PRACTICE PAPER-1 (SOLUTION)

CLASS : XII

SUBJECT : PHYSICS

SECTION – A

1. **(c)** **[1]**

Spheres A and B will be charged due to induction.

2. **(c)** **[1]**

At centre of the dipole potential is zero but electric field is not zero.

3. **(c)** **[1]**

B to C

4. **(d)** **[1]**

When the length is increased by 100%, it becomes 2l and area of cross-section decreases to A/2.

New resistance,

$R' = \rho(\ell'/A') = \rho[2\ell/(A/2)] = 4\rho(\ell/A) = 4R$

Change in resistance,

$[(R'-R)/R] \times 100 = [(4R-R)/R] \times 100 = 300\%$

5. **(b)** **[1]**

$R_1/R_2 = (l_1/l_2).(A_2/A_1) = (l_1/l_2).(\pi r_2^2/\pi r_1^2) = (l_1/l_2).(r_2/r_1)^2 = (4/3).(3/2)^2 = 3$

For wires connected in parallel, $V_1 = V_2$ OR $I_1R_1 = I_2R_2$

$$\frac{I_1}{I_2} = \frac{R_2}{R_1} = \frac{1}{3}$$

6. **(b)** **[1]**

For a straight current carrying wire,

$B \propto 1/r$

$B'/B = r/2r = ½$

$B' = (1/2)\,B = (1/2) \times 0.4 = 0.2$ T

7. **(c)** **[1]**

Let the radii of the two coils be 2a and a, then their resistances will be 2 R and R respectively.

Given

$B_1 = B_2$

$(\mu_0 I_1)/(2 \times 2a) = (\mu_0 I_2)/2a$

$(\mu_0/4a).(V_1/2R) = (\mu_o/2a).(V_2/R)$

$V_1 : V_2 = 4 : 1$

8. **(b)** **[1]**

Susceptibility of a ferromagnetic material decreases with the increase in temperature and above the curie temperature T_C, it becomes paramagnetic.

9. **(b)** **[1]**

The emf induced in the coil

$$\varepsilon = -\frac{nd\phi}{dt}$$

$$= -n(\phi_2 - \phi_1)/t$$

Total resistance R' = R + 4R = 5RΩ

Induced current, $I = \varepsilon/R' = n(\phi_1 - \phi_2)/5Rt$

10. **(c)** **[1]**

Resonant frequency

$f_r = 1/[2\pi\sqrt{(LC)}]$

When C is changed to 2C, L should be changed to L/2 so that f_r, remains unchanged.

11. **(d)** **[1]**

The frequency of the e.m. wave remains same when it passes from one medium to another.

Refractive index of the medium, $n = \sqrt{(\varepsilon/\varepsilon_0)} = \sqrt{(4/1)} = 2$

Wavelength of the electromagnetic wave in the medium.

$\lambda_{med} = \lambda/n = \lambda/2$.

12. **(a)** **[1]**

$\mu = \lambda_a/\lambda_g$

$\lambda_g = \lambda_a/\mu = (2400 \times 10^{-10}\ \text{m})/1.5 = 1600$ Å

13. **(a)** **[1]**

$W_o = hc/\lambda_o = (6.63 \times 10^{-34} \times 3 \times 10^8) / (5000 \times 10^{-10})$ J

$= 4 \times 10^{-19}$ J.

14. **(a)** **[1]**

P.E. of an electron $= \dfrac{-kze^2}{r}$

K.E. of an electron $= \dfrac{1}{2}\dfrac{kze^2}{r}$

Total energy of an electron $= -\left(\dfrac{1}{2}\right)\dfrac{kze^2}{r}$

When an electron makes a transition from an excited state to the ground state, the value of r decreases.

K.E. increases

P.E. decreases as it becomes more negative.

Total energy decreases as it becomes more negative.

