. The impedance of choke coil is given by

$$Z = \sqrt{(R^2+\omega^2L^2)}$$

Since $\omega = 2\pi\nu$, therefore we have :

$$Z = \sqrt{(R^2+(2\pi\nu)^2L^2)} \qquad (1)$$

Now, resistance $R = V/I = 15/10 = 1.5\ \Omega$

Impedance $Z = V_{ac}/I$ \ $220/10 = 22\Omega$

$\nu = 50$ Hz and $\pi = 3.14$

substituting all the values in the equation we get

$$22 = \sqrt{[(1.5)^2 + (2 \times 3.14 \times 50)^2 L^2]}$$

on solving we get

L 0.07 H

Ans. (A)

26. EMF is given by

$$E = \Delta\phi/\Delta t$$

Substituting $E = IR$, we get

$$IR = \Delta\phi/\Delta t$$

Or $I\,\Delta t = \Delta\phi/R$

But, charge $Q = I\,\Delta t$

Therefore we have

$Q = \Delta\phi/R$

Ans. (A)

27. knowledge based question

Ans. (C)

28. In a LCR circuit the voltage across the conductor (L) and capacitor (C) are in opposite phase so we have

$V_L - V_C = 50 - 50 = 0$

Ans. (D)

29. Current is given by

$I = E/R'$

Substituting $E = -nd\phi/dt$, we get

$$I = (-n/R') \, d\phi/dt$$

Given that

W_1 and W_2 are the values of the flux associated with one turn of the coil

Therefore eq.1 becomes

$$I = -n/R., \, [(W_2-W_1) / (t_2-t_1)]$$

Total resistance of the combination is :

$$R' = R + 4R = 5R$$

Substituting the values of R' and $(t_2-t_1) = t$ in equation 2 we get

$$I = -n/5R \, [(W_2-W_1) / (t)]$$

$I = -n[(W_2-W_1) / 5Rt.$

Ans. (B)

30. Magnetic flux is given by

$\phi = B. A = BA \cos \theta$

Substituting $A = \pi r^2/2$ (for semicircle) ; $\theta = \omega t$

we get

$\phi = (B\pi r^2/2) \cos\omega t$

Now, induced emf is given by

$E = -d\phi / dt = -d/dt [(B\pi r^2/2) \cos \omega t]$

On differentiating we get

$E = ½ B\pi r^2 \omega \sin \omega t$

(1)

Power is given by

$P = E^2/R = B^2\pi^2r^4\omega^2\sin^2\omega / 4R$

using 1)

Substituting the mean value of $\sin^2\omega t$., that is

$\text{Sin}^2\omega t >= ½$ we get

$P = (B\pi r^2\omega)^2/8R$

Ans. (B)

31. Frequency of resonance in a LCR circuit is given by

$\omega = 1/\sqrt{LC}$

for ω to be constant, the product LC should also remain constant

$$LC = L'C'$$

Substituting $C' = 2C$, we get

$$L' = L/2$$

Ans. (C)

32. knowledge based question

Ans. (D)

33. knowledge based question

Ans. (C)

34. knowledge based question.

Ans. (B)

ELECTROMAGNETIC INDUCTION SOLUTIONS.

1. Ans. (D)

2. Ans. (D)

3. Ans. (B)

4. Ans. (C)

5. Ans. (C)

6. Ans. (A)

7. Ans. (D)

8. Ans. (A)

9. Ans. (C)

10. Ans. (A)

11. Ans. (B)

12. Ans. (A)

13. Ans. (C)

14. Ans. (C)

15. Ans. (C)

16. Ans. (C)

17. Ans. (C)

18. Ans. (B)

$\rightarrow \rightarrow$

19. $\phi = nB$. A. and $B \propto n$.

Ans. (A)

$\rightarrow \rightarrow$

20. $\phi = nB \cdot A$. and $B \propto n$.

Ans. (C)

21. The split ring commutator is used in dc generator Ans. (C)

22. No energy is drawn from the source. For ideal transformer efficiency = 1. Since output is zero so input is also zero.

Ans. (D)

23. $L \propto N^2/l$ Ans. (D)

24. eddy current circulate within the conductor

Ans. (C)

25. The induced current in the solenoid will oppose the motion of the magnet. Ans. (B)

26. When motor is switched on, the static friction comes into play, , which is much larger than the rotating friction. Hence larger power current input is needed. Ans. (B)

27. L is analogous to mass and I is analogous to velocity. Ans. (C)

28. E = L. dI/dt, here E = 2V , dI = 1A and dt = 10^3 s. hence L = 2mH. Ans. (D)

29. $L_P = L_1L_2 / (L_1 + L_2) = L^2/2L = L/2$.

Ans. (B)

30. Energy stored In an inductor $= \frac{1}{2} LT^2$.

$= \frac{1}{2} \times 50 \times 10^{-3} \times (4)^2 = 0.4$ J

Ans. (A)

31. In put power is 220 V x 0.5 A = 110 W. Output power will be 100 W. Hence efficiency = 100W/110 w = 90.9 %, which is very near to 90%. Ans. (D)

32. Use E = L dI/dt. Here E = 8V, dI = 2A – (-2A) = 4A

dt = 0.05 s. Hence L = 0.1 H

Ans. (A)

33. $E = L.\ dI/dt$, here $L = 15H$ and $dI/dt = 0.2\ As^{-1}$.

This gives $E = 3V$. Ans. (A)

34. $E = -L\ dI/dt$, Therefore $[L] = [E\ dt/dI]$

= volt second/ampere

= volt second/(coulomb/second)

= volt second^2/coulomb

= Joule second^2/coulomb^2.

