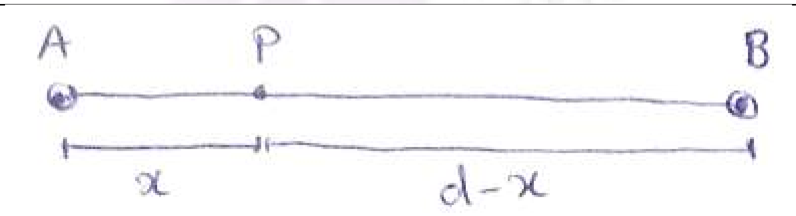
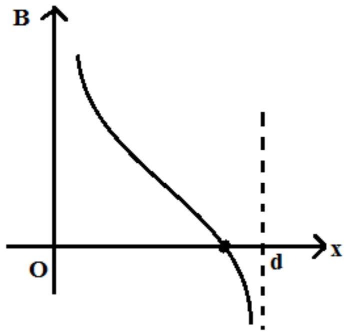
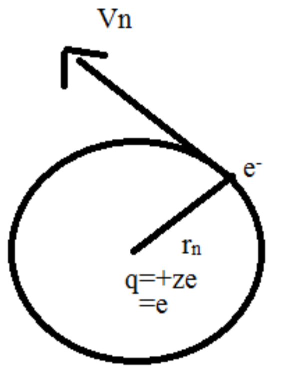
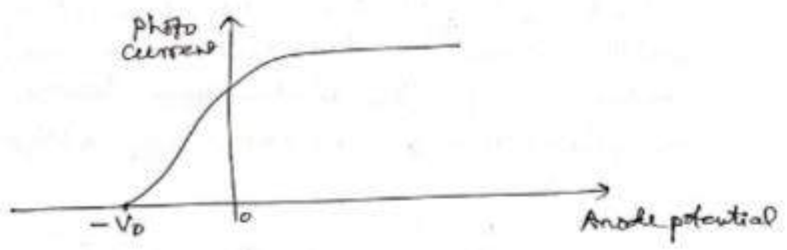
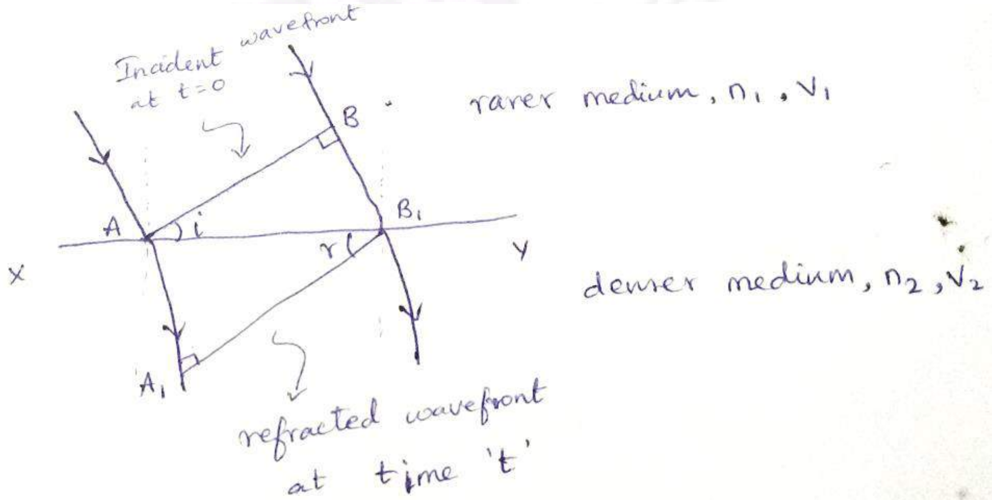
PHYSICS – BOARD EXAM – SET – 2

55/1/2

Q. NO	SOLUTION	TOTAL MARKS
	SECTION – A	
1.	(C) 1 : 3	
2.	(D) The stability of atom was established by the model.	
3.	(B) Diameter of objective	
4.	(D) material of the turns of the coil	
5.	(A) red colour	
6.	(A) 1.47	
7.	(B) Decrease in relaxation time	
8.	(C) Always a force and a torque	
9.	(A) no net charge is enclosed by the surface.	
10.	(B) Charge	
11.	$\sqrt{3}$	
12.	Integral (or) Nucleons	
13.	4 times	
14.	Eddy	
15.	Repelled	
16.	LEDs must have band gap in the order of 1.8 eV to 3 eV but Si & Ge have band gap less than 1.8 eV so these cannot be used to fabricate LEDs.	
17.	M_2 has greater value of work function due to higher value of threshold frequency.	