15. **(b)** **[1]**

Energy of Proton

$= 2B.E.\ ({}_2He^4) - B.E\ ({}_3Li^7)$

$= 2 \times 4 \times 7.6 - 7 \times 5.60$

$= 56.48 - 39.20 = 17.28$ MeV

16. **(a)** **[1]**

Both assertion and reason are true and the reason is the correct explanation of the assertion. The waves produced by the two distinct light sources are not coherent.

17. **(d)** **[1]**

Both the assertion and reason are false.

Resistivity of a semiconductor decreases with temperature. Larger amplitudes of atoms at higher temperatures increase conductivity of a semiconductor.

18. **(c)** **[1]**

For an incident photon of given energy, velocity of photoelectron ejected from near the surface is larger than that coming from the interior of the metal because, less energy is required to eject an electron from the surface than from the interior. The velocity of ejected electron may not be zero.

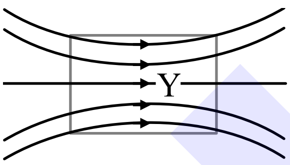
SECTION – B

19. **(a) X-ray :** Used as a diagnostic tool in medicine. **[1]**

(b) Micro wave : Used in micro wave oven **[1]**

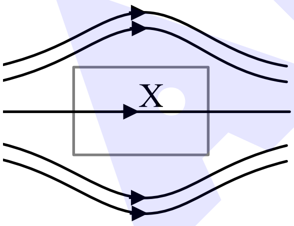
Any one other application of each.

20. (a) Paramagnetic



[1]

(b) Diamagnetic



[1]

21. Balmer, $n_i = \infty$ and $n_f = 2$

Paschen, $n_i = \infty$ and $n_f = 3$ **[1]**

$1/\lambda = R\ (1/n_f^2 - 1/n_i^2)$

$\lambda_B/\lambda_P = 4/9$ **[1]**

Or

For first excited state, n = 2

$r_2 = n^2 a_o = 2^2 \times 5.3 \times 10^{-11} = 21.2 \times 10^{-11}$ m **[1]**

Total energy $= -13.6/n^2$ eV $= -13.6/4 = -3.4$ eV **[1]**

22. From mirror formula, $1/v = 1/f - 1/u$, Now for a concave mirror, $f < 0$ and for an object at $u < 0$,

$2f < u < f$ or $\frac{1}{2}f > \frac{1}{u} > \frac{1}{f}$

$\frac{1}{2}f < \frac{1}{v} < 0$ **[1]**

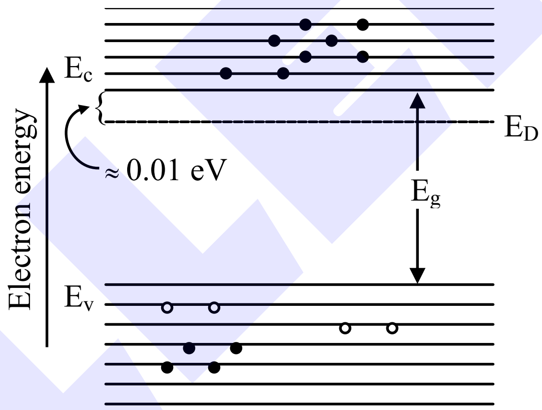
This implies that $v < 0$ so that image is formed on left.

Also the above inequality implies $2f > v$ OR $|2f| < |v|$ [2 f and v are negative] i.e., the real image is formed beyond 2f. **[1]**

23. Drift speed in B is higher. Since the two bars are connected in series, the current through both same.

$I = neAv_d$, $v_d \propto \frac{1}{n}$. Since n is much lower in semiconductors, drift velocity will be more. **[1+1]**

OR



The energy gap may decrease slightly with increase in temperature. **[1+1]**

24. $\lambda = 5890 \times 10^{-10}$ m, $a = 0.25 \times 10^{-3}$ m

Angular separation $\theta = 3\lambda/2a = 3.534 \times 10^{-3}$ radian **[2]**

25. Energy stored in the capacitor = $\frac{1}{2} CV^2$

When it is connected to another uncharged capacitor, common potential. [½]