Because volt = joule/coulomb

Ans. (A)

35. $Up = ½\ LI^2 = ½ \times 2 \times (10)^2 = 100\ J$

Ans. (C)

36. $E = L\, dI/dt = 2 \times 10\text{-}3 \times [10\text{-} (-2) \;/\; 3\times10^{-3}] = 8V$

Ans. (A)

37. $E_P/E_S = N_P/N_S \;\Rightarrow N_P = (E_P/E_S) \times N_S = (220 / 11000) \times 1000$ Ans. (B)

38. The two coils of a transformer are insulated from each other. Ans. (D)

39. $I = (E\text{-}E_b) / R \;\Rightarrow\; E_b = E\text{-}IR$

or $E_b = 200 – 2 \times 50 = 100V$

Ans. (C)

40. $E = d\phi / dt = 20 \times 5\pi \cos 5\pi t + 2t + 50$

At t = 1. we find

$E = 20 \times 5\pi \cos 5\pi + 2 \times 1 + 50 = 52$ V

Ans. (A)

41. $LI = N\phi \Rightarrow L = N\phi/I$

Or $L = (200 \times 4 \times 10^{-3}) / 2 = 0.4$ H

Ans. (D)

42. $E = L\, dI/dt = 5 \times 10\text{-}3 \times (1\text{-}0 / 0.1) = 0.5 \times 10^{-3}$

V Ans. (D)

43. $1/L_P = 1/L_1 + 1/L_2$.

Ans. (C)

44. if $\phi = BA \cos \omega t$, then $E = -d\phi/dt = B\omega A \sin\omega t$.

Ans. (C)

ELECTROMAGNETIC WAVES

SOLUTIONS

$\rightarrow \rightarrow$

1. $\varepsilon_0 E.dS$ gives electric flux. It has the dimensions of charge. Ans. (B)

2. Knowledge based questions.

   Ans. (D)

3. Knowledge based questions.

   Ans. (C)

4. Knowledge based questions.

   Ans. ((A)

5. Knowledge based questions.

Ans. (C)

6. Knowledge based questions

Ans. (A)

7. $A = \pi d^2 = \pi[2Rh] \Rightarrow A \propto h$.

Ans. (C)

8. $B = E/c$. Ans. (D)

9. $\lambda = hc/E = (6.6 \times 10^{-34} \times 3 \times 10^{8}) / (6.6 \times 10^{3} \times 3 \times 10^{-19}) = 0.825$ A @ 1 A. Ans. (B)

10. $E = -d\phi/dT$ here $\phi_i = nBA = 1000 \times 4 \times 10^{-5} \times 0.05 = 0.2 \times 10^{-2}$.

& $dt = 0.01\ s = 10^{-2}\ s.$ hence $d\phi = 0.02 \times 10^{-2} - (0.2 \times 10^{-2}) = \ = 0.4 \times 10^{-2}$.

Therefore $E = (0.4 \times 10^{-2}) / 10^{-2} = 0.4\ V$

Ans. (A)

11. Magnetic flux $\phi = BA$ Hence $B = \phi/A =$ Wb/m^2 = tesla. Ans. (C)

12. $E_S/E_P = n_S/n_P = I_P/I_S = I_P/2 = 25/1$ $\Rightarrow$ $I_P =$ 50A. Ans. (B)

13. $E = -M(dI/dt) = MI_0\omega \cos\omega t$.

$E_0 = MI_0\omega = 0.005 \times 10 \times 100\pi = 5\pi$.

Ans. (B)

14. $I = 220 / \sqrt{[(20)2 + (2 \times \pi \times 50 \times 0.2)^2]} = 220 /$

$(20 \times 3.3) = 220 / 66 = 3.33$ A. Ans. (D)

15. At resonance $\omega L = 1/\omega C$.

Ans. (A)

16. knowledge based questions.

Ans. (D)

17. $X_C = 1/\omega C = 1/ 2\pi fC$.

Ans. (C)

18. Quality factor $Q = \omega L/R$

Ans. (A)

19. Coefficient of self inductance or mutual

inductance is measured in henry (H) . also I μ =

1 Wb / 1A = 1 Wb A^{-1} = 1 weber / ampere.

Ans. (D)

20. Here equation for the current = 5 si (100t – (h/2) and equation for the voltage (V) = 200 sin (100t). Therefore standard equation for the current (I0 = Ia sin (ωt-ϕ). On comparing the given equation, with the standard equation, we get the angle between current and voltage (ϕ) = $\pi/2 = 90^0$. Therefore Power (P) = VI cos ϕ = VI cos 90^0 = VI x 0 = 0W. Ans. (D)

21. This is in accordance with Lenz's Law.

Ans. (C)

22. e.m.f.(ε) = N. ($d\phi/dt$) if N is doubled so ε is increased two times. Ans. (A)

23. knowledge based questions.

    Ans. (A)

24. Knowledge based questions.

    Ans. (C)

25. Power factor of an A.C circuit having resistance (R) and inductance (L) connected in series is given by : $\cos\phi = R/(R^2\omega^2L^2)^{1/2}$.

    Ans. (B)

26. In transformer current ratio and turns ratio is given by

that is $I_P/I_S = N_S/N_P$. here $I_P = 4A$, $N_P = 140$, $N_S = 280$.

Substituting these values in above questions, we get : $I_S = 2A$. Ans. (B)

27. Height of the tower is given by :

$h = d^2/2R \Rightarrow$ $d^2 = 2hR. \Rightarrow d = \sqrt{2hr} \Rightarrow$

$d = h^{1/2}$. Ans. (A)

28. The r.m.s value of circuit in an A.C. circuit is given by :

$I_{r.m.s.} = I_0/\sqrt{2}$. Substituting $I_0 = 5\sqrt{2}A$, we get : $I_{r.m.s.} = 5A$. Ans. (A)

29. knowledge based questions.

