WORK SHEET-I

1-marks question

- 1. Write the expression for Bohr's radius in hydrogen atom.
- 2. The total energy of an electron in the first excited state of hydrogen atom is 3.4 eV. What is potential energy of the electron in this state ? [Ans. -6.8 eV]
- 3. The activity of a radioactive element drops to $\frac{1}{16}$ th of its initial value in 32 Years. Find the mean life of the sample. [Ans. $\tau = 11.2$ yrs]
- 4. The half life of a radioactive substance is 30 s. Calculate the decay constant. [Ans. (i) $\lambda = 0.00231 \text{ s}^{-1}$
- 5. Define the terms half life period and write the relation between them.

Two marks question

6. A nucleus of an atom of ${}_{92}Y^{235}$, initially at rest, decays by emitting an α -particle as per the equation

$$_{92}Y^{235}$$
 \longrightarrow $_{90}X^{231} + _{2}He^{4} + energy$

It is given that the binding energies per nucleon of the parent & daughter nuclei are 7.8 MeV & 7.835 MeV respectively and that of α -particle is 7.07 MeV/nucleon.Assuming the daughter nucleus to be formed in the unexcited state & neglecting its share in the energy of the reaction. Calculate the speed of the emitted α -particle. (take the mass of α -particle to be 6.68 X 10⁻²⁷ Kg).

[Sol. Energy released =
$$[m (_{90}X^{231}) + m (_{2}He^{4}) - m (_{92}Y^{235})] X c^{2}$$

= $[(231 X 7.835) + (4 X 7.07) - (235 X 7.8)] MeV$
= $8.072 X 10^{-13} J$
 $\Rightarrow \frac{1}{2} m v^{2} = 8.072 X 10^{-13} \Rightarrow v = 1.55 X 10^{7} m/s]$

7. The half life of a given radioactive nuclide is 138.6 days. What is the mean life of this nuclide ? After how much time will a given sample of this radioactive nuclide will get reduced to only 12.5 %, of its initial value ?

[Ans. $\tau = 199.58$ days, t= 415.8 days]

8. The decay constant for a given radioactive nuclide has a value of 1.386 day⁻¹. After how much time will a given sample of this radionuclide get reduced to only 6.25 % of its present number ? [Ans. t = 2 days]

Three marks questions

9. Derive an expression for the average life of a radionuclide. Give its relationship with the half life. Ans:- The average time for which the nuclei of a radioactive sample exist is called mean life or average life of that sample. It is equal to the ratio of the combined age of all the nuclei to the total number of nuclei present in the given sample.

Mean life
$$(\tau) = \frac{sum of the lives of all the nuclei}{total number of nuclei}$$

Now let, at t=0, $N = N_0$. After time t, this number reduces to N. Also let dN nuclei disintegrates in time from t to t + dt.As dt is very small so the life of each of the dN nuclei can be approximately taken equal to t.

$$\therefore \qquad \text{Total life of dN nuclei} = t \, dN$$

$$\Rightarrow \qquad \text{Total life of all the } N_0 \text{ nuclei} = \int_0^{N_0} t \, dN$$

$$\qquad \text{mean life } (\tau) = \frac{\text{Total life of all the } N_0 \text{ nuclei}}{N_0}$$
or
$$\tau = \frac{1}{N_0} \int_0^{N_0} t \, dN \qquad -----(1)$$

As $N = N_0 e^{-\lambda t}$

 $\Rightarrow \qquad \qquad dN = -\lambda \ N_0 \ e^{-\lambda t} \ dt$

Also when t=0, $N = N_0$ and when N = 0, $t = \infty$ changing limits of integration in terms of time we get,

$$\tau = \frac{1}{N_0} \int_0^\infty t \ \lambda \ N_0 e^{-\lambda t} \ dt$$

$$\tau = \lambda \int_0^\infty t \ e^{-\lambda t} \ dt$$

$$\tau = \lambda \left[\left\{ \frac{t e^{-\lambda t}}{-\lambda} \right\}_0^\infty - \int_0^\infty \left(\frac{e^{-\lambda t}}{-\lambda} \right) dt \right]$$

$$\tau = \lambda \left[0 + \frac{1}{\lambda} \int_0^\infty e^{-\lambda t} \ dt \right]$$

$$\tau = \int_0^\infty e^{-\lambda t} \ dt$$

$$\tau = \left[\frac{e^{-\lambda t}}{-\lambda} \right]_0^\infty$$

$$\tau = -\frac{1}{\lambda} \left[e^{-\lambda \infty} - e^{-0} \right]$$

$$\tau = -\frac{1}{\lambda} \left[0 - 1 \right]$$

$$\tau = \frac{1}{\lambda} \left[0 - 1 \right]$$

$$\tau = \frac{1}{\lambda} \left[0 - 1 \right]$$

$$\tau = \frac{1}{0.6931/T} \qquad [\because \lambda = \frac{0.6931}{T} \right]$$

$$\tau = \frac{T}{0.6931}$$

⇒

⇒

Mean life is also given as the reciprocal of its decay constant. S.I. unit of mean life is second.

10. A star converts all its hydrogen to helium achieving 100% helium composition. It then converts $3 _{2}\text{He}^{4} \longrightarrow _{6}\text{C}^{12} + Q(7.27)$ helium to carbon via the reaction MeV). The mass of the star is 5.0×10^{32} Kg & it generates energy at the rate of 5×10^3 Watt. How long will it take to convert all the helium in to carbon at this rate?