$V' = V/2$

Energy stored in the combined system = $\frac{1}{2}(C + C) \times (V/2)^2$

$$= \frac{1}{4} CV^2$$ [1]

Required ratio = ½ **[½]**

SECTION C

26. Statement of Ampere's Law :

It states that line integral of magnetic field is equal to μ_0 times the total current passing through the surface **[1]**

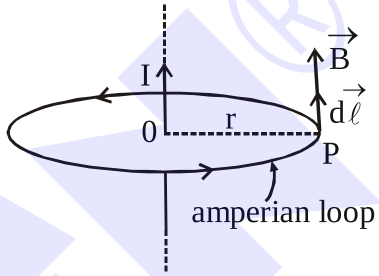
$$\boxed{\oint \vec{B}\cdot d\vec{\ell} = \mu_0 I}$$

Expression for Magnetic Field :

Apply ampere's law to find out magnetic field at point 'p'

$$\oint \vec{B}.d\vec{l} = \mu_0 \Sigma I$$

$$\oint B dl \cos\theta = \mu_0 I \quad \begin{cases} \theta = 0 \\ \cos\theta = 1 \\ \Sigma I = I \end{cases}$$



$$B\oint dl = \mu_0 I$$

$$B \times 2\pi r = \mu_0 I$$

$$\boxed{B = \frac{\mu_0 I}{2\pi r}}$$

Magnetic field at the centre $B = \mu_0 I/2a$

If I= 2 and a = a/2, B' = 4B **[1½ + ½]**

27. (a) As n decreases, $L = \mu_0 n^2 Al$ decreases, $X_L = L\omega$ decreases, brightness increases. **[1]**

(b) When an iron rod is inserted, L increases, $X_L = L\omega$ increases, brightness decreases. **[1]**

(c) When a capacitor is introduced, since $X_L = X_c$, impedance = R, minimum, hence brightness increases. **[1]**

OR

$R = 100\ \Omega$, $L = 4/\pi^2$ H, $V_{rms} = 200$ V, $\nu = 50$ Hz

At resonance, Impedance $Z = R = 100\ \Omega$

$L\omega = 1/C\omega$, $C = 1/\omega^2 L$ **[1]**

$\omega = 2\pi\nu = 2\pi \times 50 = 100\ \pi$ **[1]**

$C = 1/40000 = 25\mu F$ **[1]**

28. Statement of Faraday's law :

1. **First law** – Whenever there is a change in the magnetic flux linked with a given coil, an emf get induced in coil. The induced emf lasts as long as the magnetic flux linked with the coil changes. **[1]**

2. **Second law** – Rate of change of magnetic flux linked with a coil is directly proportional to the induced emf in it.

$$\varepsilon \propto \frac{d\phi}{dt}$$

$$\varepsilon = k\frac{d\phi}{dt}$$

$$\varepsilon = \frac{d\phi}{dt} \qquad [\because k = 1]$$ **[1]**

emf induced = $\frac{1}{2}BR^2\omega$

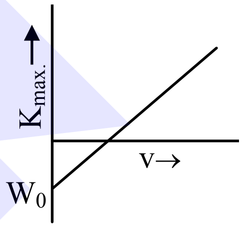
B = 1T, R = L = 1m, $\omega = 2\pi v = 2\pi \times 50 = 100\,\pi$

Emf = $\frac{1}{2} \times 1 \times 1^2 \times 2\pi \times 50 = 50\,\pi = 157$ V **[1]**