18.	Decreases	
19.	$\frac{R_2}{R_1}=\left(\frac{A_2}{A_1}\right)^{\frac{1}{3}}\Rightarrow R_2=3.6\left(\frac{64}{27}\right)^{\frac{1}{3}}=3.6\times\frac{4}{3}$ $=4.3$ Fermi **OR** $\frac{\lambda_p}{\lambda_e}=\frac{\frac{h}{m_p v_p}}{\frac{h}{m_e v_2}}=\frac{m_p}{m_e}\times\frac{v_p}{v_e}=\frac{1.67\times10^{-27}}{9.1\times10^{-31}}=1.8\times10^{23}$	
20.	Conduction current is established by actual movement of free electrons through a metallic conductor while displacement current is established by polarization of molecules of a dielectric under the influence of an external electric field. Displacement current is produced by time varying electric flux and electric field across the dielectric medium between capacitor plates that leads to polarization and displacement of charges.	
	SECTION – B	
21.	 $\overrightarrow{B_P}=\overrightarrow{B_A}+\overrightarrow{B}_B=\frac{\mu_0 I}{2\pi x}$(upwards) + $\frac{\mu_0 I}{2\pi(fx)}$(down) $=\frac{\mu_0 I}{2\pi}\left[\frac{1}{x}-\frac{1}{d-x}\right]$ $=\frac{\mu_0 I}{2\pi}\left[\frac{d-x-x}{x(d-x)}\right]=\frac{\mu_0 I}{2\pi}\left(\frac{d-2x}{x(d-x)}\right)$upwards $+\frac{\mu_0 I}{2\pi(d-x)}$(down) (1) ÷ (2) $\Rightarrow\frac{mv_n^2 r_n}{mv_n r_n}=\left(\frac{ze^2}{4\pi\varepsilon_0}\right)\left(\frac{2\pi}{nh}\right)$	

	$\Rightarrow$ speed of e^- As $B_A > B_B$ (b)  	
22.	 $m =$ mass of e^- Centripetal force = Electrostatic required by e^- attraction to resolve nucleus $\Rightarrow \frac{mv_n^2}{r_n} = \frac{1}{4\pi\varepsilon_0}\frac{(Ze)^2}{r_n^2} \Rightarrow mv_n^2 rn = \frac{e^2}{4\pi\varepsilon_0}[z=1]$ (i) By Bohr's II postulate, Angular momentum of $e^- = mv_n r_n = \frac{nh}{2\pi}$ (ii) From (ii) $v_n = \frac{nh}{2\pi m r_n}$ substituting in (i) $\Rightarrow mr_n \frac{n^2h^2}{4\pi^2 m^2 r_n^2} = \frac{e^2}{4\pi\varepsilon_0}$	

	$\Rightarrow \frac{n^2h^2}{\pi m r_n} = \frac{e^2}{\varepsilon_0}$ $\Rightarrow r_n = \frac{n^2h^2\varepsilon_0}{m\pi e^2}$ **(or)** (a) (i) instantaneous phenomenon. (ii) Existence of threshold v or λ. (b) 	
23.	Wavefront: It is a locus of all the disturbances oscillating with energy in same phase at a given instant.  A plane wavefront AB is incident in rarer medium at instant t = 0 on interface XY separating it from a denser medium. When wavelet A is on interface, B is at a distance BB, from it. It takes t time to cover the distance $BB_1 = v_1 t$ to reach on interface XY. Mean while, the wavelet from A reaches to point A_1 covering a distance $AA_1 = v_2 t$ in denser medium.	

To locate A_1, draw a secondary wavelet with radius $AA_1 = v_2 t$ & centre A. Draw tangent from B, onto this sec. wavelet intersecting at A_1.

A_1B_1 is refracted wavefront at instant t.

$i =$ angle of incidence

$r =$ angle of refraction.

$$\therefore \ \Delta ABB_1 \Rightarrow \sin i = \frac{BB_1}{AB_1}$$

$$\Delta AA_1B_1 \Rightarrow \sin r = \frac{AA_1}{AB_1}$$

$$\therefore \quad \frac{\sin i}{\sin r} = \frac{BB_1}{AA_1} = \frac{v_1 t}{v_2 t} = \frac{v_1}{v_2}$$

$$\therefore \quad \frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \text{constant}$$

Which is Snell's law.

OR

Ace to lens maker's formula

$$\frac{1}{v} - \frac{1}{u} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \dots (1)$$

When object is at placed at infinity,

$$u = \infty$$

Image is obtained at focus

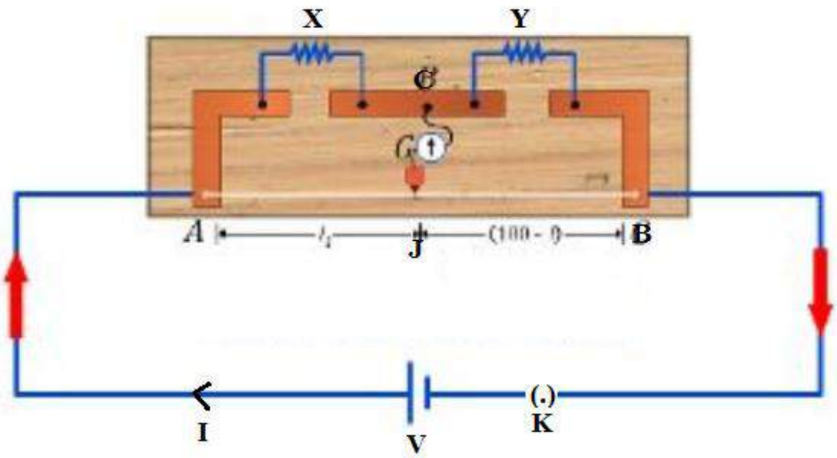
$$v = f$$

Using these values in Eq (1)

