Practice Paper -2 (SOLUTION)

CLASS: XII

Session: 2022-23

Subject : Physics

SECTION – A

1. (d) Both the electric potential and electric field achieve a maximum magnitude at B. **[1]**

2. (d) 42 rad/s and 58 rad/s **[1]**

3. (b) $i = neAv_d$ **[1]**

as per question $i = ne\pi r^2 v$ …(1)

then for $2i = ne\pi(2r)^2 v_2$ …(2)

Divide equation (2) by eq.(1)

$$\frac{2i}{i} = \frac{ne\pi 4r^2 v_2}{ne\pi r^2 v} \Rightarrow v_2 = \frac{v}{2}$$

4. (c) Wavelength is halved and the frequency remains unchanged **[1]**

5. (c) 30º **[1]**

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

7. (a) only on impact parameter **[1]**

8. (a) There the mobile charges exist **[1]**

9. (b) 9/5 **[1]**

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

In circuit, A is at −10V and B is at 0V. So, B is positive than A. So, D_2 is in forward bias and D_1 is in reverse bias so no current flows from A to B or B to A

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

$$\frac{1}{2}mv^2 = qV$$

$$v = \sqrt{\frac{2qV}{m}} \quad \ldots(1)$$

$$r = \frac{mv}{qB} = \frac{m}{qB}\sqrt{\frac{2qV}{m}}$$

$$r^2 = \frac{m^2}{q^2B^2} \times \frac{2qV}{m}$$

$$r^2 = \frac{2mV}{qB^2}$$

$V \propto r^2$

since r is doubled, V becomes 4 times.

12. (d) kinetic energy is high enough to overcome repulsion between nuclei **[1]**

13. (c) In (i) V remain same but Q changes **[1]**

14. (c) Move towards the wire or towards Left. **[1]**

15. (b) The angle between the area vector and the field lines is 90°. Thus, $\phi_E = EA\cos\theta = 0$ **[1]**

16. (b) Both A and R are true and R is NOT correct explanation of A. **[1]**

17. (a) Both A and R are true and R is correct explanation of A. **[1]**

18. (a) Both A and R are true and R is NOT correct explanation of A. **[1]**

SECTION – B

19. Here $I_1 = 2A$, $I_2 = 1A$, $d_1 = 10$ cm, $d_2 = 30$ cm, $\mu_o = 4\pi \times 10^{-7}$ TmA^{-1}

we have

$$F = \frac{\mu_0 I_1 I_2 \ell}{2\pi d}$$ **[½]**

Net force on ab and cd $= \dfrac{\mu_0 \times 2 \times 1 \times 20 \times 10^{-2}}{2\pi}\left[\dfrac{1}{10\times10^{-2}} - \dfrac{1}{30\times10^{-2}}\right] = 5.33\times10^{-7}\,N$ **[1]**

This net force is directed towards the infinitely long straight wire. **[½]**

20. When a dc source is connected to a capacitor, the capacitor gets charged and after charging no current flows in the circuit and the lamp will not glow.

There will be no change even if C is reduced. **[1]**

With ac source, the capacitor offers capacitative reactance ($1/\omega C$) and the current flows in the circuit. Consequently, the lamp will shine. Reducing C will increase reactance and the lamp will shine less brightly than before. **[1]**

21. $I_d = \varepsilon_0 \dfrac{d\phi_E}{dt}$ **[1]**

Charging current = displacement current = 0.25 mA **[1]**

22. The locus of all point which has same phase of vibration is called a wave front. **[1]**

Plane wave front. **[1]**

OR

$I = 4 I_0 \cos^2 (\phi/2)$

(i) Path difference $\lambda/4 \Rightarrow$ phase difference $\pi/2$

$I_1 = 4I_0 \times \cos^2\left(\dfrac{\pi}{4}\right) = 2I_0$ **[1]**

(ii) Path difference $\dfrac{\pi}{3} \Rightarrow$ phase difference $\dfrac{2\pi}{3}$

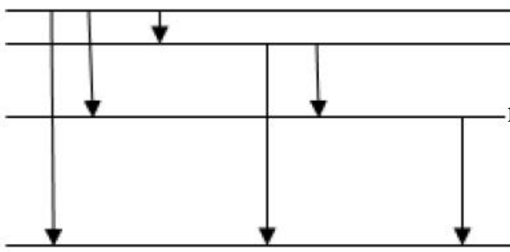
$I_2 = 4I_0 \times \cos^2\left(\dfrac{2\pi}{3\times2}\right) = I_0$ **[1]**

23. (i) There in minimum frequency required for the incident light to produce photoelectric effect. **[1]**