[Sol. Mass of each helium atom		$= 4 \text{ amu} = 4 \text{ X} 1.66 \text{ X} 10^{-27} \text{ Kg}$
Number of helium atoms in g	given mass	$= 5.0 \text{ X } 10^{32} / 4 \text{ X } 1.66 \text{ X } 10^{-27} = \frac{5}{6.64} \text{ X } 10^{59}$
Number of r	reactions	$=\frac{1}{3} X \frac{5}{6.64} X 10^{59}$
Now given that energy releas	ed in each react	tion = 7.27 MeV = 7.27 X 1.6 X 10^{-13} J
Total energy released	(E) = No. of E	reactions X energy relesed in one reaction
	$=\frac{1}{3}X_{\frac{1}{6}}$	$\frac{5}{0.64}$ X 10 ⁵⁹ X 7.27 X 1.6 X 10 ⁻¹³ = 2.96 X 10 ⁴⁶ J
F	Required time t	$=\frac{E}{P}$ = 2.96 X 10 ⁴⁶ / 5 X 10 ³ = 1.85 X 10 ⁸ years]
11. Using the Bohr's model calcula	te the speed of	the electron in a hydrogen atom in the $n=1,2$ and 3
levels. Calculate the orbital peri	iod in each of th	nese levels.
[Ans.(a) $v_1 = 2.186 \times 10^6 \text{ m/s}$	$v_2 = 1.093 \text{ X}$	$10^6 \text{ m/s}, \ v_3 = 0.729 \text{ X} \ 10^6 \text{ m/s}$
(b) $T_1 = 1.52 \text{ X } 10^{-16} \text{ s, A}$	s $T_n = n^3 T \Rightarrow T$	$T_2 = 1.22 \text{ X } 10^{-15} \text{ s}, T_3 = 4.10 \text{ X } 10^{-15} \text{ s}$

Five marks question

12. State Bohr's postulate for the permitted orbits for the electron in a hydrogen atom. Use this postulate to prove that the circumference of the nth permitted orbit for the electron can contain exactly 'n' wavelengths of the de-Broglie wavelength associated with the electron in that orbit.

Ans:- (i) An atom is a hollow sphere ($\approx 10^{-10}m$) consists of a small massive central core in which entire positive charge and almost the whole mass of the atom are concentrated. This core is called the nucleus ($\approx 10^{-15}m$).

(ii) Electrons revolve around the nucleus in various circular orbits, for which the necessary centripetal force is provided by the electrostatic force of attraction between electron and nucleus.

(iii) Electrons can revolve only in those circular orbits in which the angular momentum of an electron is an integral multiple of $\frac{h}{2\pi}$; h being the Planck's constant.

i,e,
$$mvr = n \frac{h}{2\pi}$$
 where $n = 1,2,3,4,-----\&$ is principal quantum number.

This is called Bohr's quantisation condition of angular momentum. While revolving in these permissible orbits , an electron does not radiate energy. These non-radiating orbits are called stationary orbits. (v) An atom can emit or absorb radiation in the form of discrete energy photons only when an electron jumps from a higher to a lower orbit or from a lower to a higher orbit respectively.

i,e, $hv = E_2 - E_1$ where h is called Planck's constant.



But

 $\lambda = \frac{h}{mv}$ $2\pi r = n \frac{h}{mv}$

⇒

⇒

 $mvr = n \frac{h}{2\pi}$, n = 1,2,3 ---

This is famous Bohr's quantisation condition for angular momentum.

WORKSHEET-II

(1-MARKS QUESTION)

1. The ground state energy of hydrogen atom is -13.6 eV. What is the potential energy of an electron in the 3rd excited state?

[Ans. (i) -1.75 Ev]

2. Total energy of an electron in the first excited state of hydrogen atom is - 3.4 eV. What is its kinetic energy?

[Ans. 3.4 eV]

- 3. Compare the radii of two nuclei with mass numbers 1 and 27 respectively. [Ans. 1:3 because the $r \propto A^{1/3}$]
- Plot a graph showing the variation of potential energy of a pair of nucleons as a function of their separation. Ans.



5. The sequence of stepwise decays of a radioactive nucleus is -



If the atomic number and mass number of D₂ are 71 & 176 respectively, what are their corresponding values for D?

(2 MARKS QUESTIONS)

6. What is the ratio of radii of the orbits corresponding to first excited state and ground state in a hydrogen atom?

[Ans. 4:1]

7. Obtain the binding energy (in Mev) of a Nitrogen nucleus $(_7N^{14})$. $m(_7N^{14}) - 1400200$ Given.

$$m_{\rm H} = 1.00307 \text{ u}$$
$$m_{\rm H} = 1.00783 \text{ u}$$
$$m_{\rm n} = 1.00867 \text{ u}$$

[Ans 104.67 MeV]

- 8. State two properties of nuclear forces.
 - Ans. (i) Nuclear forces are very short range attractive forces.
 - (ii) Nuclear forces are charge independent.

(3-MARKS QUESTIONS)

9. Draw a plot showing the variation of binding energy per nucleon as a function of mass number for a large number of nuclei, $2 \le A \le 240$. How do you explain the constancy of binding energy per nucleon in the range 30<A<170 using the property that nuclear force is short ranged.

[Ans. Nuclear force is short range. For a sufficiently large nucleus a nucleon is under the influence of only some of its neighbours, which come within the range of the nuclear force. If a nucleon can have maximum of 'P' neighbours within the range of nuclear force, its binding energy, would be proportional to 'P'. Thus on increasing 'A' by adding nucleons binding energy will remain constant.]