29. $K_{max} = h\nu - \theta_0$

Slope of the graph gives the value Plank's constant

Intercept on the negative Y axis gives the value of work function **[1+1+1]**



OR

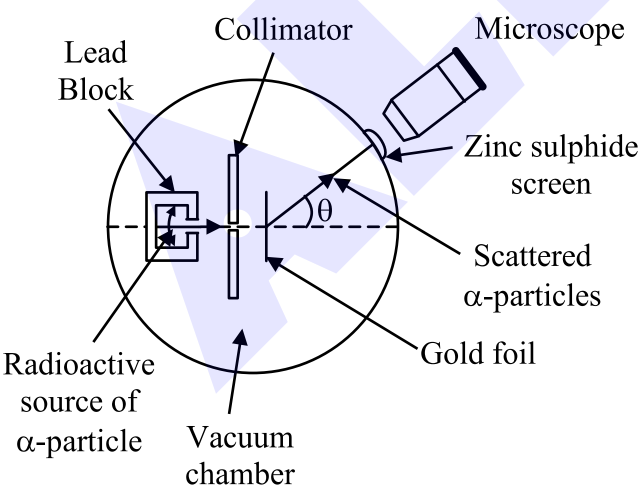
$\phi_0 = 2.14$ eV, $\nu = 6 \times 10^{14}$ Hz

(a) $K_{max} = h\nu - \phi_0 = 0.34$ eV **[1]**

(b) $K_{max} = eV_0 \Rightarrow V_0 = 0.34$ V **[1]**

(c) $K_{max} = \frac{1}{2} mV^2 \max \Rightarrow V_{max} = 345.8 \times 10^3$ m/s **[1]**

30.



[1]

$K = 7.7 \text{ MeV} = 7.7 \times 10^6 \times 1.6 \times 10^{-19}$

$K = Ze \times 2e/\,4\pi\varepsilon_0 \Rightarrow r_0 = \frac{2ze^2}{4\pi\varepsilon_o k}$

Substituting, $r_0 = 30$fm **[2]**

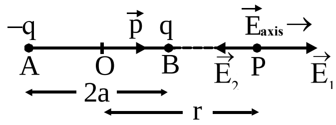
SECTION D

31. (a) Derivation of expression for electric field.

Electric field at an axial point due to an electric dipole :-

Electric field at point P due to charge +q

$$E_1 = \frac{kq}{(r-a)^2} \quad (\text{towards right})$$



Electric field at point P due to charge –q

$$E_2 = \frac{kq}{(r+a)^2} \quad (\text{towards left})$$

Resultant electric field at point P

$$E_{axis} = E_1 - E_2$$

$$E_{axis} = \frac{kq}{(r-a)^2} - \frac{kq}{(r+a)^2} \Rightarrow E_{axis} = kq\left[\frac{(r+a)^2 - (r-a)^2}{(r^2 - a^2)^2}\right]$$

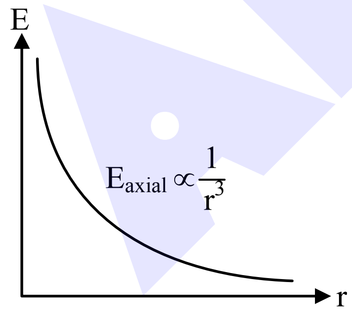
$$E_{axis} = \frac{kq(4ra)}{(r^2 - a^2)^2}, \quad \text{If } r >> a, \text{ then } r^2 - a^2 \approx r^2$$