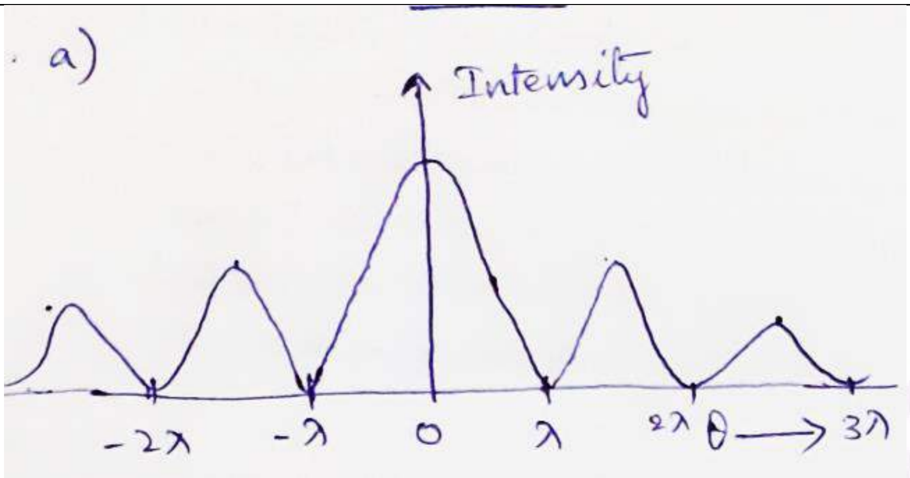
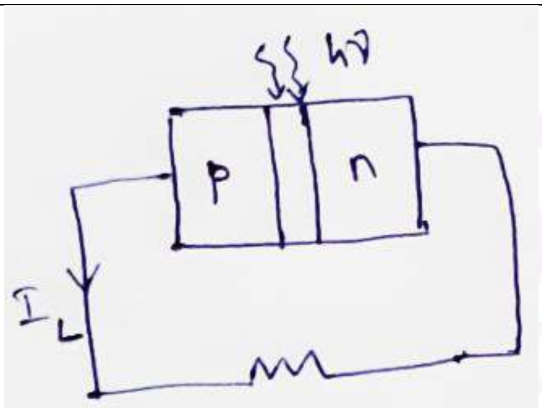
$$\frac{1}{f} - \frac{1}{\infty} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

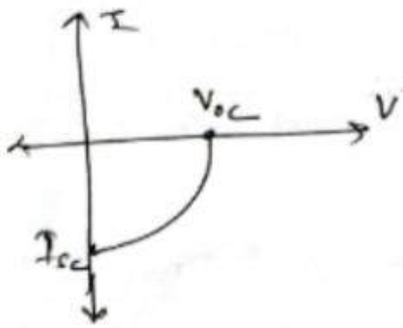
$$\Rightarrow \quad \frac{1}{f} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \dots (2)$$

$$\therefore \quad \text{By Eq (1) \& (2)} \Rightarrow \quad \frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

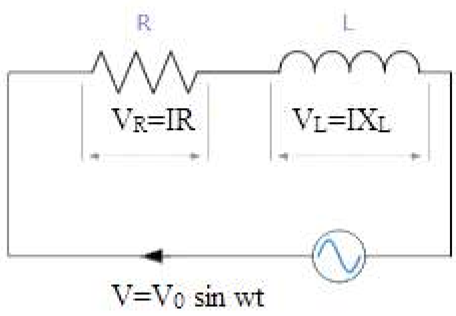
	Depletion layer: It is a layer of immobile ions formed near the p-n junction by diffusion of majority charge carriers and electron-hole recombination. Potential barrier: It is the potential difference developed across the junction when diffusion current & drift current attains equilibrium across the junction. (a) When forward biased, width of depletion layer decreases. (b) And value of barrier potential also reduces as $v_0 - v$.	
24.	Meter bridge works on the condition of balanced wheatstone bridge condition.  X = Unknown resistance Y = known resistance $l =$ balancing length Then $X = Y \frac{l}{100 - l}$	
25.	Depletion layer: It is a layer of immobile ions formed near the p-n junction by diffusion of majority charge carriers and electron-hole recombination. Potential barrier: It is the potential difference developed across the junction when diffusion current & drift current attains equilibrium across the junction. (a) When forward biased, width of depletion layer decreases. (b) And value of barrier potential also reduces as $v_0 - v$.	