    Ans. (C)

30. Knowledge based questions.

    Ans. (A)

MAGNETIC EFFECT OF ELECTRIC CURRENT AND MAGNETISM

QUESTIONS FROM THE COMPETITIVE EXAMS

1. $F = (\mu_0/4\pi)\ (2I_1I_2 / R)$

   $= 10^{-7} \times (2 \times 10 \times 10) / 0.1 = 2 \times 10^{-4}$ N

   force between parallel current is attractive

   Ans. (A)

2. The magnetic field is given by

   $B = (\mu_0/4\pi)(2I/r)$

   It is independent of the radius of the wire

   Ans. (D)

$\rightarrow \quad \rightarrow \rightarrow$

3. $F_m = q_0 \nu \times B$

Ans. (C)

it will be centripetal force and no work will be done on the particle

4. As they enter the magnetic field of the earth, they are deflected away from the equator Ans. (C)

5. The electric dipole moment varies inversely as the cube of the distance Ans. (D)

6. $B = (\mu_0/4\pi)(2\pi I/R)$, also $l = 2\pi R_1 = 2 \times 2\pi R_2$.

Ans. (C)

That is $R_2 = R_1/2$ hence $B_2 = 2B_1$.

7. knowledge based question

Ans. (C)

8. $B = (\mu_0/4\pi)\ (2\pi I/r)$

Ans. (B)

9. Diamagnetic material move towards weaker fields. Ans. (B)

10. Inside the magnetic field is cancelled.

Ans. (B)

11. $B \propto i$. since current is unchanged so in the case with B. Ans. (D)

12. A moving charge in motion, in free space produces both electric and magnetic field. Ans. (C)

$\theta = \theta$

13. Work done = $\int$ MH sinθ dθ. = MH (1-cosθ)

Ans. (D)

$\theta = 0$

14. Use $mv^2 /r = B\ q\ v\sin\theta$.

Ans. (C)

This gives

$R = mv/ B\ q \sin\theta = (3 \times 10^5) / (0.3 \times 10^8 \times ½) =$

2 cm

15. Knowledge based question.

Ans. (D)

16. Here $B = 7 \times 10^{-5}$ Wb/m^2, $r = 5 \times 10^{-2}$m

Therefore,

$$B = (\mu 0/4\pi) \times 2\pi l/R$$

This gives, $I = BR/\{ (\mu_0/4\pi) \times 2\pi\} = 7\times 10^{-5} \times (5 \times 10^{-2}) / 10^{-7} \times 2 \times 3.142 = 5.57$ A.Ans. (D)

17. Here angle of the bar magnet (θ_1)= 90^0 ; Initial torque (τ_1) τ and the final torque(τ_2) = $\tau/2$

Therefore the initial torque (τ_1) = MB $\sin\theta_1$ = MB $\sin 90^0$ = MB, therefore torque (.τ_2) = MB $\sin\theta_2$. Therefore, $\tau/2$ = MB $\sin\theta$ or MB/2 = MB $\sin\theta_2$ or $\sin\theta_2$ = ½ or θ_2 = 30^0.

Hence angle by which the bar magnet to be rotated (θ_2) = 30^0. Ans. (A)

18. Cyclotron is suitable for accelerating heavy particles like proton , deuteron, α particles etc.

Ans. (D)

19. As sensitivity of the galvanometer.

$\sigma = nAB/C$, where n is a number of turns, A area of coil , b the magnetic field and C is the torsional constant of the suspension strips. Therefore , the value of σwill not increase with the decrease in n, A or B.

Ans. (D)

20. Curies law gives variation susceptibility with temperature. Only parra and ferromagnets obeys curies law. So the diamagnets material do not change their properties withtemperature. Ans. (A)

21. As $mv^2 = r = qvB$ and $v = r\omega$,

Therefore , $\omega = qB/m$

Thus $f = \omega/2\pi = (qB/2\pi m) = eB/2\pi m.$

Ans. (C)

22. Knowledge based question

Ans. (C)

23. Given a circular coil of A of radius R and current I is flowing through it , then magnetic field due to coil A is

$$B_A = (\mu_0/4\pi)(2\pi I/R)$$

(1)

Similarly , magnetic field due to coil B of radius 2R and current 2I flowing through it is given by

$$B_B = (\mu_0/4\pi)(2\pi\ 2I / 2R)$$

$$B_B = (\mu_0/4\pi)(2\pi I/R)$$

(2)

From equation (1) and (2) , we get $B_A/B_B = 1$.

Ans. (A)

24. when a charged particle moves at right angle to magnetic field , radius of circular path is given by

$$r = mv/qB$$

Ans. (A)

therefore curved path for electron and proton is same since both of them possess same momentum

25. Time period of charged particle undergoing a circular motion in a uniform magnetic field is given by

$$I = 2\pi m/qB.$$

Where, m = mass

q = charge

B = magnetic induction

Hence time period is independent of speed.

Ans. (A)

26. Knowledge based question.

Ans. (B)

27. When similar poles are on same side time period of oscillation T_1 is given by

$$T_1 = 2\pi \sqrt{[(I_1 + I_2) / \{(M_1 + M_2) B_H]}$$

Given that , $M_1 = 2M$, and $M_2 = M$.

$$T_1 = 2\pi \sqrt{[(I_1 + I_2) /(3M) B_H]}$$

(1)

When polarity of one magnet is reversed, time period of oscillation T_2 is given by

$$T_2 = 2\pi \sqrt{[(I_1 + I_2) / \{(M_1 - M_2) B_H]}$$

$T_2 = 2\pi 2\pi \sqrt{[(I_1 + I_2) / MB_H]}$

(2)

Comparing equations 1 and 2 we get

$T_2 > T_1$.

Ans. (A)

28. When a galvanometer is connected to hunt resistance then we have

Potential drop across the galvanometer.