$$E_{axis} = \frac{2kp}{r^3} \quad \{p = q(2a)$$

$$\boxed{E_{axis} \propto \frac{1}{r^3}}$$

In vector form $\boxed{\vec{E}_{axis} = \frac{2k\vec{p}}{r^3}}$ **[3]**

(b) **[½]**



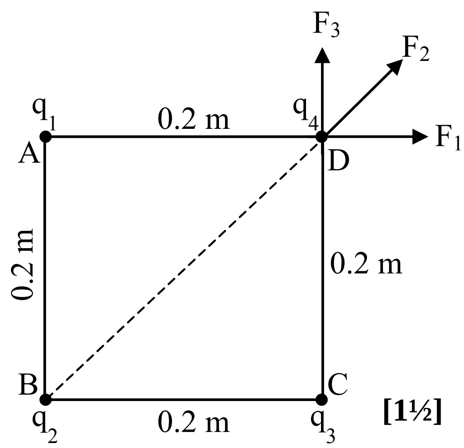
(c) $F = q_1q_2/4\pi\epsilon_0 r^2$

F_1 = 57.6 N along AD produced

F_2 = 28.8 N along BD produced

F_3 = 57.6 N along CD produced

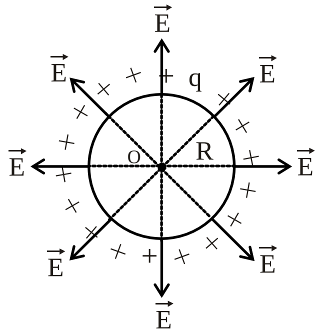
Resultant of F_1 and F_3 is 81.5 N



[1½]

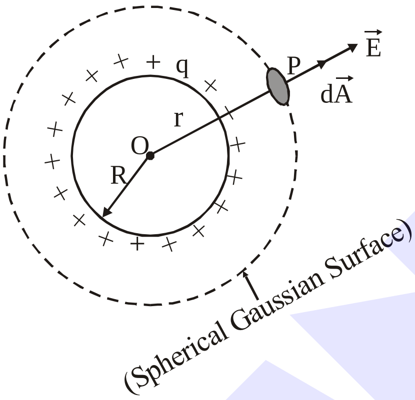
Total force on q_4 = 28.8 + 81.5 = 110.3 N along BD produced

OR



(a) Charge given to a conducting sphere is distributed uniformly over it's outer surface. At all points of this sphere, the magnitude of the electric field is same and its direction everywhere is perpendicular to the surface.

(i) When point lies outside the sphere (r > R) :-



Using Gauss law, at a point P situated outside the sphere,

$$\oint EdA\cos\theta = \frac{q_{inside}}{\varepsilon_0}$$

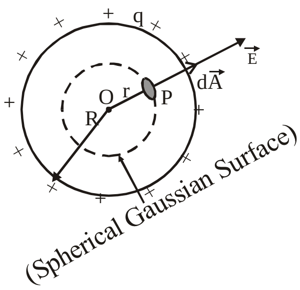
$$E\oint dA = \frac{q}{\varepsilon_0} \qquad \begin{cases} E \Rightarrow \text{constant} \\ \theta = 0° \end{cases}$$

So $\quad E \times 4\pi r^2 = \frac{q}{\varepsilon_0}$

$$\boxed{E_{out} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}} \Rightarrow \boxed{E_{out} = \frac{kq}{r^2}} \Rightarrow \boxed{E_{out} \propto \frac{1}{r^2}}$$ **[3]**

(ii) When point lies inside the sphere (r < R) :-

From Gauss law :-



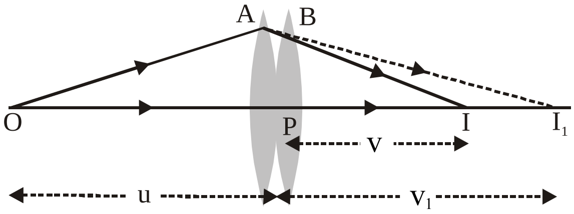
$$\oint EdA\ \cos\theta = \frac{q_{inside}}{\varepsilon_0} \qquad \{ q_{inside} = 0$$ **[1]**

$$\oint EdA\ \cos\theta = 0 \Rightarrow \boxed{E_{in} = 0}$$

(b) $\phi = \frac{q_{enclosed}}{\varepsilon_0}$

$\phi = \frac{-2q}{\varepsilon_0}$ **[1]**

32. (a) Ray Diagram :



[1]

(b) Expression for Power :

Considering two thin lenses A and B of focal lengths f_1 and f_2 placed in contact with each other. An object is placed at a point O beyond the focus of the first lens A. The first lens produces an image at I_1 (virtual image), which serves as a virtual object for the second lens B, producing the final image at I.

