SAMPLE PAPER-02
PHYSICS (Theory)
Class – XII

Time allowed: 3 hours Maximum Marks: 70

Solutions

1. Only integral number of electrons can be transferred from one body to the other.

2. Slow moving neutron whose energy is absorbed by moderators in reactor is known as thermal neutrons.

3. $M^0 L^0 T^4$

4.

$$_{15}P^{32} \xrightarrow{\beta} {}_{16}S^{32} + {}_{-1}e^0 + Q$$

5.

$$P = \frac{1}{f} = \frac{1}{\infty} = 0$$

6.

(i) $$as\phi = \frac{q}{\varepsilon_0} \Rightarrow \frac{\phi_1}{\phi_2} = \frac{q}{q+2q} = \frac{1}{3}$$

(ii) $$\phi = \frac{q}{\varepsilon_m} = \frac{q}{\varepsilon_0 \varepsilon_r} = \frac{1}{5}\phi_1$$

7.

Diamagnetic	Paramagnetic	Ferromagnetic
If kept near a magnet materials are freely repelled.	Feebly attracted	Strongly attracted.
X is negative and small	X is positive and small	X is Positive and large
μ is slightly less than one.	μ is slightly more than one.	μ is quite larger than one.

8. Laws

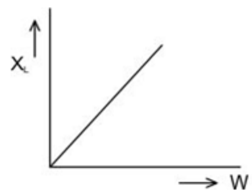
   a. It is an instantaneous process

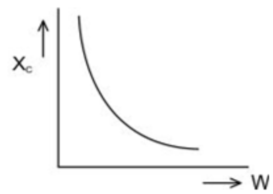
   b. No photo emission takes place below threshold frequency of material no matter how intense the incident beam.

c. The maximum photo current does not depend upon stopping potential or frequency but depends on intensity of incident radiation.

d. Stopping potential is independent on intensity of incident radiation.

9. $X_L = \omega L$ and $X_C = 1/WC$





10. $E_Y = 30 \sin (21 \times 10^{11} t + 300\pi x)$

Comparing with $E_Y = E_0 \sin (\omega t + kx)$ dir^n of propagation is $-x$ direction &

$B_Z = B_0 \sin (2 \times 10^{11}t + 300\pi x)$

Where $B_0 = E_0 /C = 10^{-7}$T.

11.

Given r =8cm, N =20, ω = 50 rad/s B =3 x 10^{-2}T

Using the formula, $N = w/2\pi$ and Emf (maximum) = $NBA\omega$, we get

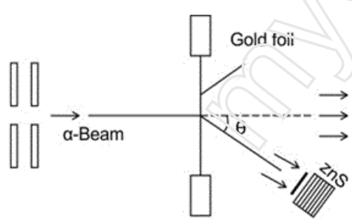
$= 20 \times 3 \times 10^{-2} \times \pi (8\times10^{-2})^2 \times 50$

$= 30\pi \times 64 \times 10^{-4}$

$= 9.42 \times 10^{-5}$ volt.

Average emf =0.

12. The fact that only small fraction of incident particles rebounded back that number of α – particles undergoing head on collision is small this leads the mass confined in small region.



13. The electric field is zero inside the conductor and has no tangential compound on the surface. So, no work is done in moving a small test charge within the conductor and on its surface. Therefore, there is no potential difference between any two points inside or on the surface of the conductor, hence the electrostatic potential is constant throughout the volume of the conductor and has the same value (as inside)on its surface.

14. Voltmeter is a high resistance galvanometer. When it is connected in parallel in the circuits.it draws minimum current from the circuit.so, the potential difference to be measured is not affected appreciably. If the voltmeter were connected in series in a circuit, then there will be appreciable reduction in current in the circuit due to appreciable increase in the resistance of the circuit. This would produce an appreciable fall in potential difference between two points in a circuit. This is not desirable because a measuring instrument should not appreciably change the quantity that it intends to measure.