= Potential drop across the shunt.

That is

$iG = (i – i0)S$.

(1)

Here, i = current through the galvanometer.

G = resistance of galvanometer.

i_0 = current through the shunt resistance.

S = shunt resistance

From (1) we have

The part of the total current that flows through galvanometer is

$$i / i_0 = S / (G+S)$$

Substituting , $S = 2.5\ \Omega$; $G = 25\Omega$ we get

$i/i_0 = 1/11$

Ans. (D)

29. the kinetic energy of a moving proton is given by

$K = ½ mv^2$.

$v = \sqrt{(2k/m)}$

Substituting $K = 5MeV = 5 \times 10^6 eV$

$= 5 \times 10^6 \times 1.6 \times 10^{-19} J = 8 \times 10^{-13} J$;

$m = 1.7 \times 10^{-27}$, we get

$v = 3 \times 10^{-7} ms^{-1}$.

Now the force experienced by the proton

moving vertically downwards in a horizontal

magnetic field is given by

$\rightarrow \rightarrow$

$F = q(\nu \times B) = q\nu B\sin\theta$.

Substituting $q = e = 1.6 \times 10^{-19}$ C;

$\nu = 3.1 \times 10^{7}$ ms^{-1} ; $B = 1.5$ Wbm^{-1}.

$\theta = 90^{0}$ we get

$F = 7.4 \times 10^{-12}$ N

Ans. (A)

30. Knowledge based questions.

Ans. (C)

31. Shunt resistance is given by

$S = G/(n-1) = 0.81 / (10-1) = 0.09\ \Omega$

Ans. (A)

32. As $T = 2\pi\sqrt{(I / P_m B)}$

When magnet is broken into two equal halves

then its magnetic moment becomes half i.e.

$P'm = pm^{1/2}$

The moment of inertia $I = MR^2/2$ becomes.

$I' = ½ M/2 = (R/2)^2 = ½ MR^2/8 = I/8.$

$T' = 2\pi\sqrt{(I / p'mB)}$

$= 2\pi \sqrt{[(1/8) / (pm/2 B)]} = T/2$

. so $T'/T = ½$

Ans. (C)

33. When a particle of mass M , charge Q moving

with velocity ν describes a circular path of

radius r placed in a uniform magnetic field, then work done by the field when particle completes circle is zero

Ans. (C)

34. Knowledge based questions.

Ans. (B)

35. $\tau = Pm\ B \sin\theta$ (1)

and $W = PmB\ (1-\cos\theta)$

$Pm = W / B\ (1-\cos\theta)$ (2)

Now substituting the values of Pm in equation (1) we get

$\tau = W\sin\theta / (1-\cos\theta)$

here $\theta = 60^0$. $\tau = \sqrt{3}W$

Ans. (B)

36. Knowledge based questions.

Ans. (C)

37. $T = 2\pi \sqrt{(I/PmB_H)}$

$T = 2\pi \sqrt{(I'/PmB_H)}$

$T \propto \sqrt{I}$

Therefore $T/T' = \sqrt{(I/I')}$

Also we know that, $I = 1/2MR^2$.

According to question, $M' = 4M$

Then $T'/T = \sqrt{(M/4M)} = ½$

$\Rightarrow$ 2T

Ans. (A)

38. $B = \mu_0 nI$

if I is doubled and the number of turns per cm is halved, then new magnetic field is

$B' = B$

Ans. (A)

39. Susceptibility , $x_m \propto 1/T$

Ans. (D)

40. Magnetic field due to circular loop at the centre is :

$B = \mu_0 I/2r.$

Substituting the values of

$B = 0.5 \times 10^{-5}\ Wbm^{-2}$, $r = 5 \times 10^{-2}m$ and μ_0,

We get

$$I = 0.4A$$

Ans. (B)

41. Knowledge based question.

Ans. (B)

42. Knowledge based question

Ans. (C)

43. Radius of circular path of a charged particle moving in a magnetic field is given by

$$r = mv/qB$$

$r \propto m/q$

$r_1/r_2 = (m_1/m_2) \times (q_1/q_2)$

(1)

for proton we have

$q_1 = e$; $m_1 = m$

for α particle, we have :

$q_2 = 2e$; $m_2 = 4m$

Substituting the values in equation (1), we get

$r_1/r_2 = ½$

Ans. (B)

44. Knowledge based question.

Ans. (A)

45. Since no current is enclosed by the loop, therefore the magnetic field will be zero inside the tube.

Ans. (B)

46. When the wire is bent into a circle of radius r, then we have

Circumference = length of the wire.

That is $2\pi r = l$

$$R = l/2\pi \qquad (1)$$

Now, magnetic field due to the circular loop at the centre is given by

$$B = \mu_0 I/2r$$

Using 1 we have

$$B = \mu_0 I\pi/l \qquad (2)$$

Further when the same wire bent into a circular loop n turns, then we have

$$n(2\pi r') = l$$

$$r' = l/2\pi n$$

(3)

Therefore magnetic field at the centre of the circular pool having n terms is given by

$$B' = \mu_0 nI/2r'$$

Using 3 we have

$$B' = n^2(\mu_0 I\pi / l)$$

Using 2 we get

$B' = n^2B$.