26.	$q_{new} = Nq$; $q =$ charge on each small droplet $\frac{4}{3}\pi R^3 = N\left(\frac{4}{3}\pi R^3\right) \Rightarrow R = N^{1/3}r$ R = radius of larger drop $\because \; V = \frac{kq}{r} =$ potential on each small dropper. $\therefore$ V'=Potential on large drop $= \frac{k\,q_{new}}{R} = \frac{K(Nq)}{N^{1/3}r} = N^{2/3}\left(\frac{kq}{r}\right)$ $\Rightarrow V' = N^{2/3}V$	
27.	Activity → If is defined as the number atoms decaying per unit time at a given instant. $\lambda = 0.0693h^{-1} \Rightarrow T_{1/2} = \frac{0.693}{0.693} = 10hr$ $\frac{R}{R_0} = \left(\frac{1}{2}\right)^n \Rightarrow \left(\frac{R_{0/2}}{R_0}\right) = \left(\frac{1}{2}\right)^{t/10}$ $\Rightarrow \frac{1}{2} = \left(\frac{1}{2}\right)^{t/10} \Rightarrow \frac{t}{10} = 1 \Rightarrow t = 10hr$	
	SECTION – C	
28.	(a)	

	 (b) (i) Intensity increases, angular width decreases (ii) Intensity increases, no effect on angular width	
29.	 When solar radiations are incident near the depletion layer of solar cell, covalent bonds break absolving the photons to create e^- hole pairs and following three important process occur. (i) Generation of $e-h$ pair by breaking of covalent bonds absorbing radiations incident on depletion layer when $h\upsilon > Eg$. (ii) separation of e^- and hole in n-side and holes in p-side to develop a photovoltage V_{OC} across the solar cell. (iii) Collection of electrons reaching the n-side by the front contact and holes reaching the p-side by the back contact. I-V characteristics Thus the p-side become positive and the n-side becomes negative giving rise to photo voltage.	



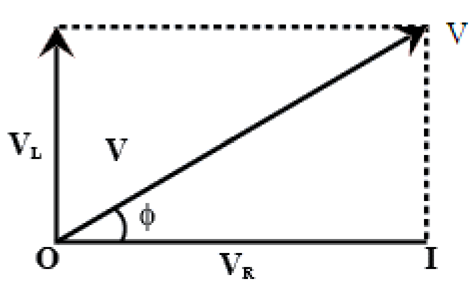
30.



(a) Peak value of voltage drop across

(i) $R \Rightarrow V_R = I_0 R = \dfrac{V_0 R}{\sqrt{R^2 + X_L{}^2}}$

(ii) $L \Rightarrow V_L = I_0 X_C = \dfrac{V_0 X_C}{\sqrt{R^2 + X_L{}^2}}$

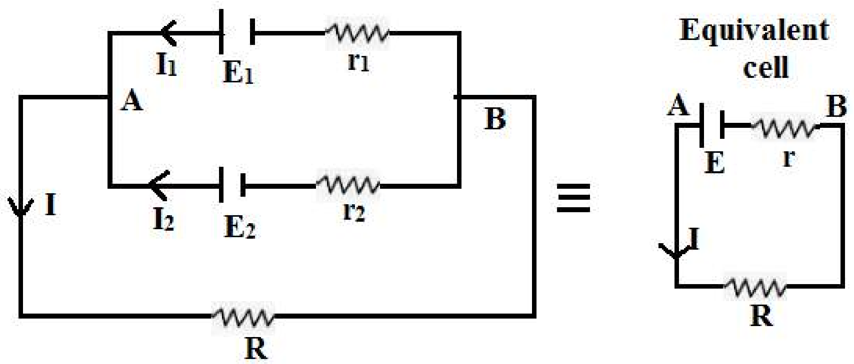


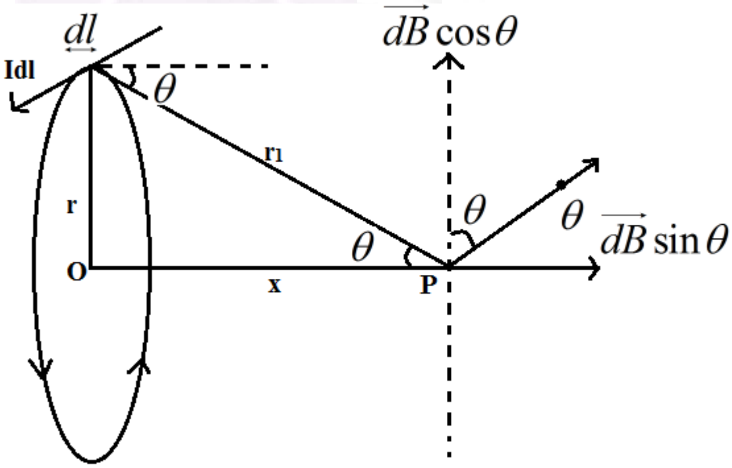
Phase difference between $V \& I$ is $\phi = \tan^{-1}\left(\dfrac{V_L}{V_R}\right) = \tan^{-1}\left(\dfrac{X_L}{R}\right)$

V is ahead of I.

31.