(ii) Stopping potential does not change with intensity of light. **[1]**

24. Number of spectral lines = 6 **[1]**

Energy level diagram



[1]

25. It is the distance of charged particle from the centre of the nucleus, at which the whole of the initial kinetic energy of the (far off) charged particle gets converted into the electric potential energy of the system. **[1]**

Distance of closest approach (r) is given by, $r = \frac{1 \times 2ze^2}{4\pi\varepsilon_0 \, K}$

Therefore when K is doubled r becomes r/2 **[1]**

OR

1. According to Rutherford model, electron orbiting around the nucleus, continuously radiates energy due to the acceleration hence the atom will not remain stable. **[1]**

2. As electron spirals inwards its angular velocity and frequency change continuously; therefore it will emit a continuous spectrum. **[1]**

SECTION – C

26. **(a)** Let $C_X = C$, $C_Y = 4C$

For series combination $C = \frac{C_X C_Y}{(C_X + C_Y)} \Rightarrow \frac{4C}{5}$

$C_X = C = 5\ \mu F$, $C_Y = 20\ \mu F$ **[1]**

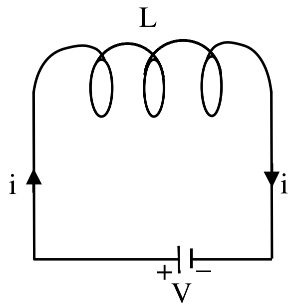
(b) Total charge $Q = CV = 4\ \mu F \times 15V = 60\ \mu C$

$V_X = \frac{Q}{C_X} = \frac{60}{5} = 12\ V$

$V_Y = \frac{Q}{C_Y} = \frac{60}{20} = 3\ V$ **[1]**

(c) $\frac{E_X}{E_Y} = \frac{Q_X^2}{2C_X} \times \frac{2C_Y}{Q_Y^2} = \frac{20}{5} = 4:1$ **[1]**

27. **Energy stored in an inductor:** Work has to be done by battery against the opposing induced emf in establishing a current in an inductor. The energy supplied by the battery is stored in the inductor.



Let current flowing through the circuit at any instant (t) be i.

Rate of change of current at that time = $\frac{di}{dt}$

magnitude of induced emf in the inductor,

$$e = L\frac{di}{dt}$$

Work done by the battery in time dt,

$$dW = Vdq = edq$$

$$dW = eidt$$

$$\Rightarrow \quad dW = \left(L\frac{di}{dt}\right)idt$$

$$dW = Lidi$$

Total work done by the battery in increasing current from 0 to I

$$W = L\int i\,di \Rightarrow \boxed{W = \frac{1}{2}LI^2}$$

This work done is stored in an inductor in the form of magnetic energy.

$$\boxed{U_B = \frac{1}{2}LI^2}$$ **[1]**

Energy density (u_B) $\rightarrow$ Energy stored per unit volume in the magnetic field of an inductor is know as energy density.

$$u_B = \frac{\text{Energy stored in an inductor}}{\text{Volume}}$$

$$u_B = \frac{\frac{1}{2}LI^2}{A\times\ell} \Rightarrow = \frac{\frac{1}{2}\times\left(\frac{\mu_0N^2A}{\ell}\right)\times\left(\frac{B\ell}{\mu_0N}\right)^2}{A\times\ell} \qquad \left\{\begin{array}{l}\because\ B = \frac{\mu_0NI}{\ell}, \\ L = \frac{\mu_0N^2A}{\ell}\end{array}\right.$$

$$\boxed{u_B = \frac{B^2}{2\mu_0}}$$ **[1]**

Energy density $u = \frac{1}{2}\epsilon_0 E^2$, E is electric field between plate of capacitor. **[1]**

OR

(i) Direction of induced current is abcda (Clockwise) **[1]**

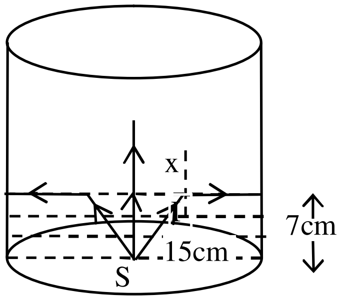
(ii) Direction of induced current is acba (Clockwise) **[1]**

(iii) Direction of induced current is abcda (Clockwise) **[1]**

28. For an incident ray, travelling from an optically denser medium to optically rarer medium, the angle of incidence, for which the angle of refraction is 90°, is called the critical angle.