Since, the lenses are thin, we assume the optical centres (P) of the lenses to be co-incident.

For the image formed by the first lens A, we obtain

$$\frac{1}{v_1}-\frac{1}{u}=\frac{1}{f_1} \qquad ...(i)$$

For the image formed by the second lens B, we obtain

$$\frac{1}{v}-\frac{1}{v_1}=\frac{1}{f_2} \qquad ...(ii)$$

Adding eqs. (i) and (ii), we obtain

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f_1}+\frac{1}{f_2} \qquad ...(iii)$$

If the two lens system is regarded as equivalent to a single lens of focal length f. We have,

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f} \qquad ...(iv)$$

From eqs (iii) and (iv), we obtain

$$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2} \qquad ...(v)$$

$$P=\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}$$ **[3]**

(c) To increase magnification, focal length of objective maximum and focal length of eye piece minimum,. To increase the light gathering power, aperture of objective, must be maximum. Hence objective is L_1 and eyepiece is L_3 **[1]**

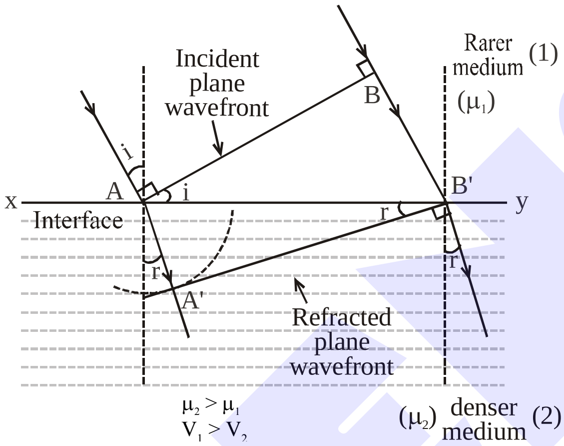
OR

(a) Wave Front - Locus of all the particles which are in same phase of vibration at a given instant is called wave front. **[1]**

(b) Geometrical construction :

Refraction of plane wavefront at plane surface on the basis of Huygen's principle–

Consider a plane wavefront AB (at t = 0) incident on interface xy. Let time taken by wavelets to reach from B to B' is t. If velocity of light in rarer medium is v_1, then $BB' = v_1 t$



If velocity of light in denser medium is v_2, then distance travelled by wavelets in time t : $AA' = v_2 t$

Taking 'A' as centre and draw a spherical arc of radius AA' = v_2t. Now draw a tangential plane A'B' which touches the spherical arc at point 'A'. This tangential plane A'B' acts as a refracted plane wavefront.

In $\Delta ABB'$, $\sin i = \frac{BB'}{AB'}$ ...(1)

In $\Delta AA'B'$, $\sin r = \frac{AA'}{AB'}$ ...(2)

Eq. (1) ÷ (2)

$$\frac{\sin i}{\sin r} = \frac{BB'}{AA'} \Rightarrow \frac{\sin i}{\sin r} = \frac{v_1 t}{v_2 t} \Rightarrow \frac{\sin i}{\sin r} = \frac{v_1}{v_2} \text{ (Huygen's law)}$$

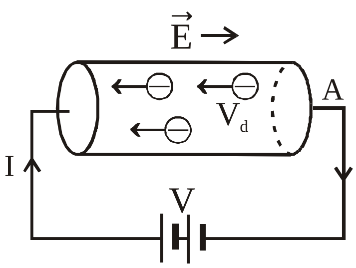
$$\frac{\sin i}{\sin r} = \frac{c/\mu_1}{c/\mu_2} \Rightarrow \frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1} \Rightarrow \frac{\sin i}{\sin r} = {}_1\mu_2 \text{ (Snell's law)}$$