Or

Forproton. $T_1 = \frac{2\pi m}{Bq}$

For α - particle. $T = \frac{2\pi(4m)}{B(2q)} = 2T_1$

Again, radius of path of proton, $R_1 = \frac{mv}{Bq}$

Radius od path of α - particle,

$$R_2 = \frac{(4m)v}{B(2q)} = 2R \qquad \therefore \qquad \frac{R_1}{R_2} = \frac{1}{2}$$

15. $\phi_0 = 4.2 \text{ eV} = 4.2 \times 1.6 \times 10^{-19}$ J, $\lambda = 2000 \overset{0}{A} = 2000 \times 10^{-10}$ m

Maximum kinetic energy of photoelectrons

$$K_{max} = \frac{hc}{\lambda} - \phi_0 = \frac{6.6\times10^{-34}\times3\times10^{8}}{2000\times10^{-10}} - 4.2\times1.6\times10^{-19} = 3.18\times10^{-19} \text{ J}$$

$$\text{Stopping potential, } V_0 = \frac{K_{max}}{e} = \frac{3.8\times10^{-19}}{1.6\times10^{-19}} = 11.9875 \text{ V}$$

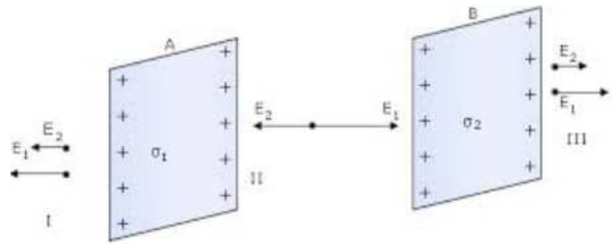
For the threshold wavelength λ_0, the stopping potential is zero.

$$\lambda_0 = \frac{hc}{\phi_0} = \frac{6.6\times10^{-34}\times3\times10^{8}}{4.2\times1.6\times10^{-19}} = 2.946\times10^{-7}\, m = 2946 \overset{0}{A}$$

16. The properties of electric field lines are as follows:

(i) The electric field lines are discontinuous curves.
(ii) The tangent to the electric line of ofrce at any point gives the direction of electric field at that point.
(iii) No two electric lines of force intersect can each other.
(iv) The electric field lines are always normal to the surface of a conductor.
(v) The electric field lines contract longitudinally.
(vi) The electric field lines exert a lateral pressure on each other.

17. Let A and B be two thin infinite parallel charged sheets held parallel to each other.



Let, σ_1 = uniform surface density of charge on A, σ_2 = uniform surface density of charge on B
Now by using the superposition principle, we can calculate the electric field. By the convention, a field pointing from left to right is taken as positive and the one pointing from right to left is taken as negative. Here we assume that $\sigma_1 > \sigma_2 > 0$.

In region I: $E_I = -E_1 - E_2 = \frac{-\sigma_1}{2\in_0} - \frac{\sigma_2}{2\in_0} = \frac{-1}{2\in_0}(\sigma_1 + \sigma_2)$

In region II: $E_{II} = E_1 - E_2 = \frac{\sigma_1}{2\in_0} - \frac{\sigma_2}{2\in_0} = \frac{1}{2\in_0}(\sigma_1 - \sigma_2)$

In region III: $E_{III} = E_1 + E_2 = \frac{\sigma_1}{2\in_0} + \frac{\sigma_2}{2\in_0} = \frac{1}{2\in_0}(\sigma_1 + \sigma_2)$

In some special cases, let $\sigma_1 = \sigma$ and $\sigma_2 = -\sigma$
So, $E_I = 0$

$E_{II} = \frac{2\sigma}{2\in_0} = \frac{\sigma}{\in_0}$ = a constant

$E_{III} = 0$

18. (a) The current density at a point in a conductor is defined as the amount of current flowing per unit area of the conductor around that point provided the area is held in a direction normal to the current. It is denoted by J.