10. Calculate the binding energy per nucleon of $^{35}_{17}Cl$ nucleus. Given, $m(_{17}^{35}Cl) = 34.980000 u$ Mass of proton = 1.007825 u Mass of neutron = 1.008665 u $\& 1 u = 931 MeV/c^2$

[Ans. 8.22 MeV]

11. A nucleus 10Ne23, β -decays to give the nucleus of ₁₁Na²³. Write down the β -decay equation. Calculate the kinetic energy of electron emitted. (Rest mass of electron may be ignored.) Given.

 $m(10Ne^{23}) = 22.994466 u$

$m(_{11}Na^{23}) = 22.9897704 u$

[Ans.4.37 MeV]

(5-MARKS QUESTION)

12. What is radioactivity? State the law of radioactive decay. Show that the radioactive decay is exponential in nature.

Ans. Radioactive decay

The spontaneous emission of radiation from a radioactive element is called radioactive decay.

Decay Law

The number of nuclei disintegrating per second of a radioactive sample at any instant is directly proportional to the number of

undecayed nuclei present in the sample at that instant.

i,e,

 $\frac{dN}{dt} \propto N$ $\frac{dN}{dt} = -\lambda N$

----- (1)

-----(2)

⇒

Where λ is constant of proportionality & is called decay constant.

From equation (1) we have

⇒

$$\frac{dN}{dt} = -\lambda N$$
$$\frac{dN}{N} = -\lambda dt$$

 $\int \frac{dN}{N} = -\lambda \int dt$

Integrating on both sides we get,

⇒

But, when t=0, $N=N_0$, therefore from equation (2) we get

⇒

⇒

⇒

⇒

⇒

 $\log_e N_0 = C$

 $\log_e N_0 = -\lambda X 0 + C$

 $\log_e N = -\lambda t + C$

On putting this value of C in equation (2) we get

$$\log_e N = -\lambda t + \log_e N_0$$
$$\log_e N - \log_e N_0 = -\lambda t$$
$$\log_e \frac{N}{m} = -\lambda t$$

$$\log_e \frac{N}{N} = -$$

 $N = N_0 e^{-\lambda t}$ -----(3)

 $\frac{N}{N_0} = e^{-\lambda t}$



 N_0

This equation is known as decay equation.

From eqn (3) we have

 $N = N_0 e^{-\lambda t}$

Substituting $t = \frac{1}{\lambda}$ in the above equation we get

$$N = N_0 e^{-1}$$
$$N = N_0 \left(\frac{1}{a}\right)$$

⇒

Thus decay constant of a radioactive element may be defined as the reciprocal of the time in which number of UN decayed nuclei of that radioactive element falls to $\frac{1}{a}$ times of its initial value.

S.I. unit of decay constant is sec⁻¹.

WORKSHEET III

1MARK QUESTIONS-

- 1. What will be the ratio of radii of two nuclei of mass numbers A1 and A2?
- 2. Define impact parameter.
- 3. What is the angle of scattering for zero impact parameter?
- 4. What is Rydberg's constant? Give its value.
- 5. The ionisation potential of an atom is 24.6 V. How much is its ionisation energy?

2 MARK QUESTIONS-

- 6. Calculate the longest and shortest wavelength in the Blamer series of hydrogen spectrum. Given $R = 1.0987 \times 10^7/m$.
- 7. Describe Rutherford's experiment on scattering of α -particles. What are its consequences?
- 8. Draw a labeled diagram of Geiger Marsden experiment on the scattering of

aparticles. How the size of the nucleus estimated is based on the experiment?

3 MARK QUESTIONS-

- 9. What is impact parameter? How does it influence the trajectory of an α-particle scattered by heavy nucleus? What is the value of impact parameter for a head on collision?
- 10. Sketch the energy level diagram for hydrogen atom. Mark the transition corresponding to Lyman and Balmer series.
- 11. Define the terms excitation and ionisation energies; and excitation and ionisation potentials.

5 MARK QUESTIONS-

12. State Bohr's postulates. Using these postulates derive an expression for the total energy of an electron in the nth orbit of an atom. What does negative value of this energy signify? What is Bohr's radius?

OR

The energy levels of an element X are shown in the figure. A Photon of wavelength 620 nm is emitted and this corresponds to which of the transition A, B, C, D or E?



<u>`WORKSHEET IV</u>

1MARK QUESTIONS-

- 1. What is the ratio of nuclear densities of two nuclei having mass number 1:4?
- 2. What happens to the neutron to proton ratio after the emission of alpha particles?
- 3. How many joules are there in 1 MeV?
- 4. Name three nuclei which lie on maxima of binding energy curve.
- 5. Define radioactive decay constant.

2MARK QUESTIONS-

6. The sequence is represented as $D \xrightarrow{\alpha} D_1 \xrightarrow{\beta} D_2$ if the mass numbers and atomic numbers of

 D_2 are 176 and 71 respectively, what is the mass number and atomic number of D.

- 7. What are nuclear forces? Give their important properties.
- 8. Radioactive isotope of silver has half-life of 20 minutes. What fraction of the original mass would remain after one hour?