Incident ray, refracted ray and normal all lie in same plane. **[3]**

(c) Fringe width = $\lambda D/d$

As d decreases, fringe width increases. **[1]**

33. Definition of relaxation time : According to drift velocity expression, relaxation time is the average time interval between successive collisions of an electron. **[1]**



When conductor is subjected to an electric field E, each electron experience a force.

$$\vec{F} = -e\vec{E}$$

and acquires an acceleration

$$a = \frac{\vec{F}}{m} = \frac{-e\vec{E}}{m} \quad .....(i)$$

Here m = mass of electron, e = charge, E = electric field.

The average time difference between two consecutive collisions is known as relaxation time of electron.

$$\tau = \frac{\tau_1 + \tau_2 + ... + \tau_n}{n} \quad .....(ii)$$

As v = u + at (from equations of motion)

The drift velocity V_d is defined as –

$$\vec{V}_d = \frac{\vec{v}_1 + \vec{v}_2 + ... + \vec{v}_n}{n}$$

$$\vec{V}_d = \frac{(\vec{u}_1 + \vec{u}_2 + ... + \vec{u}_n) + a(\tau_1 + \tau_2 + ... + \tau_n)}{n}$$

$$\vec{V}_d = 0 + \frac{a(\tau_1 + \tau_2 + ... + \tau_n)}{n}$$

($\because$ average thermal velocity = 0)

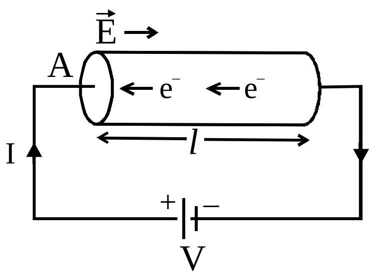
$\therefore$ $\vec{V}_d = 0 + at$

$$\vec{V}_d = -\left(\frac{e\vec{E}}{m}\right)\tau \Rightarrow |\vec{V}_d| = \left(\frac{e\tau}{m}\right)E$$ **[2]**

We know that the current flowing through the conductor is :

$$I = nAeV_d$$

$$\therefore \quad I = neA\left(\frac{eE\tau}{m}\right)$$



Using $E = \frac{V}{\ell}$

$$I = neA\left(\frac{eV}{ml}\right)\tau = \left(\frac{ne^2A\tau}{ml}\right)V = \frac{1}{R}V$$

$I \propto V \rightarrow$ Which is ohm's law

Where $R = \frac{ml}{nAe^2\tau}$ is constant for particular conductor at a particular temperature and is called the resistance of the conductor.

$$R = \left(\frac{m}{ne^2\tau}\right)\frac{l}{A} = \frac{\rho l}{A} \Rightarrow \rho = \left(\frac{m}{ne^2\tau}\right)$$ **[3]**

In metals, as temperature increases, relaxation time decreases.

OR

(a) Kirchhoff's Laws:

(i) Kirchhoff's Current Law (KCL)

(ii) Kirchhoff's Voltage Law (KVL)

(i) **Kirchhoff's Current Law (KCL) or Junction Rule**

It states that the sum of the currents entering any junction must equal to the sum of the electric currents leaving that junction.

i.e. $\Sigma I = 0$.

This law is based upon conservation of charge.

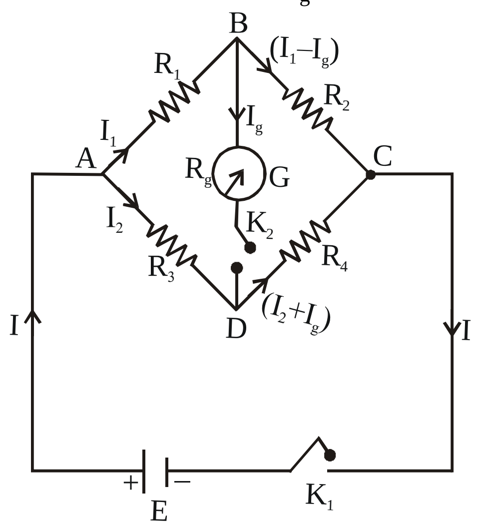
(ii) **Kirchhoff's Voltage Law (KVL) Or Loop Rule:**

It states that the algebraic sum of all voltage drop in a closed electrical circuit must be zero i.e.