(a) $v = \dfrac{1}{\sqrt{\mu_0 \mu_r \varepsilon_0 \varepsilon_r}} = \dfrac{c}{\sqrt{\mu_r \varepsilon_r}}$

	(b) (i) Microwaves 10^{-1} to 10^{-3} $m=\lambda$ (ii) Infrared $10-4\ to\ 10^{-6}$ $m=\lambda$ $(>700\,nm)$	
32.	(a)  Potential difference across A & B $V=V_A-V_B=E_1-I_1r_1$ … (1) $V=V_A-V_B=E_2-I_2r_2$ … (2) $\Rightarrow\quad I_1=\frac{E_1}{r_1}-\frac{V}{r_1}$ … (3) (from (1)) $I_2=\frac{E_2}{r_2}-\frac{V}{r_2}$ … (4) (from (2)) For Equivalent cell $I=\frac{E}{r}-\frac{V}{r}$ … (5) $\because\quad I=I_1+I_2$ $\therefore\quad \frac{E}{r}-\frac{V}{r}=\left(\frac{E_1}{r_1}-\frac{V}{r_1}\right)+\left(\frac{E_2}{r_2}-\frac{V}{r_2}\right)$ $=\left(\frac{E_1}{r_1}+\frac{E_2}{r_2}\right)-V\left(\frac{1}{r_1}+\frac{1}{r_2}\right)$ Comparing we get $\frac{1}{r}=\frac{1}{r_1}+\frac{1}{r_2}$ $\therefore$ Equivalent internal resistance is	

	$r = \frac{r_1 r_2}{r_1 + r_2}$ Also $\frac{E}{r} = \frac{E_1}{r_1} + \frac{E_2}{r_2} = \frac{E_1 r_2 + E_2 r_1}{r_1 r_2}$ $\therefore$ Equivalent emf is $E = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$ (b) $E = \frac{5\times 2 + 5\times 2}{2+2} = 5\text{ V}$ $r = \frac{2\times 2}{2+2} = 1r$ $I = \frac{E}{R+r} = \frac{5}{10+1} = \frac{5}{11}A$ $\therefore$ Voltage across $R \Rightarrow V = IR = \frac{5}{11}\times 10 = \frac{50}{11}V = 4.54V$
33.	(a) Magnetic moment $\overrightarrow{M} = Ni\left(\pi r^2\right)\hat{n}$ (b)  Magnetic field at point P(x, 0, 0) due to $I\overrightarrow{dl}$ $\overrightarrow{dB} = \frac{\mu_0}{4\pi}\frac{Idl\sin 90°}{r_1^2}$ along PQ

For entire coil $\int \overrightarrow{dB} \cos\theta = 0$

$\therefore$ $\vec{B}$ at P $\Rightarrow B = \int dB \sin\theta = \frac{\mu_0 I \sin R}{4\pi R^2}\int_0^{2\pi r} dl$

$$= \frac{\mu_0 I}{4\pi r_1^2} \times \frac{r}{r_1} \times (2\pi r)$$

$\Rightarrow$ $\vec{B} = \frac{\mu_0 I r^2}{2(r^2 + x^2)^{\frac{3}{2}}}\hat{i}$

Coil has N turns then

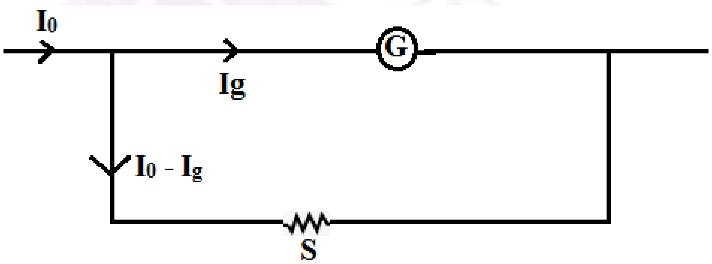
$$\vec{B} = \frac{\mu_0 I N r^2}{2(r^2 + x^2)^{\frac{3}{2}}}\hat{i}$$

(OR)

(a) Current sensitivity: It is defined as the amount of deflection produced per unit magnitude of current passes.

$$C_S = \frac{\phi}{I} \text{ or } C_S = \frac{NAB}{k}$$

(b) (i)



(G) can be converted into an ammeter by connected a small stunt resistance parallel to (G) coil so that

$$IgG = (I_0 - I_g)S$$

$\therefore$ $S = \frac{IgG}{I_0 - I_g}$

(ii) Effective resistance of (A) $\Rightarrow \frac{GS}{G+S}$

34. Energy released = Q = 7.835 × 231 + 7.07 × 4 – 7.8 × 235

$\Rightarrow Q = 1809.885 + 28.28 - 1833$

$= 5.165\, MeV$

$= 5.165 \times 1.6 \times 10^{-13}\, J$

This energy will be taken away by α – particle as kinetic energy.