3 MARK QUESTIONS-

- 9. Draw a diagram to show the variation of binding energy per nucleon with mass number for different nuclei. State the reason why light nuclei usually undergo nuclear fusion.
- 10. State the law of radioactive decay. If N_0 is the number of radioactive nuclei in the sample at some initial time, t_0 , find out the relation to determine the number N present at a subsequent time. Draw a plot of N as a function of time t.
- (a) Define the activity of a radioactive nucleus and state its SI unit.
 (b) Two radioactive nuclei X and Y initially contain equal number of atoms. The half-life is 1 hour and 2 hours respectively. Calculate the ratio of their rates of disintegration after two hours.

5 MARK QUESTIONS-

12. Calculate the binding energy per nucleon in the case of ${}_{26}^{56}Fe$. Given mass of proton = 1.007825 amu. Mass of neutron = 1.00865 amu, mass of the ${}_{26}^{56}Fe$ nucleus is 55.934939 amu.

OR

Use the basic law of radioactive decay, to show that radioactive nuclei follow an exponential decay law. Hence obtain a formula, for the half-life of a radioactive nuclide, in terms of its disintegration constant.

OR

Draw the schematic arrangement of the Geiger-Marsden experiment .How did the scattering of α particles by a thin foil of gold provide an important way to determine an upper limit on the size of nucleus?

NUMERICALS (AISSCE)

- 1. A pd of 30V is applied across a colour coded carbon resistor with rings of blue, black and yellow colours. What is the current to the resistor?
- 2. Find the resistance between the points (i) A and B and (ii) A and C in the following network.



- 3. Nichrome and Cu wires of the same length and same diameter are connected in series in an electric circuit. In which wire will the heat be produced at a higher rate?
- 4. Two bulbs are marked 220V-100W and 220V-50W. They are connected in series to 220V mains. Find the ratio of heat generated in them.
- 5. State the Principle of working of a potentiometer.
- 6. An electric bulb rated for 500W at 100V is used in circuit having a 200V supply. Calculate the resistance R that must be put in series with the bulb, so that the bulb delivers 500W.
- 7. A potentiometer wire has a length L and resistance R_0 . It is connected to a battery and a resistance combination as shown. Obtain an expression for the potential difference per unit length of the potentiometer wire. What is the maximum emf of a 'test cell' for which one can get a balance point on this potentiometer wire? What precautions should one take while connecting this test cell to the circuit?



In a potentiometer circuit, a battery of negligible internal resistance is set up as shown to develop a constant potential gradient along the wire AB. Two cells of emfs ξ₁ and ξ₂ are connected in series as shown in the combination (1) and (2). The balance points are obtained respectively at 400cm and 240cm from the point A. Find (i) ξ₁/ξ₂ and (ii) balancing length for the cell ξ₁ only.



9. Two cells of emfs ξ_1 and ξ_2 ($\xi_1 > \xi_2$) are connected as shown in figure When a potentiometer is connected between A and B, the balancing length of the potentiometer wire is 300cm. On connecting the same potentiometer between A and C, the balancing length is 100cm. Calculate the ratio of ξ_1 and ξ_2 .



In the potentiometer circuit shown, the balance point is at X. State with reason where the balance point will be shifted when (i)Resistance R is increased, keeping all parameters unchanged. (ii)Resistance S is increased keeping R constant.

(iii)Cell P is replaced by another cell whose emf is lower than that of that cell Q.



11. Find the value of X and current drawn from the battery of emf 6V of negligible internal resistance



12. Find the value of the unknown resistance X and the current drawn by the circuit from the battery if no current flows through the galvanometer. Assume the resistance per unit length of the wire is $0.01\Omega \text{cm}^{-1}$.



13. In a meter bridge, the null point is found at a distance of 60.0 cm from A. If now a resistance of $5'\Omega$ is connected in series with S, the null point occurs at 50 cm. Determine the values of R and S.



14. In a meter bridge, the null point is found at a distance of 40 cm from A. If a resistance of 12 Ω is connected in parallel with S, the null point occurs at 50.0 cm from A. Determine the values of R and S.



15. Figure shows two circuits in each having a galvanometer and a battery of 3 V. When the galvanometers in each arrangement do not show any deflection, obtain the ratio R_1 : R_2 .



Value Based Questions

1. On July 30th 2012, India plunged into darkness due to overdrawing of power in some states. Vijay is disturbed by this and carries out a survey to identify the causes of power loss in our country. He also educates his neighbours on using electricity judiciously to save power.

(i) What values are reflected in Vijay's behaviour?

(ii) What measures have the Government taken to fulfil the energy demands of people?

(iii) How can the people help the Government in their efforts?

Ans:- (i) Social concern, taking initiative, responsible behaviour, leadership, team work/ collaboration work, patriotism (ii)initiating to establish hydroelectricity, nuclear power projects, also trying to establishing wind energy/ solar energy plants in remote villages for their needs(iii)By saving electricity and not misusing it.

2. Harish living in a village with his family had to take a old man, a victim of snake bite to the district hospital 40 km away from his village for an immediate treatment to save his life. He found that the battery of his bike was not working properly and the kick lever was also damaged. He removed the 6 V battery and fixed a 4 dry cell pack (1.5 V each) in place of the battery. The bike still did not start. His younger brother Dadu was using a solar power lantern fitted with a 6 V storage battery (lead acid accumulator battery). He told his elder brother that the dry cells could not deliver the sufficient current required to initiate ignition in the bike. Dadu brought his storage battery and helped his elder brother Harish, to start the bike and take the patient to the city for treatment.

(i) List two qualities possessed by Harish and two qualities possessed by Dadu.