$\Sigma V = 0$

This law is based upon conservation of energy **[1]**

(b) Let the current in galvanometer be I_g and resistance of galvanometer is R_g.



Apply Kirchhoff's voltage law in loop ABDA-

$-I_1R_1 - I_gR_g + I_2R_3 = 0$ ……(1)

Apply KVL in loop BCDB -

$-(I_1 - I_g)R_2 + (I_2 + I_g) R_4 + I_gR_g = 0$ ……(2)

In balanced Wheat Stone Bridge ($I_g = 0$)

From eq. (1) & (2)

$I_1R_1 = I_2 R_3$ ……(3)

$I_1R_2 = I_2R_4$ ……(4)

Divide eq. (3) by (4)

$\frac{R_1}{R_2} = \frac{R_3}{R_4}$ This is the condition of balanced Wheat Stone Bridge. **[2]**

(c) Applying Kirchhoff's rule $I_1 + I_2 + I_3$

For the loop ABEFA, $2I_3 + 5I_1 = 12$

For the loop BCDEB, $-2I_3 - 3I_2 = -6$

Solving the above equation, $I_1 = 48/31A$, $I_2 = 18/31$, $I_3 = 66/31$ A **[2]**

SECTION-E

34. (a) Condition for sustained interference :

(i) Sources of light must be coherent.

(ii) Amplitude of two waves should be equal for good contrast.

(iii) Two sources should be narrow to avoid overlapping of fringes.

(iv) The two sources should be close to each other to avoid overlapping of fringes.

(v) Distance of the screen from the sources should be large. **[Any two]** **[1]**

(b) We know that

$I_R = 4I_0 \cos^2 \frac{\phi}{2}$

Given $I_R = 2I_0$

So $2I_0 = 4I_0 \cos^2 \frac{\phi}{2}$

$\text{Cos}^2 \frac{\phi}{2} = \frac{1}{2}$

$\text{Cos} \frac{\phi}{2} = \frac{1}{\sqrt{2}}$

$\frac{\phi}{2} = \frac{\pi}{4}$

$\phi = \frac{\pi}{2} (2n + 1)$

$\Delta x = \frac{\lambda}{2}\pi(\phi) = \frac{\lambda}{2\pi} \times \frac{\pi}{2}(2n+1)$

$= \frac{\lambda}{4}(2n+1)$ **[1]**

(c) Ratio = 1 : 1

OR

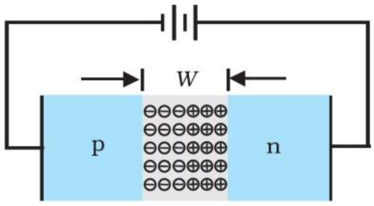
$\beta = \lambda\ D/d$

$\beta_1 = \frac{4500 \times 10^{-10} \times D}{d} = 0.4 \times 10^{-2}$ So, $\beta_2 = \frac{4500 \times 10^{-10} \times \frac{D}{2}}{d} = \frac{\beta_1}{2}$

Taking the ratio new fringe width is half the first one = 0.2 cm **[2]**

35. **(a)** This is because the energy gap for Ge (E = 0.7 eV) is smaller than the energy gas for Si (E = 1.1 eV) **[1]**

(b) Reverse Bias : **[2]**



(c) If the reverse bias decreases the width of the depletion region decreases. **[1]**

OR

(c) Drift & Diffusion.