Ans. (B)

48. Force between two long parallel current carrying conductors is given by

$$F = \mu_0/2\pi\ (I_1I_2/d)\ .l$$

(1)

Substituting $I'\ 1 = -2I_1$; $d' = 3d$, we get

$F' = \mu_0/2\pi\ (I_1I_2/d')\ .l = \mu_0/2\pi(-2l_1)\ (I_2/3d)\ .l$

$F' = (-2/3)\ \mu_0/2\pi\ (I_1I_2/d)\ .l$

Using 1 we have

$F' = (-2/3)F$

Ans. (C)

49. Time period of vibration of a vibration magnetometer is given by

$$T = 2\pi\sqrt{(I/MB)}$$

if B = constant, then we have

$$T \propto \sqrt{(I/MB)}$$

$$I'/T = \sqrt{(I'/I)} \times \sqrt{(M/M')}$$

(1)

Here, I = moment of inertia of magnet

M = magnetic moment

Now for a bar magnet , we have

$I = 1/12\ ml^2$ and $M = (\text{pole strength}) \times l$

When magnet is cut along the length into three equal parts, then we have

$I' = 1/12\ (m/3)\ (l/3)^2$.

For combined three parts , we have

$I' = 1/12\ (m/3)\ (l/3)^2 \times 3 = 1/9\ [1/12\ ml^2]$

$I' = I/9$

Also M' = pole strength (will remain same) x $(l/3) \times 3 = M$

Substituting $I' = 1/9$; $M' = M$ in equation 1 we get

$T' = 1/\sqrt{9} = 2/3s$

Ans. (B)

50. Knowledge based question.

Ans. (B)

51. Knowledge based question

Ans. (C)

52. Knowledge based question

Ans. (D)

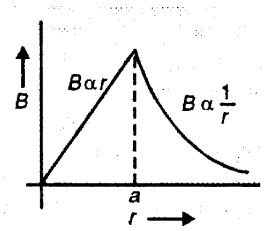
53. Knowledge based question

Ans. (A)

54. Knowledge based question

Ans. (C)

55. Magnetic field at a point outside the straight conductor is given by Ans. (A)



$B - \mu_0 I/2\pi r \Rightarrow B \propto 1/r$ (at $r > a$)

Also, the magnetic field at a point outside the straight conductor is given by

$$B = \mu_0 I/2\pi r \Rightarrow B \propto 1/r \text{ (at } r > a)$$

Hence the graph is obtained as follows.

56. Magnetic field at a point on the axis of a circular loop at a distance r is given by Ans. (D)

$$B = \mu_0/4\pi \; 2\pi I R^2 / (R^2 + r^2)^{3/2}.$$

When $r > R$, then we have

$B = \mu_0/4\pi \; 2\pi IR^2 / (r^3)$.

57. Knowledge based question.

Ans. (B)

58. The magnetic moment of a current carrying conductor is given by Ans. (D)

$$M = IA = I\,(\pi r)^2 \quad \Rightarrow M \propto r^2.$$

59. Cyclotron frequency is given by

$$\nu = qB/2\pi m$$

Substituting $q = 1.6 \times 10^{-19}$ C ; $B = 1T$;

$\pi = 3.14$; $m = 9.1 \times 10^{-31}$ kg, we get

$\nu = 28 \times 10^9$ Hz.= 28 GHz.

Ans. (D)

PHYSICS OF THE ATOM

ATOMIC PHYSICS

1. knowledge based questions Ans. (A)

2. Ans. (A)

3. Ans. (C)

4. Ans. (D)

5. It is statement of a fact. Ans. (B)

6. When the substance in bulk is at very very high temperature, continuous spectrum is produced.

Ans. (C)

7. Molecule given band spectrum Ans. (C)

8. Due to the continuous loss of energy the

electron will move along a spiral path towards a nucleus.

Ans. (D)

9. The coulomb force of the nucleus keeps the electrons bound to the nucleus Ans. (A)

10. $L_n = nh/2\pi$. Hence $L_{n+1} - L_n = h/2\pi$. Ans. (B)

11. P.E. increases , K.E decreases.

Ans. (A)

12. $E_n \propto 1/n^2$. As n increases ($E_n - E_{n+1}$) decreases.

13. $\nu \propto Z^2$.

14. $R = (me^4)/(2\varepsilon^2_0 ch^3)$ Ans. (B)

15. $3 \rightarrow 1$, $3 \rightarrow 2$, $2 \rightarrow 1$. Ans. (C)

16. K. E = ½ P.E. however K. E. is + VE. and P. E .is –VE. Ans. (B)

17. En = [-13.6 Z^2/n^2] eV. Here Z = 11 , n =1

Ans. (C)

18. $r \propto (1/Z)$ Ans. (C)

19. $\lambda \propto 1/Z^2$. For lithium Z =3.

Nuclear physics.

20. First nuclear fission reaction was developed by Hahn and Strassmann Ans. (C)

21. .Hydrogen atom join together to form helium

Ans. (B)

22. Chain reaction is sustained only when the mass is equal or more than the critical mass. Ans.(D)

23. Fission of U^{235} releases 200 MeV of energy.

    Ans. (D)

24. High energy is required to merge the nuclei.

    Ans. (D)

25. The nuclear fall out etc. after the large scale explosion of the atomic bomb is called nuclear holocaust. Ans. (D)

26. Density of the nucleus is constant for all the nuclei. Ans. (D)

27. Chemical reaction is same with all types of the isotopes of an element. Ans. (C)

28. The number of neutron in hydrogen is zero. It is an exception. Otherwise $N \geq Z$ in all cases.

Ans. (D)

29. Neutron was discovered by Chadwick.

Ans. (B)

30. Hydrogen nucleus contains only one protons.

Ans. (A)

31. Atomic weight is the mean value for all the isotopes of an element. Ans. (A)

32. $E = mc^2$ and mass of electron $= 9.1 \times 10^{-31}$ kg.

Ans. (B)

33. The binding energy per nucleon is of the same order of 8 MeV.

Radioactivity

34. α-rays are consist of helium nuclei

Ans. (B)

35. γ-rays are consists of high energy photons.

Ans. (D)

36. β - rays consists of electron emitted from within the nucleus Ans. (C)

α β

37. ${}_{n}A^{m} \rightarrow {}_{n-2}A^{m-4} . \rightarrow {}_{n-1}B^{m-4}$.