(ii) Why 4 dry cells of emf 1.5 V each were not able to supply the sufficient current required for starting the bike?

(iii) Guess in which way he would have connected the dry cells to get the emf of 6 V.

Ans:- (i) Harish – concern for others, helping nature, Dadu – helping nature, high degree of general awareness(ii)the internal resistance of dry cells is very high compared to storage batteries, therefore in compliance with the relation I = E/(R+r) current drawn is less (iii)in series combination

3. Tanvi Rastogi and Ayushi Sinha were performing an experiment to determine the internal resistance of a cell using a potentiometer set up. After completing the circuit when the jockey was touched with two extreme ends of the wire the deflection in the galvanometer was not reversed. They have tried their level best to rectify the circuit to ensure both side deflection of the galvanometer needle but could not succeed. In order to hurriedly complete the experiment Tanvi suggested that they will copy and use the observations of the students of II batch. Ayushi however did not agree. She approached the teacher for help. The teacher told them 3 possible causes of same sided deflection. Now Tanvi and Ayushi completed the experiment and determine the value of internal resistance of cell using

relation $r = R \frac{l_1 - l_2}{l_2}$ where, R is the resistance taken out of the resistance box, l_1 and l_2 are the

balancing lengths when the key of the auxiliary circuit is open and closed respectively.

(i) What are the values possessed by Ayushi and Tanvi?

(ii) List the various causes for same sided deflection of galvanometer.

(iii) Can you suggest any other method to determine the internal resistance of the cell using a potentionmeter?

Ans:- (i) Ayushi – Honesty and desire to learn and improve, Tanvi - Respect for her friend's feelings (ii) (a) loose connection (ii) the positive terminal of driver battery may not be connected to the positive terminal of the auxiliary circuit (c) the emf of testing cell may be higher than the emf of driver battery (iii) comparing the relation $\frac{l_1}{l_2} = (r/R) + 1$ with the straight line equation, the slope of

the graph between $\frac{l_1}{l_2}$ and (1/R) gives the internal resistance 'r'

4. While performing an experiment on determination of an unknown resistance using a meter bridge, Rahul obtained deflection in the galvanometer in the same direction even after repeated adjustments in the circuit and thus could not get any results. In order to avoid getting noticed and scolded by the teacher, he pretended having performed the experiment and copied the readings obtained by another student.

(i) Write the possible reasons for getting the deflection in the galvanometer in the same direction.

(ii) Which two values is Rahul violating in copying the readings from another student?

(iii) What in your opinion, should have Rahul done in the given circumstances?

Ans:- (i) (a) The two resistances in the gaps (P and Q)are not of comparable value. (b) Current may not be flowing in both the arms due to loose connections. (ii) Honesty, truthfulness, sincerity, desire to learn more and improve. (iii) Rahul should have sought help from teacher to know the reasons for not able to get desired results.

5. Mr. Pradeep Gupta an electrical engineer visits his friend Waseem's just received his electricity bill from the meter reader appointed to take the meter reading by electric supply company. He was complaining to the meter reader about the huge charges he will have to pay. Pradeep quietly inspects the electrical appliances used in Waseem's house observes that his friend is using traditional incandescent lamps for lighting. He talks to his friend about the probable causes of huge electricity bill and advised him to replace traditional incandescent lamps which were of rating of 100W-220V by the CFLs of 28W and the night bulbs of 15W-220V by LEDs of 4 W. he makes an unrest appeal to his friend and his family members to spread the message among his friends and relatives about the need for such changes.

(i) In your opinion what values were displayed by Mr. Pradeep Gupta?

(ii) Why CFLs and LEDs are better than traditional incandescent lamps.

Ans:- (i) (a) keen to apply the knowledge acquired for the welfare of society. (b) his deep concern for environment. (ii) energy efficient, long life, environmental friendly.

6. Father and a son returned home completely drenched due to heavy rain. Father advised his son not touch any electrical units with wet hands for he may get a shock; In spite of this, on immediately entering the house, the son switches on the light (supply voltage is 220 V) and gets a severe shock; He was fortunate not to get electrocuted. Father, who is a Biologist, told that when the skin is dry, resistance of a human body is 105 Ω; and when the skin is wet the body resistance is 1500 Ω.
(a) What is the lesson learnt by you?

(b) Calculate the current that flow through (i) a wet body and (ii) a dry body.

(c) Dry skin or wet skin? - When will we have serious consequences and why?

Ans: (a) to obey elders. (b) Using, I = V/R (i) 147 mA; (ii) 2.2 mA. (c) wet skin – with 147mA, when the current flows, the result is fatal.

7. Based on the previous knowledge learnt in the class,two students of class XII(A and B) were asked to conduct an experiment in the laboratory using a meter bridge-one is made of Nichrome and the other one is made of Copper, of same length and same diameter of constant potential difference. The tudent A could not give explanation for not achieving the result whereas student B, could get the result and was also able to explain.

(a) What made student B to perform successfully?

(b) Give the formula to calculate the rate of heat production.