$\mu = \frac{1}{\sin i_c}$

$i_c = \sin^{-1}\left(\frac{1}{\mu}\right)$



$\mu = \frac{1}{\sin i_c}$

$\sin i_c = \frac{3}{4}$

$\cos i_c = \frac{\sqrt{7}}{4}$

$\tan i_c = \frac{3}{\sqrt{7}}$

from figure,

$\tan i_c = \frac{x}{7} \Rightarrow \frac{3}{\sqrt{7}} \Rightarrow \frac{x}{7} \Rightarrow x = 3\sqrt{7}\text{cm}$

Area = $\pi x^2 = 63\pi$ cm^2 **[2]**

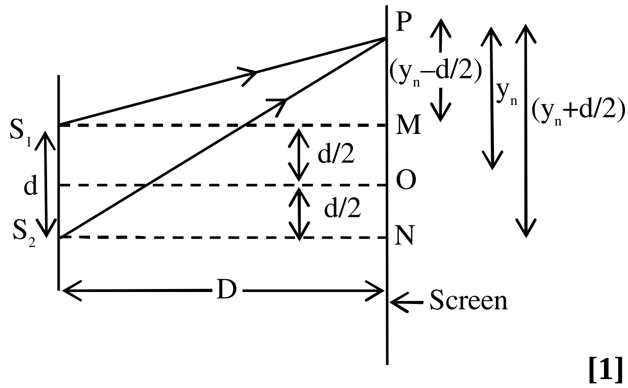
[1]

29. Young's double slit experiment

Path difference bet^n waves from S_1 & S_2 reaching at point P on the screen $\Delta = S_2P - S_1P$

From ΔS_2PN

$S_2P^2 = D^2 + \left(y_n + \frac{d}{2}\right)^2$ ...(1)



Similarly from ΔS_1PM

$S_1P^2 = D^2 + \left(y_n - \frac{d}{2}\right)^2$ ...(2)

Subtract eq. (2) from (1) - **[1]**

$S_2P^2 - S_1P^2 = \left(y_n + \frac{d}{2}\right)^2 - \left(y_n - \frac{d}{2}\right)^2$

$(S_2P + S_1P)(S_2P - S_1P) = y_n^2 + \frac{d^2}{4} + y_nd - y_n^2 - \frac{d^2}{4} + y_nd$

$(S_2P + S_1P)(S_2P - S_1P) = 2y_nd$

If point 'P' is very close to 'O', then $S_1P \approx S_2P \approx D$

$2D(S_2P - S_1P) = 2y_nd$

Path difference $\boxed{S_2P - S_1P = \frac{y_nd}{D}}$ ...(3) **[1**]

Position of bright fringes :

If n^{th} bright fringe is formed at point P, then

$S_2P - S_1P = n\lambda$

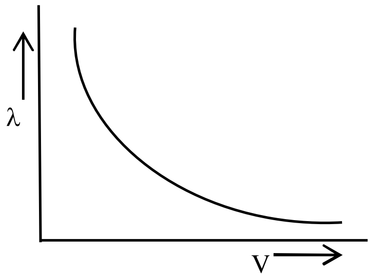
$$\frac{y_n d}{D} = n\lambda \Rightarrow \boxed{y_n = \frac{n\lambda D}{d}}$$

Where, $y_n \Rightarrow$ distance of n^{th} bright fringe from point 'O' on screen.

Bright fringe width (β) - Distance between two consecutive bright fringes is called bright fringe width.

$$\beta = y_{n+1} - y_n \Rightarrow \beta = \frac{(n+1)\lambda D}{d} - \frac{n\lambda D}{d} \Rightarrow \boxed{\beta = \frac{\lambda D}{d}}$$ **[1]**

In interference pattern fringe width of bright & dark are same. So dark fringe width will be 2 mm. In interference pattern, central fringe on screen will be bright, because path difference between waves from S_1 & S_2 at point O is zero and due to constructive interference, point O will be bright.

30.  **[1]**

$$\lambda = \frac{h}{\sqrt{2mqv}} = \frac{h}{\sqrt{2mK}}, \text{ now } m_d > m_p$$ **[1]**

For the same λ we must have Kp > Kd

i.e Proton has more kinetic energy. **[1]**

OR

(a) For the cutoff or threshold frequency, the energy $h\nu_0$ of the incident radiation must be equal to work function ϕ_0 so that

$$\nu_0 = \frac{w_0}{h} = 5.16 \times 10^{14}\,\text{Hz}$$ **[1]**

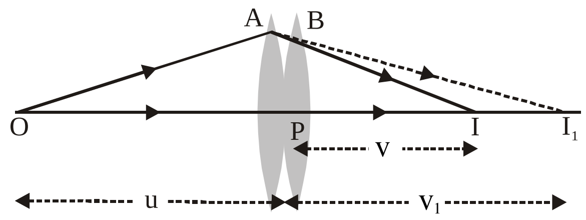
(b) Photocurrent reduces to zero, when maximum kinetic energy of the emitted photoelectrons equals the potential energy eV_0 by the retarding potential V_0. Einstein's Photoelectric equation is