$\therefore \quad \frac{1}{2} m v^2 = Q$

$\Rightarrow$ Speed of α – particle

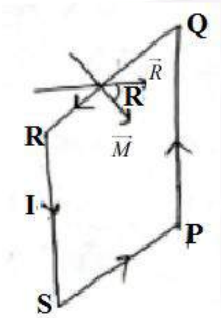
$$v = \sqrt{\frac{5.165 \times 1.6 \times 10^{-13} \times 2}{6.68 \times 10^{-27}}}$$

$$= \sqrt{\frac{16.528}{6.68} \times 10^{14}} = \sqrt{2.474} \times 10^7$$

$= 1.573 \times 10^7$ m/s

SECTION – D

35. (a)



$PQ = RS = l$

$PS = QR = b$

Area A $= lb$

$\vec{M} \times I\vec{A}$

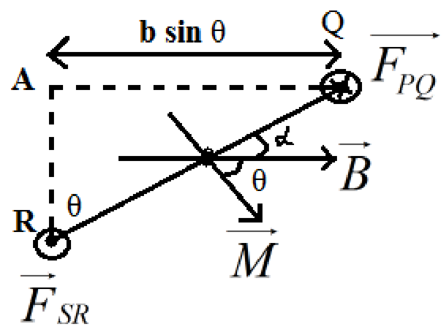
$\overrightarrow{F_{PQ}} = IlB \otimes$

$\overrightarrow{F_{RS}} = IlB\Theta$

$\overrightarrow{F_{QR}} = IbB\sin(90° - \theta) = IbB\cos\theta$ up

$\overrightarrow{F_{SP}} = IbB\sin(90° - \theta) = IbB\cos\theta$ down

Only $\overrightarrow{F_{PB}}$ & $\overrightarrow{F_{RS}}$ form a couple to apply torque on loop



$\tau = F_{PQ}(AQ) = (IlB)(B\sin\theta)$

$= I(lb)B\sin\theta$

$\Rightarrow \tau = MB\sin\theta$

Magnetic field is taken radial in Galvanometer coil in order to create $\theta = 90°$ at every orientation of coil in the magnetic field so that current varies linearly with deflection.

(b) $qV = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{\frac{2qV}{m}}$

$\because \vec{v} = vi \perp \vec{B}(= Bj)$

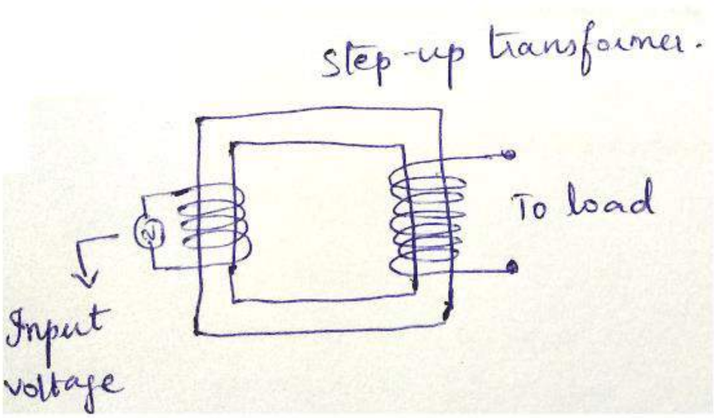
$\therefore$ Particle deflects along circular path of radius $r = \frac{mv}{qB} = \frac{m}{qB}\sqrt{\frac{2qv}{m}} = \frac{1}{B}\sqrt{\frac{2mv}{q}}$

$r = \frac{1}{2\times10^{-3}}\sqrt{\frac{2\times6.4\times10^{-27}\times10^{4}}{2\times1.6\times10^{-19}}}$

$$= \frac{1}{2\times10^{-3}} \times 2\times10^{-2} = 10^{1} m = 10\, m$$

(OR)

(a)



AC voltage v_i is applied at primary P of transformer (with turns N_P).

By self induction, pot diff developed is

$$e_P = -N_P \frac{d\phi}{dt} = v_i$$

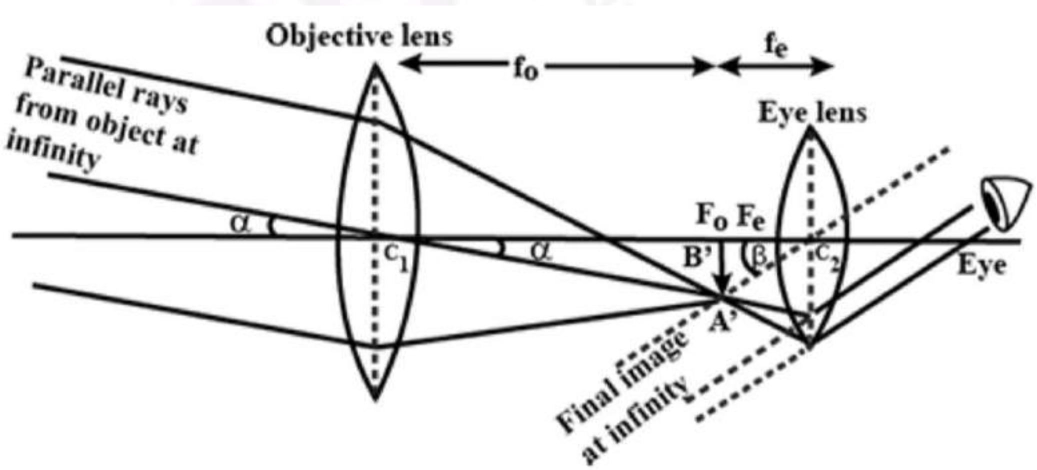
Also, by mutual induction, pot diff developed in secondary (turns N_S)