Ans: (a) student B had concentrated in the class room teaching and also had studied again to remember what was taught. (b)

- 8. An old woman who had suffered from a heart stroke was taken to the hospital by her grandson who is in class XII. The grandson has studied in Physics that, to save a person who is suffering from a heart stroke, regular beating of the heart is to be restored by delivering a jolt to the heart using a defibrillator, whose capacity is 70 microfarad and charged to a potential of 5000V and energy stored in 875J; 200J of energy is passed through' a person's body in a pulse lasting 2 milliseconds. The old woman gets panicked and refuses to be treated by defibrillator. Her grandson then explains to her the process that would be adopted by medical staff and how the result of that would bring her back to normalcy. The woman was then treated and was back to normal
 - (a) What according to you, are the values displayed by the grandson?
 - (b) How much power is delivered to the body to save a person's life from heart attack?
 - Ans: (a) Presence of mind, Knowledge of subject, Concern for his grandmother, Empathy, Helping and caring.

(b) Power = energy / time = $(200/2) \times 10^{-3} = 100$ KW)

WORK SHEET-01 1 Mark Questions:

1.The wavelength of electromagnetic radiation is doubled. What will happen to the energy of photon?

2. Ultraviolet light is incident on two photosensitive materials having work function $\phi 1 > \phi 2$ ($\phi 1 > \phi 2$). In which of the case will K.E. of emitted electrons be greater? Why?

3. An increase in the intensity of incident light does not change the maximum velocity of the emitted photo electrons. Why?

4. Two beams, one of red light and other of blue light, of same intensity are incident on a metallic surface to emit photoelectrons. Which one of the two beams emits electrons of greater kinetic energy?

5. The stopping potential in an experiment on photoelectric effect is 1.6 volt.what is the maximum kinetic energy of the photoelectrons emitted?.

2 Marks Questions:

- 1. The work function of lithium is 2.3 eV. What does it mean? What is the relation between the work function and threshold wavelength of a metal?
- 2. In a plot of photoelectric current versus anode potential, how does

(i)The saturation current vary with anode potential for incident radiations of different frequencies but same intensity?

(ii)The stopping potential vary for incident radiations of different intensities but same frequency?

2. Draw a graph showing the variation of stopping potential with frequency of radiation incident on metal plate .How can the value of Planck's constant be determined from the graph ?

3 Marks Questions:

- 1. Write Einstein's photoelectric equation. State clearly the three salient features observed in photoelectric effect which can explain on the basis of this equation.
- 2. (i) Define the term 'stopping potential' in relation to photoelectric effect.

(ii) What is the stopping potential applied to a photocell if the maximum kinetic energy of a photoelectron is 5*eV*?

(iii) How does the maximum kinetic energy of electron emitted vary with the work function of the metal?

- 3. The following graph shows the variant of stopping potential V_s with the frequency (v) of the incident radiation for two photosensitive metals X and Y.
 - (i) Which of the metals has larger threshold wavelength? Give reason.
 - (ii) Explain Giving reason which metal gives out electrons having larger kinetic energy, for the same wavelength of the incident radiation.
 - (iii) If the distance between the light source and metal X is halved, what will be the kinetic energy of electrons emitted due to this change? Give reason.



5 Marks Questions:

1. What is photoelectric effect? Explain Hertz photoelectric experiment to understand the (i) Effect of intensity (ii)Effect of potential(iii)Effect of frequency by drawing graphs also.

WORK SHEET-02

1Mark Questions:

- **1.** Name the experiment which verified the wave nature of particles.
- **2.** What is de Broglie wavelength associated with an electron, accelerated through a potential of 100 V?
- **3.** Electrons and protons are moving with the same speed, which will have more wavelength.?
- **4.** The de Broglie wavelength associated with a proton and a neutron are found to be equal. Which of the two has a higher value for kinetic energy?
- 5. Show graphically, the variation of de-Broglie wavelength (λ) with the potential (*V*) through which an electron is accelerated from rest.

2 Marks Questions:

- 1. Why wave nature of matter not apparent in our daily life?
- 2. A photon and electron have got same de-Broglie wavelength. Which has greater total energy ? Explain.
- 3. An α -particle and a proton are accelerated from rest by the some potential. Find the ratio of their de-Broglie wavelengths.

3 Marks Questions:

- 1. Mention the significance of Davisson-Germer experiment. An α -particle and a proton are accelerated from rest trough same potential difference V. Find the ratio of de-Broglie wavelength associated with them.
- 2. An electromagnetic wave of wavelength λ is incident on a photosensitive surface

of negligible work function. If the photoelectrons emitted from the surface have de-Broglie

wavelength λ_1 . Prove that $\lambda = (\frac{2mc}{h})\lambda_1^2$.

4. An α-particle and proton are accelerated from rest by the same kinetic energy. Find the ratio of their de-Broglie wavelengths.

5 Marks Questions:

1. Describe Davisson and Germer experiment to establish the wave nature of electrons. Draw a labeled diagram of apparatus used.

WORK SHEET -3

- 1. Name the experiment which establishes the wave nature of particle.
- 2. The wave length of electromagnetic radiation is doubled; How will the energy of a photon change ?
- 3. What is the stopping potential applied to a photo cell is the maximum. Kinetic energy of photo electron to 5 ev?
- 4. Two metal A and B have work function 2 ev and 4 ev respectively which metal has a lower threshold wavelength for photoelectric effect?
- 5. Why are alkali metal metals most suited for photoelectric emission?
- 6. An ∞ particle and a proton are accelerated from state of rest through the same potential difference V. Find the ratio of de-Broglie wavelength associated with them?
- 7. For a photosensitive surface, threshold wavelength is λ_0 . Does photoemission if the wavelength radiation is (i) more than λ_0 and (ii) less than λ_0 ? Justify your answer.
- 8. Radiations of frequency 10^{15} H_z are incident on two photosensitive surfaces P and Q. Following observations are made.