Ans. (D)

38. Each α - decays decreases the atomic number by 2 and mass number by 4. Each β-decays increases the nuclei number by 1.

Ans. (B)

39. Lead is stable. It is not radioactive. Ans. (B)

40. Half life period is a characteristic of the substance. Ans. (C)

41. The Z decreases by 1 in β - decay. Ans. (A)

42. 30 min = 6 half lives . $A = A_0(1/2)^n$.

Ans. (D)

43. $A = A_0(1/2)^n$. here n = 9/3= 3. Ans. (D)

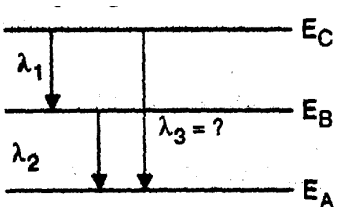
Questions from the competitive exams.

44. In 10 years number of un decayed particles be $N_0/4$. That is number of decayed particles will be $3N_0/4$. Hence probability of decay will be 75%.

Ans. (B)

45 The pulse returns to transmitter in 100 micro second. Hence range = 3×10^5 kms^{-1} x 500×10^{-6} s = 150 km. Ans. (D)

46. $E_3 = E_1 + E_2$



$h\nu_3 = h\nu_1 + h\nu_2$

$\Rightarrow 1/\lambda_3 = (1/\lambda_1) + (1/\lambda_2)$

or $\lambda_3 = (\lambda_1\lambda_2) / (\lambda_1 + \lambda_2)$

Ans. (B)

47. ${}_6C^{12} + {}_0n^1 \rightarrow {}_6C^{13} \rightarrow {}_7N^{13} + \phi - {}_1e^0$.

Ans. (C)

48. $En = E_1/n^2 = [13.6/(5)^2]eV = -0.54$ eV.

Ans. (A)

49. $hc/\lambda = \omega + ½ mv^2$. here $\omega = 1$ eV.

$= 1.6 \times 10^{-19}$ J, $\lambda = 3000A = 3000 \times 10^{-10}$ m,

$c = 3 \times 108$ ms^{-1} , $h = 6.6 \times 10^{-34}$ Js,

$m = 9.1 \times 10^{-31}$ kg. hence $\nu = 10^6$ ms^{-1}.

Ans. (D)

50. Energy of γ-ray photon

$= 2 \times 0.5$ MeV + 0.78 MeV = 1.78 MeV

Ans. (B)

51. X-ray diffraction helps in the study of the structure of solids Ans. (B)

52. de- Broglie wavelength is $\lambda = h/p = h/m\nu$

Ans. (A)

53. This is statement of fact.

Ans. (A)

54. $E_3 = -13.6/9 = 1.51$ eV.

And $E_4 = -13.6/16 = 0.85$ eV.

Hence $E_4 - E_3 = 0.66$ eV.

Ans. (D)

55. In two half lives, the activity becomes one fourth.

Ans. (B)

56. The radioactivity is measured in curie.

Ans. (C)

57. The crystals are used as diffraction gratings.

58. Work function = hc/λ_0, where λ_0 is threshold wavelength. Hence $\omega_1/\omega_2 = \lambda_2/\lambda_1 = 2/1$.

Ans. (B)

59. $\omega_0 = hc/\lambda_0$

$= (6.625 \times 10^{-34} \times 3 \times 18) / (5000 \times 10^{-10})]$ J

$\cong 4 \times 10^{-19}$J. Ans. (C)

60. $h\nu = \omega_0 + K.E.$ here $h\nu = 0.62$ eV., $\omega_0 = 4.2$ eV.

Hence K.E = 2eV

$= 2 \times 1.6 \times 10^{-19}$ J $= 3.2 \times 10^{-19}$ J.

Ans. (B)

61. Photoelectric current is proportional to the

intensity of light. Ans. (A)

62. In the seconds excited state the n=3,hence energy

is $(13.2/3^2) = 1.51$ eV. Ans. (A)

63. Large cohesive energy makes it hard.

Ans. (B)

64. Following transitions can occur $4 \rightarrow 3$; $4 \rightarrow 2$, $4 \rightarrow 1$, $3 \rightarrow 2$, $3 \rightarrow 1$ & $2 \rightarrow 1$ Ans. (B)

65. Neon street sign emits light of specific wavelengths Ans. (B)

66. 6400 years = 4 half life periods . So amount of element left $= 1/2^4 = 1/16^{th}$ part Ans. (B)

67. The CO_2 is formed through covalent bonds.

Ans. (D)

68. $\frac{1}{2} Mv^2 = qV$. Mass of helium ion is 4 times that of hydrogen ion and charge on helium ion is

twice of that on hydrogen ion.

Ans. (C)

69. $r \propto n^2$. here radius of the final state/radius of first state =4. Ans. (B)

70. $r \propto (A)^{1/3}$.

Ans. (C)

71. The peaks correspondence to characteristic radiation Ans. (C)

72. $\lambda = h/p$.

Ans.(D)

73. $\lambda = h/p$

Ans. (A)

74. $eV = hc = [(1/\lambda) - (1/\lambda_0)]$ (i)

$eV/3 = hc [(1/2\lambda) - (1/\lambda_0)]$ (ii)

Solving (i) & (ii)

$\lambda_0 = 4\lambda$.

Ans. (B)

75. $\Delta x, \Delta p \geq h/2\pi$.

Ans. (C)

76. $h\nu_{max} = eV$. Or $hc/\lambda_{min} = eV$.

Hence $\lambda_{min} \propto 1/V$.

Ans. (D)

77. $r = [\varepsilon_0 h^2/\pi m e^2] n^2$.