density = Electric current / Area
It is a vector quantity and its unit is Ampere/metre^2.
The reciprocal of resistance is called conductance. It is denoted by G.
Conductance = 1 / resistance
Its unit is mho or siemen.
(b) As we know that, $I = neAv_d$

$I = nAe\left(\frac{eE}{m}\tau\right) = \frac{nAe^2\tau E}{m}$

$\frac{I}{A} = \frac{ne^2\tau E}{m}$

$J = \frac{I}{A} = \frac{1}{\rho}E \qquad \left(\because \rho = \frac{m}{ne^2\tau}\right)$

$J = \sigma E \qquad \left(\because \sigma = \frac{1}{\rho}\right)$

It is also called as the microscopic form of Ohm's law.

19. (a) The electrical conductivity of copper is high. Therefore, it conducts the current without offering much resistance. The copper being diamagnetic material does not get magnetized due to current through it and hence does not disturb the current I the circuit.

(b) Here, l = 1 m, D = 0.4 × 10^{-3} m = 4 × 10^{-4} m, R = 2 ohm

Area of crossection, A = $\frac{\pi D^2}{4} = \frac{\pi(4\times10^{-4})^2}{4} = 4\pi\times10^{-8}\,m^2$

Now, $\rho = \frac{RA}{l} = \frac{2\times4\pi\times10^{-8}}{1} = 2.514\times10^{-7}\,\Omega m$

20. (a) The railway carriage works as an electric screen. The electric field inside the carriage is zero and any change from outside in electric field cannot enter the carriage. Hence the electromagnetic signals do not find their entry in the railway carriage. Due to this, the transistor does not work in railway carriage.

(b) $\beta = \frac{\alpha}{1-\alpha} = \frac{0.99}{1-0.99} = 99$

Volatge gain, A_v = $\beta\frac{R_0}{R_i} = 99\times\frac{10\times10^3}{1\times10^3} = 990$

Power gain = $\beta^2\frac{R_0}{R_i} = (99)^2\times\frac{10\times10^3}{1\times10^3} = 98010$

21. (a) Modulation is the process of superimposing the low frequency message signal on a high frequency wave. The resulting wave is the modulated wave which is to be transmitted.

Demodulation is the reverse process of modulation. It is the phenomenon of retrieval of information from modulated wave at the receiver.

(b) Here, A_m = 0.1 V, A_c = 0.2 V

$\mu = \frac{A_m}{A_c} = \frac{0.1}{0.2} = 0.5$

22. (a) The decay constant of a radioactive element is the reciprocal of the time during which the number of atoms left in the sample reduces to 1/e times the original number of atoms in the sample.

(b) As the mass number of each α particle is 4 units and its charge number is 2 units, therefore, for D_4

A = 176 – 8 = 168, Z = 71 – 4 = 67

Now, charge number of β is -1 and its mass number is zero, therefore, for D

A = 176 + 0 + 4 = 180, Z = 71 – 1 + 2 = 72

23. (a) Presence of mind and knowledge of static electricity.

(b) When balloons were rubbed with woolen sweater, it becomes negatively charged. When taken nearer the wall, positive charges are induced by electrostatic induction on that part of the wall, so gets attracted. Yes, when the bodies are similar charged they repel.

24. (a) According to de Broglie, a moving material particle sometimes acts as a wave and sometimes acts as a particle or a wave is associated with moving material particle which controls the particle in every respect. The wave associated with the moving particle is called matter wave or de Broglie wave.

Derivation: According to Plank's quantum theory, the energy of a photon of a radiation of frequency ν and wavelength λ is

$E = h\nu$ .....(1)

Where, h is the Plank's constant. If photon is considered to be a particle of mass m, the energy associated with it, according to Einstein mass energy relation, is given by

$E = mc^2$ .....(2)

From (1) and (2), we get

$h\nu = mc^2$

$m = \frac{h\nu}{c^2}$ .....(3)

Since each photon moves with the same velocity c, therefore, momentum of photon,

p = mass × velocity

$p = \frac{h\nu}{c^2} \times c = \frac{h\nu}{c} = \frac{h}{\lambda}$

or, $\lambda = \frac{h}{p}$

This is the de Broglie wave equation for material particle.