(i) For surface P, photoelectric emission occurs but photoelectrons have zero kinetic energy.

(ii) For surface Q, photoelectric emission occur and photoelectrons have some kinetic energy. Which one of these has a higher work function?

If the incident frequency is slightly reduced, what will happen to the photoelectric emission in the two cases?

8.. Following table gives the values of work function for few photosensitive metals.

S,No.	Metal	Work Function (eV)
1	Na	1.92
2	К	2.15
3	Мо	4.17

If each of these metal is exposed to radiations of wavelength 300nm, which of them will not emit photoelectrons and why?

9. .If the frequency of incident radiation on a photocell doubled for the same intensity, What changes will you observe in

(a) the K.E of the photoelectron emitted

(b) photoelectric current and

(c) stopping potential? Justify your answer.

.....

UNIT IX

ELECTRONIC DEVICES

Numerical Problems Worksheet

Level -01

(Numerical direct formula Based)

- Q.1 : What is relation between voltage gain and trans conductor of a trimester amplifier?
- Ans :- Voltage gain = Trans Conductance X Output resistance.
- Q. 2: A transistor is being used as a common emitter amplifier. What is the value of phase difference, if any ,between the collector-emitter voltage and input signal?
- Ans.: 180° or π radian
- Q.3. Write is the phase relationship between the output and input voltage in the common faze transmitter amplifier?
- Ans: Output voltage is in phase with the input signal voltage.
- Q.4. Write the relation between current gains ∞ or β .

Ans:
$$\beta = \underline{\infty}$$

1- ∞

- Q.5. Calculate the Current gain β of a transistor, if the current gain $\infty = 0.98$
- Ans: $\beta = \frac{\infty}{1-\infty} = \frac{0.98}{1+100}$ 49.
- Q. 6 For a Transmitter the value of β is 100, what is the value of ∞ .
- Ans $\infty = \underline{\beta} = \underline{100} = 0.99$
- Q.7. When the voltage drop across a p.n. Junction is increased from 0.65 v to 0.70, the charge in the diode current is 5 ma . What is the dynamic resistance of the diode ?
- Ans. Here,

$$\Delta V = 0.7 - 0.65 = 0.05 V$$

 $\Delta I = 5mA = 5 \times 10^{-3} A$ Dynamic resistance of junction diode is

$$rd = \underline{\Delta V} = \underline{0.05} = 10 \Omega$$

- Q.8. p n p transistor circuit, the collector is 10 ma , If 90 % of the reach the Collector, find emitter and base currents.
- Ans: Here, I E = 10 m A

As 90 % of the holes reach the collector, so the collector current,

I c = 90 % of I E = 90/100 IE

I E = 100/900 Ic = 100/90 x 10 = 11 m A.

Base Current, I B = I E - I c = 11-10 = 1 mA.

- Q.9. A photodiode is fabricated from semi conductor with band gap of 2.8 e V . Can it detect a wave of 6000 nm? Justify.
- Ans : Energy Corresponding to Wave length 6000 nm is

The photon $e_{ne}rgy$ (E = 0.2 ev) of $gi_{ve}n$ waveleanth is much less then band gap (Eg.), hance it caneot detevt the $gi_{ve}n$ wavelength.

- Q.10. The number of silicon atoms per m3 is 5 x 1022 atom per 33 of A_{ne} senice and 5 x 1020 per m3 atoms of Indian. Calculate the number of electrons and holes . Gi_{ve}n that Ni = 1.5 X 1016 per m3 . In the material N-type on P-Type?
- Ans : Ar_{ne}sic is n-type impurty and indium is P-type impurity Number of electron, $ne = n0 nA = 5 \times 1022 5 \times 1020 = 4.95 \times 1022 m-3$

We have, ni2 = nenh

 Gi_{ven} , ni = 1.5 x 1016 m -3

Number of holes, $_{ne} = \underline{ni2}_{ne} = \underline{(1.5 \times 1016)2}_{4.95 \times 1022}$

nh = 4.54 x 109m-3 as $_{ne} > _{ne}$; so the material is an n-type semiconductor.

LEVEL –II Moderate difficulty level

Q.1. When the voltage drop across a p-n junction diode is incrase from 0.65 v to 0.70 v, the change in the diode current is 5mA. What is the dynamic resistance of the diode?

Ans: r _d	=	Δv ΔI
	=	<u>0.70 - 0.65</u> 5x10-3
	=	<u>0.05</u> 5 x 10-3
	=	10Ω.

Q.2. Diode used in figure has a constant voltage drop at 0.5 V at all current and a maximum power rating of 100mw. What should be the value of resistance R, conected in series for maximum current.

Ans: Current, I = $\frac{P}{V}$ = $\frac{100 \times 10-13}{0.5}$ = 0.2 A

From Circuit,

IR + 0.5 = 1.5

- i.e., 0.2 + 0.5 = 1.5
- i.e. $\frac{R = 1.5 0.5}{0.2} = 5 \Omega.$

Q.9. On the figure shown, find out the current passing through R_L and Ze_{ner} diode :



Ans: Here,

V2 = 5V

Voltage drop across $R = Input voltage - V_2$

= 10 - 5 = 5v

 $= I_L = V2$ 5v 5 x 10⁻²A

Here,

Current through R,

I = Voltage drop across R =
$$5V_{100}$$
 6.25 x 10^{-2} A
R 80Ω

Applying Kirchoff's Law :

 $I = I_2 + I_L$ $I_2 = I - I_L$ $= 6.25 \times 10^{-2}$ $= 1.25 \times 10^{-2} A.$

Q.4. A common emitter transistor has current gain of 100. If emitter current is 8.08 m A, find the base and collector current.