Ans. (C)

78. the electron will jump to n =3 orbit.. So emission will correspond to $3 \rightarrow 1$, $3 \rightarrow 2$ and $2 \rightarrow 1$ transitions

Ans. (C)

79. $R \propto A^{1/3}$.

Ans. (B)

80. when electron jumps from inner to an outer orbit. It absorbs energy. Ans.(A)

81. Each photon ejects one electron . therefore greater intensity of light produces larger photo current

Ans.(C)

82. $E \propto 1/n^2$., $E_1 = -13.6/4 = -3.4$ eV.

Ans.(A)

83. $r \propto n^2$. For ground state n -1 and for the first excited state n =2. Ans.(D)

84. Factual statement

Ans.(B)

85. ${}_0n^1 = {}_1p^1 + {}_1e^0 + \nu$. Antineutrino is required for conservation of spin. Ans. (B)

86. $A = A_0e^{-\lambda t}$ or $975 = 9750\ e^{-\lambda x5}$.

Hence $e^{5\lambda} = 10$. That is $5\lambda = \log_e 10 = 2.3026$

$\log_{10} 10 = 2.3026$ or $\lambda = 0.461$ Ans. (B)

87. Penetration is directly proportion to the energy of radiations. Ans.(D)

88. $\lambda = 0.69/T = 0.69/2.3 = 0.3$.

Ans.(C)

89. Factual statement

Ans.(A)

90. conservation of force is meaningless.

Ans.(B)

91. $\lambda \propto 1/Z^2$. Hence $Z = 2$.

Ans.(A)

92. $E = hc/\lambda$, where $\lambda = 21$ cm $= 0.21$ m

Ans.(D)

93. $hc/\lambda = \omega_0 + E_k$.

Ans.(A)

94. $hc/\lambda_1 = \omega 0 + ½ mv_1^2$ and $hc/\lambda_2 = \omega_0 + 1/2\ mv_2^2$.

Ans.(D)

95. $N_1 = N_0 (1/2)^4 = N_0/16$; $N_2 = N_0 (1/2)^2 = N_0/4$.

Ans.(C)

96. Let ${}^{10}_{5}B : {}^{11}_{5}B = x : y$.

Then $(10x + 11y) / (x + y) = 10 : 81$. this

gives $x/y = 19/81$ Ans.(A)

97. $r_n \propto n^2$.

Ans.(A)

98. knowledge based questions.

Ans.(D)

99. When β-particles is emitted the number of protons increase by 1 and that of neutron decrease.

Ans.(B)

100. knowledge based questions

Ans.(A)

101. $\Delta E = B_a - 2B_d = 4 \times 7\ MeV_{-2 \times 2 \times 1.1}$ MeV = 23.6 MeV.

Ans.(C)

102. knowledge based questions

Ans.(C)

103. knowledge based questions

Ans.(A)

104. $T = 0.693 / \lambda$

Ans.(C)

105. the eV is energy gained by a proton when accelerated through TV. Ans.(C)

106. knowledge based questions

Ans.(D)

107. knowledge based questions

Ans.(A)

108. Use $\omega = h\,(c/\lambda)$; Also 1 eV = 1.6×10^{-19}C.

Ans.(C)

109. knowledge based questions.

Ans.(C)

110. knowledge based questions.

Ans. (B)

QUESTIONS FROM THE COMPETITIVE EXAMS

1. $x = 3t^3 + 7t^2 + 5t + 8.$

dx/dt = velocity $= 3(3t^2) + 7(2t) + 5.$

$= 9t^2 + 14t + 5.$

d^2x/dt^2 = acceleration $= 9(2t) + 14 = 18t + 14.$

at $t = 1$, $d^2x/dt^2 = (18\,t + 14)_{t=1} = 18 + 14 =$

32m/s2. Ans. (2)

2 The velocity of an object is independent of its

mass. Ans. (3)

3. $F = ma$

$5 \times 10^4 = 3 \times 10^7 \times a.$

$a = (5/3) \times 10\text{-}3\ m/s^2$; $s = 3m$, $u = 0$

$v^2 = u^2 + 2as = 2 \times (5/3) \times 10^{-3} \times 3$

$\Rightarrow \quad v^2 = 10^{-2} \quad \Rightarrow \quad v = 0.1\ m/s.$ Ans.

(1)

4. $x \propto t^2 \quad \Rightarrow x = kt^2.$

$\Rightarrow v = dx/dt = 2kt$ and $a = dv/dt = 2k = const.$

Ans. (2)

5. $x = 2 - 5t + 6t^2.$

$v = dx/dt = 0 - 5 \times 1 + 12t$

$= -5 + 12.0 = -5\ m/s.$

Ans. (4)

6. $v = at = (F/m)t = (100 \times 10) / 5 = 200$ cm/sec.

   Ans. (2)

7. Ans. (4)

8. Given : we know that at every instant of time, the image of man will be as far away as the man is in front. Therefore the rate of change of distance of image is same as that of the object(man).

   Hence the speed of the image is 15 m/s. towards mirror. Ans. (2)

9. we know that gravitational acceleration is same for all falling bodies. But coin which is heavier

body experiences less air resistance as compared to paper.

Therefore coins falls faster.

Ans. (3)

10. Ans. (2)

11. $h = \frac{1}{2} gt^2$.

$h/2 = \frac{1}{2} g (2t - 1)$

dividing we get

$t^2 - 4t + 2 = 0$

$t = 4 \pm \sqrt{(16-8)} / 2 = (2 \pm \sqrt{2})s.$

Ans. (4)

12. $t \sqrt{x} + 3$ or $x= (t-3)^2$.

$\nu = dx/dt = 2(t-3) = 0$

$t = 3x.$

$x = (3-3)^2 = 0$ Ans.