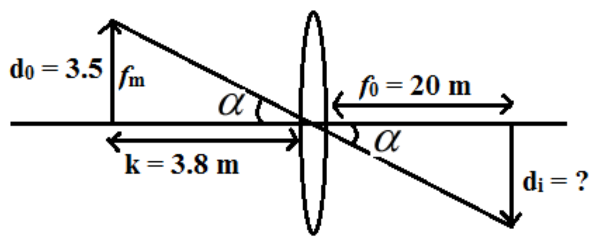
$$e_S = -N_S \frac{d\phi}{dt} = v_0 = \text{output AC voltage}$$

Here $\frac{d\phi}{dt} =$ time rate of charge of magnetic flux of each turn

$$\therefore \frac{e_S}{e_S} = \frac{N_S}{N_P} = \frac{v_0}{v_i}$$

(i) Core is laminated to block or minimize the paths of eddy currents to minimize heat loss against resistance of core.

	(ii) Thick copper wire is used in order to reduce the resistance of transformer coil to minimize heat loss. (b) (i) $F = ilB = \left(\frac{Blv}{R}\right)lB = \frac{B^2l^2v}{R}$ $= \frac{(0.4)^2 \times (20\times10^{-2})^2 \times (10\times10^{-2})}{0.1}$ $= 640\times10^{-4+2+1} = 6.4\times10^{-3}\,N$ (ii) Power = $P = Fv = \frac{B^2l^2v^2}{R}$ $= 6.4\times10^{-3}\times10\times10^{-2}$ $= 6.4\times10^{-4}$ watt	
36.	(a)  Resolving power $= \frac{D}{1.22\lambda}$ (b) (i) $m = -\frac{f_0}{f_e} = -\frac{20}{10-2} = -2000$	

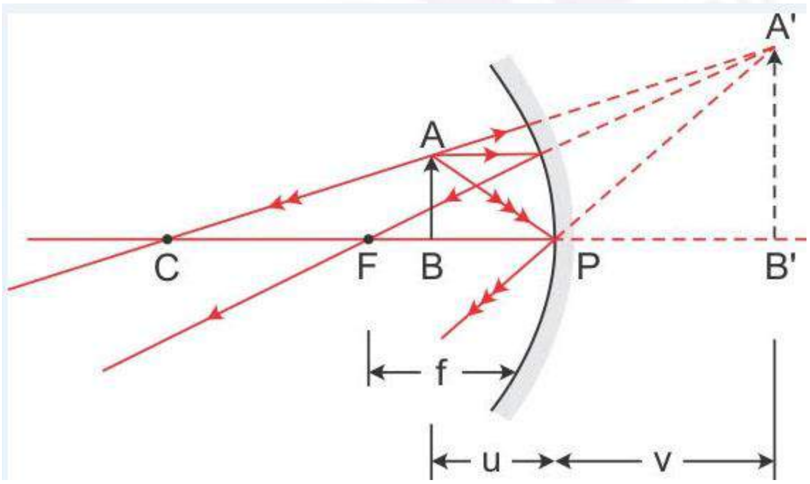


$$\tan\alpha = \frac{d_0}{u} = \frac{di}{f_0}$$

$$\Rightarrow d_i = \frac{3.5\times10^6}{3.8\times10^8}\times20 = 0.18\,m$$

(OR)

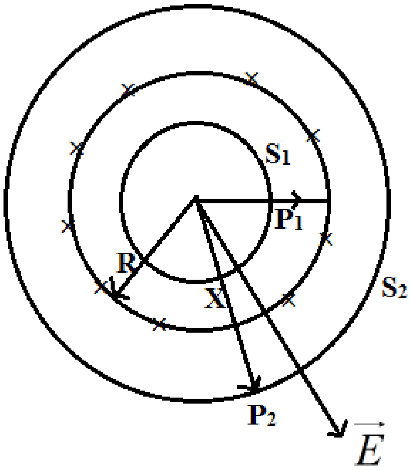
(a)



$$\Delta ABC \sim \Delta A_1B_1C \Rightarrow \frac{A_1B_1}{AB} = \frac{A_1C}{AC} = \frac{(+v)+(-R)}{(-R)-(-u)} \quad \ldots (1)$$

$$\Delta ABP \sim \Delta A_1B_1P \Rightarrow \frac{A_1B_1}{AB} = \frac{A_1P}{AP} = \frac{+v}{-u} \quad \ldots (2)$$