(b) Here, $v = 3 \times 10^3$ m/s, Mass of hydrogen molecule = 2 amu = $2 \times 1.67 \times 10^{-27}$ kg

$$\lambda = \frac{h}{mv} = \frac{6.62\times10^{-34}}{2\times1.67\times10^{-27}\times3\times10^{3}} = 6.6\times10^{-11} m$$

25. (a): The main features of the Rutherford's atom model are given below:

(i) Every atom consists of a tiny central core, called the atomic nucleus, in which the entire positive charge and almost entire mass of the atom are concentrated.
(ii) The size of nucleus is of the order of 10^{-15} m, which is very small as compared to the size of the atom which is of the order of 10^{-10} m.
(iii) The atomic nucleus is surrounded by certain number of electrons. As atom on the whole is electrically neutral, the total negative charge of electrons surrounding the nucleus is equal to total positive charge on the nucleus.
(iv) These electrons revolve around the nucleus in various circular orbits as do the planets around the sun. The centripetal force required by electron for revolution is provided by the electrostatic force of attraction between the electrons and the nucleus.

(b): From the relation, $\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For K_α line, $n_1 = 1$, $n_2 = 2$

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3}{4}RZ^2$$

$$RZ^2 = \frac{4}{3\lambda}$$

Ionisation energy of K shell electron is

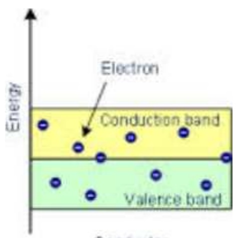
$$E = \frac{2\pi^2 mK^2Z^2e^4}{h^2}\left(\frac{1}{1^2}-\frac{1}{\infty^2}\right) = \frac{2\pi^2 mK^2Z^2e^4}{h^2(ch)}(ch) = RZ^2(ch)$$

By using equation (1), $E = \frac{4}{3\lambda}(ch) = \frac{4\times3\times10^8\times6.63\times10^{-34}}{3\times1.38\times10^{-10}} = 19.5\times10^{-16}\ J$

$$E = \frac{19.5\times10^{-16}}{1.6\times10^{-19}}eV = 1.22\times10^4 eV$$

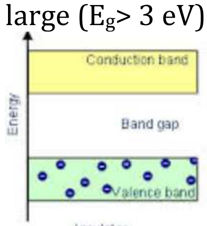
So, the ionization potential = 1.22×10^4 V

26. (a): Metals: The energy band diagram for a metal is such that either the conduction band is partially filled with electrons, or the conduction and valence band partly overlap each other and there is no forbidden energy gap in between as shown in the diagram.



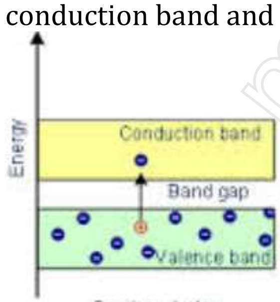
Conductor

Insulators: The energy band diagram of insulators is shown in the diagram given below. Here, the valence band is completely filled, the conduction band is empty and the energy gap is quite large (E_g> 3 eV).



Insulator

Semiconductors: The energy band diagram of a semiconductor is shown below. Here, the valence band is totally filled and the conduction band is empty but the energy gap between the conduction band and the valence band is quite small.



Semiconductor

(b) Here, $n_i = 2 \times 10^{16}\ m^{-3}$, $n_h = 4.5 \times 10^{22}\ m^{-3}$

$$n_e = \frac{n_i^2}{n_h} = \frac{(2\times10^{16})^2}{4.5\times10^{22}} = 8.89\times10^9\ m^{-3}$$