Ans: Here,

B = 100IE = 8.08 MAUsing, <u>IC</u> = В IB We get $Ic = BI_B = 100 I_B$ Using, IE = IB + ICWe get IE = 101 IBOr, $IB = \underline{IE} = \underline{8.08} =$ 0.08mA 101 101 From Eq^{n} (i) $IC = 100 \times 0.08 = 8ma$.

Q 5. (I) Calculate the value of output voltage V0 and Current I if Silicon diode and germanium diode conduct at 0.7 v and 0.3 v respectively (refer figure)





Ans.: (I) Germanium diode conducts at 0.3 v only, so curret will prefer to pass through germanium diode so,

$$V0 = 12 - 0.3 = 11.7 v$$

And,

$$I = \frac{11.7}{5 \times 10^3}$$

= 2.34 mA

(II) When germanium diode is reversed biased, the current will flow through the silicon diode.

Then,

$$V0 = 12 - 0.7 = 11.3 \text{ v}$$

And ,
 $I = \frac{11.3}{5 \times 10^3} 2.26 \text{ mA}$

Q.6 In a common –emitter transistor amplifier, the input resistance is 200Ω , RL = $20K\Omega$. Find (i) voltage gain and (ii) Power gain . Goven current gain B = 10.

Ans: Here,

Q.7.

Ri = 200
$$\Omega$$
, RL = 20 k Ω
= 2 x 10⁴ Ω
(i) Voltage gain, A_v = $\beta^{\text{RL}/\text{RI}}$
= $\frac{10 \times 2 \times 10^4}{200} \times 10^3 = 10^3$
(ii) Power GainB^{2 RL}/_{Ri} = $\frac{(10)^2 \times 2 \times 10^4}{200}$
= 10^4
A full wave rectifier is built with help of two diodes each having resistance is 1.2 10-3 Ω . A.C. input signal has
(i) Maximum value of applied voltage

- (ii) r.m.s. value of current
- (iii) Current
- (iv) Efficiency
- (v) Ripple factor

Ans: (i) Vo = Io + (RL + RF) = $\frac{1}{24}$ (6+1.2)10³

(ii) Irma =
$$\underline{Io} = \frac{1}{\sqrt{2}}$$

$$= 29.46 \times 10^{3} A$$
(i) Id.c = $2\left(\frac{I_{0}}{\pi}\right)$

$$= \frac{2 \times 1}{24 \times 3.14}$$

$$= \frac{2 \times 1}{26.5 \times 10^{3}} (* \text{ there are 2 diodes})$$
(ii) N = $8^{2}\left(\frac{RL}{Rf + RL}\right)$

$$= 8.12\left(\frac{6.10^{3}}{(6+1.2)10^{3}}\right)$$

$$= \frac{8.12}{1.2}$$

$$= 67.7 \%$$

(iii) Ripple factor,
$$\left\{ \underbrace{\frac{\text{Irms}}{\text{Iav}}}^{2} - 1 \right\}^{\frac{1}{2}} = \left\{ \underbrace{\frac{29.5}{26.5}}^{2} - 1 \right\}^{\frac{1}{2}} = 0.48$$

Q.8. For a common emitter amplifier, current gain = 50. If the emitter current is 6.6 mA, Calculate gain, when emitter is working as common-base amplifier.

Ans. Here $\beta = 50$ $I_E = 6.$	6mA								
Step 1. Since $\beta = \underline{IC}$ IB									
	= Ic	$= \beta I_B$	$s = 50I_B$	l					
Step 2. Now,	I _E	=	Ic +	I _B					
	6.6	=	50I _B +	IB					
	I_B	= <u>6.0</u>	<u>5</u>	=	0.129	mA			
Hence,	Ic	=	50 x _	<u>6.6</u> 51	=	6.47m	А		
Step 3.	В	=	$\frac{\infty}{1-\infty}$	_	or,	∞ =	<u>β</u> 1+ β		
		= <u>50</u> 51)	=	0.98				
Q.9. For a transistor with $\beta = 75$ the maximum collector current for an emitter current of 5mA ?									
Abs :- Here,	β	=	75						
Step 1 :- Using	I_E	=	5mA						
	β	= _	<u>∞</u> 1- ∞		we get	t,			
	75	=	$\frac{\infty}{1-\infty}$	or, '	75 – 75	$\infty = \infty$			
	Or, 76	$i\infty =$	75	or, ∞	=	<u>75 x</u> 5 76			
step 2., ∞	=	Ic		Ic	=	∞I^E	=	$\frac{75}{76}$ x 5 =	4.93mA.

Q.10. In n p n transistor circuit, the collector current is 10 mA. If 95% of the electron emitted reach the collector, what is the base current ?

Ans :	Step 1	:-				
	1	Ic	=	95 %		
		$I_{\rm E}$	=	0.95I _E		
		$I_{\rm E}$	=	<u>Ic</u> 0.95		
			=	<u>10</u> 0.95	_	($:: Ic = 10 \text{ mA}$)
			=	10.53	mA	
Step 2	:-					
Now,	Now,	$I_{\rm E}$	=	I _C	+	I _B
		IB	=	\mathbf{I}_{E}	+	I _C
			=	10.53	- 10	
			0.53m	A		