(1)

13. $\nu^2 = u^2-2as.$

Or $S = u^2/2a = mu^2/2F$ or $S \propto u^2$

$S_1/S_2 = (u_1/u_2)^2.$

Or $2/S_2 = ¼\ S_2 = 8$ m Ans. (1)

14. $\nu = \sqrt{(\nu^2 + 2gh)}$ = same for both.

Ans. (2)

15. Acceleration observed by the man outside the lift

= (g-a)

Acceleration observed by the man outside lift = g

Ans. (3)

16. $v^2 = u^2 - 2aS = 0$

or $S = u^2/2a \propto u^2$.

$S_1/S_2 = (u_1/u_2)^2 = (u/4u)^2 = (1/16)$

Ans. (4)

17. When the lift is stationary ,acceleration = g.

$m = W/g = 49/9.8 = 5kg.$

$W = m (g-a) = 5 \times (9.8-5)$

$= 5 \times 4.8 = 24$ N Ans.

(1)

18. $v_x = dx/dt = 3 \propto t^2$. or $v_y = dy/dt = 3\beta t^2$.

$\nu = \sqrt{(\nu^2_x+\nu^2_y)}$ $= 3t^2 \sqrt{(\alpha^2+\beta^2)}$

Ans. (2)

19. $\nu^2 = u^2 + 2as = 2as$

this is the equation of a parabola

Ans. (3)

20. Let the resistive acceleration of air is a for upward motion $\nu = u - (g + a)t$

straight line of negative slope for downward motion

$\nu = (g-a)t$. Straight line of positive slope

Ans. (3)

21. $a \propto x$ given $K =1/2\ m\nu^2$.

$dK/dt = ½\ m\ 2v\ dv/dt \quad = ma^2dt \propto a^2 \propto x^2.$

Ans. (4)

22. $h = ½\ gT^2.$ and $h' = ½\ g\ (T/2)^2$

$h/h' = 9$ or $h' = h/9$

Distance from ground = $h-h' = h- (h/9) = 8h/9$

Ans. (3)

→ → →

23. Changes in velocity $(\Delta v) = v_n - v_e$

$= \sqrt{(5^2 + 5^2)} = 5\sqrt{2}$ m/s.

therefore acceleration

$(a) = \Delta v/\Delta t = 5\sqrt{2}/10 = 1/\sqrt{2}\ m/s^2.$

Ans. (3)

24. $S = S1 + S2 + S3$

$S = \sqrt{(S_1^2 + S_2^2 + S_3^2)}$

$\Rightarrow \quad S = \sqrt{(12^2+5^2+6^2)} = 14.31$ m

Ans. (3)

25. $E = ½ m\nu^2 = p^2/2m.$

$\Rightarrow \quad E \propto 1/m$ Ans.

(1)

26. $E = ½ m\nu^2 = qV$

$\Rightarrow \nu = \sqrt{(2qV/m)} \quad \Rightarrow \quad \nu \alpha \sqrt{(q/m)}$

$\nu_{He}/\nu_H = \sqrt{(2/1)} \times (1/4) = 1/\sqrt{2}$

Ans. (3)

27. $m_1\nu_1 + 0 = (m_1+m_2)\nu'$

$\Rightarrow v' = mv/(m + 2m) = v/3$

Ans. (3)

28. Ans. (2)

29. $u = p/m = 10/5 = 2 m/s$, $a = (0.2/5)\ m/s^2$.

$v = u + at = 2 + (0.2/5) \times 10 = 2.4\ m/s^2$.

$\Delta K = ½\ mv^2 - 1/2\ mu^2 = ½ \times 5 \times (2.4)^2 – ½ \times 5 \times 2^2 = 4.4\ J$ Ans. (4)

$\rightarrow \rightarrow$

30. $W = F.d = (10i-3j+6k) . (10i – 2j + 7k -6i -5j +3k)$

$= (10\ I -3j +6k) . (4i – 7j +10k)$

$= 40 + 21 + 60 = 121$ J

Ans. (1)

31. According to the law of conservation of momentum

$m\nu = (m + M) V \quad \Rightarrow \quad V = [m / (m+M)]\nu$

Ans. (4)

32. $\nu_1 = (m_1-m_2)/ (m_1+m_2)$ u1 $= [(m-2m) / (m+2m)]u = -u/3$

$E_i = ½ mu^2, \quad E_f = ½ m (-u/3)^2 = 1/9 \times ½ mu^2.$

$(E_i – E_f) / Ei = \{1 – (1/9)\} /1 = 8/9.$

Ans. (2)

33. $F = dp/dt = m\nu n$

$n = F/mv = 144/ (0.04 \times 1200) = 3$

Ans. (1)

34. $W = mgh$

where h is the distance moved by centre of gravity

$W = 0.6 \times (4/2) \times 9.8 \times 0.3 = 3.6$ J

Ans. (2)

$\vec{\rightarrow}$ $\hat{}$ $\hat{}$ $\hat{}$ $\hat{}$ $\hat{}$

35. $W = F.\ d = (5i + 3j + 2k).\ (2i - j)$

$= 10-3 = 7$J

Ans. (2)

36. $T^2 \propto R^3$.

$T_1^2/T_2^2 = R_1^3/R_2^3$ or $R_1^3/R_2^3 = 64$.

$R_1 = 4R_2$.

37. Factual statement. Ans. (A)

38. Escape velocity of a body from the gravitational field of any planet is given by

$$V\ es = 2GMe/R = \sqrt{2gR}.$$

$\Rightarrow$`Ves is independent of mass of the body.

$\Rightarrow$ Ves $\propto m^o$.

39. If ;Ves' is the escape velocity of a body to escape from earth's surface to infinity, then kinetic energy is given as

$$K.E = ½\ mV2es. = ½\ m\ \sqrt{(2gR)^2}$$

Because $V_{es} = \sqrt{(2gR)}$

$K.E = mgR.$