	(1) = (2) $\Rightarrow \frac{v-R}{-R+u} = \frac{v}{-u}$ $\Rightarrow \quad -uv+uR = -vR+uv$ $\Rightarrow \quad uR+vR = 2uv$ ÷ by $uvR \Rightarrow \frac{1}{v}+\frac{1}{u} = \frac{2}{R}$ $\because \quad R = 2f \ \therefore \frac{1}{v}+\frac{1}{u} = \frac{1}{f}$ (b) $\frac{1}{f} = (1.5-1)\left(\frac{1}{20}-\frac{1}{\infty}\right) = \frac{0.5}{20} = \frac{5}{200} = \frac{1}{40}$ $\therefore \ f = 40$ cm Now $\frac{1}{f} = \frac{1}{v}-\frac{1}{u} \Rightarrow v = \frac{fu}{f+u} = \frac{40\times -30}{40-30}$ $\Rightarrow v = \frac{-40\times 30}{10} = -120\,cm$ Image is virtual, erect and enlarged in front of lens 120 cm away.	
37.	(a)	



S_1 & S_2 are two Gaussian spheres respectively for points

$$P_1(x<R) \qquad \& \qquad P_2(x>R)$$

(i) By Gauss law,

Net outward flux through S_1

$$\phi = \oiint_{S_1} \vec{E}.\vec{dA} = \frac{q_1}{\varepsilon_0} \to \text{charge enclosed by } S_1 = -0$$

$$\Rightarrow E = 0$$

(ii) Net outward flux through S_2

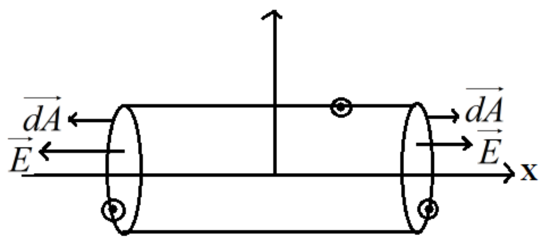
$$\phi = \oiint_{S_2} \vec{E}.\vec{dA} = \frac{q_2}{\varepsilon_0} \to \text{charge enclosed by } S_1 = \sigma\left(4\pi R^2\right)$$

$$\Rightarrow E \oiint_{S_2} dA = \frac{\sigma\left(4\pi R^2\right)}{\varepsilon_0}$$

$$\because \qquad \oiint_{S_2} dA = 4\pi x^2 \Rightarrow E = \frac{\sigma\left(4\pi R^2\right)}{\left(4\pi r^2\right)\varepsilon_0}$$

$$\Rightarrow E = \frac{\sigma R^2}{\varepsilon_0 x^2}$$

(b)



(i) $d = d_1 + d_2 + d_3$

$$= E\left(\pi r^2\right) + E\left(\pi r^2\right) + 0$$

$$= 2E\pi r^2$$

$$= 2 \times 200 \times 3.14 \times \left(5 \times 10^{-2}\right)^2$$

$$= 31400 \times 10^{-4} = 3.14\ N - \frac{m^2}{C}$$

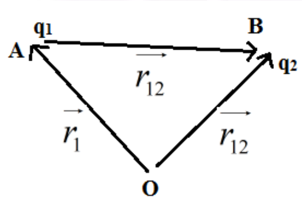
(ii) Net charge $q = d\varepsilon_0$

$$q = 3.14 \times 8.854 \times 10^{-12}$$

$$= 27.8 \times 10^{-12} C$$

(OR)

(a)



$$r_{12} = |\dot{r}_{12}| = |\dot{r}_2 - \dot{r}_1|$$

Work done to bring q_1 from ∞ in electric field

$$\vec{E}_1 \Rightarrow W_1 = q_1 V\left(\vec{r}_1\right)$$

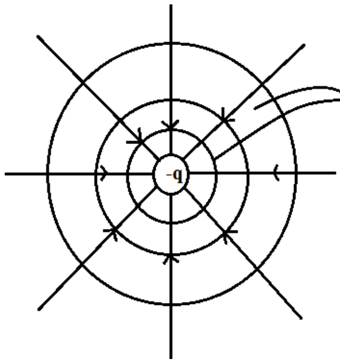
Work done to bring q_2 in field $\overrightarrow{E_K}$ & of field of q_2

$$W_2 = q_2 V\left(\vec{r}_2\right) + \frac{kq_1 i_2}{r_{12}}$$

$\therefore$ Potential energy of system

$$U = W_1 + W_2 = q_1 V\left(\vec{r_1}\right) + q_2 V\left(\vec{r_2}\right) + \frac{kq_1q_2}{|\vec{r_2} - \vec{r_1}|}$$

(b)



(c) W = Energy of system

$$= U_{12} + U_{13} + U_{23}$$

$$= \frac{k}{r}\left(q_1q_2 + q_2q_3 + q_1q_3\right)$$

$$= \frac{9\times10^9}{10\times10^{-2}}\left(\left(+1\right)\times\left(-1\right) + \left(+1\right)\left(+2\right) + \left(-1\right)\left(+2\right)\right)\times10^{-12}$$

$$= 9\times10^{-2}\left(-1+2-2\right) = -0.09J$$