$$eV_0 = h\nu - \phi_0 = \frac{hc}{\lambda} - \phi_0$$

$$\lambda = \frac{hc}{eV_0 + \phi_0} = 454 \text{ nm}$$ **[2]**

SECTION – D

31. (a) 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

$$\frac{1}{v_1}-\frac{1}{u}=\frac{1}{f_1} \quad ...(i)$$ **[1]**

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

$$\frac{1}{v}-\frac{1}{v_1}=\frac{1}{f_2} \quad ...(ii)$$ **[1]**

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

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

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

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

From eq. (iii) and (iv), we obtain

$$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2} \quad ...(v)$$ **[1]**

(b) Here, P = +10D, ${}^a\mu_g = 1.5$,

$$f_a = \frac{100}{P}=\frac{100}{10}=10\text{cm}$$

$$\frac{1}{f_a}=\left({}^a\mu_g-1\right)\left(\frac{1}{R_1}-\frac{1}{R_1}\right)$$

$$\frac{1}{10}=(1.5-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right) \text{or} \frac{1}{R_1}-\frac{1}{R_2}=\frac{1}{5}$$ **[1]**

When this lens is immersed in liquid, $f_1 = -50$cm

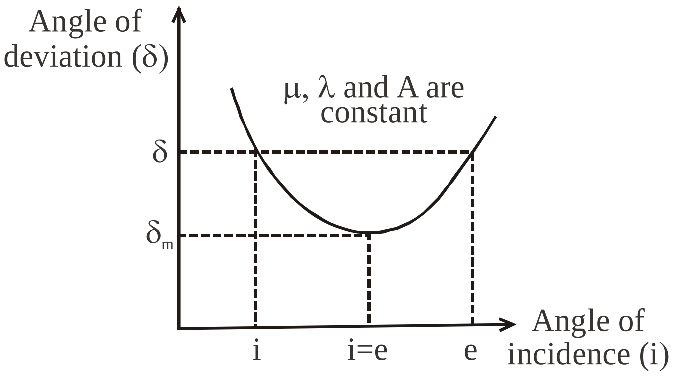
$$\frac{1}{f_1} = \left(\frac{\mu_g}{\mu_l} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{-50} = \left(\frac{1.5}{\mu_l} - 1\right) \times \frac{1}{5} \text{ or } \frac{1.5}{\mu_l} - 1 = -0.1$$

$$\text{or } \frac{1.5}{\mu_l} = 1 - 0.1 = 0.9, \mu_l = \frac{1.5}{0.9} = 1.67$$ **[1]**

OR

(a) Graph between the angle of deviation (δ) and angle of incidence (i) –



[½]

Angle of minimum deviation depends on colour of light, material of prism and prism angle.

Prism formula :

In quadrilateral ▱AQNR

$$A + \angle AQN + \angle QNR + \angle NRA = 360°$$

$$A + \angle QNR = 180° \qquad \ldots(1) \qquad \{\angle AQN = \angle NRA = 90°$$

In ΔQNR,

$$r_1 + r_2 + \angle QNR = 180°$$

…(2)

From eq. (1) and (2)

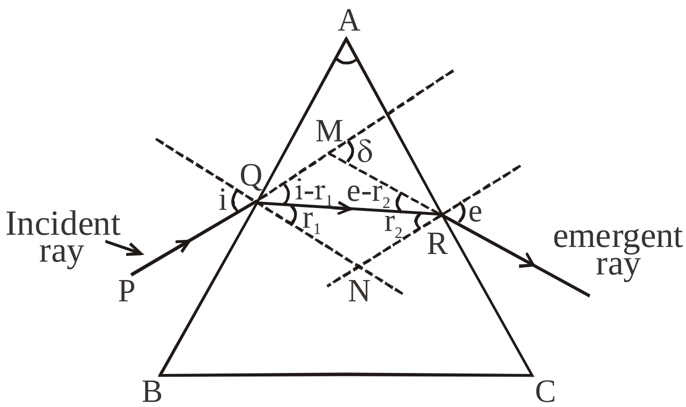
$$\boxed{A = r_1 + r_2} \qquad \ldots(3)$$

Angle of deviation (δ)

$$\delta = (i - r_1) + (e - r_2)$$

$$\delta = (i + e) - (r_1 + r_2)$$

$$\boxed{\delta = (i + e) - A} \qquad \ldots(4)$$



At minimum deviation, the refracted ray inside the prism becomes parallel to its's base. Hence in case of minimum deviation -

$i = e$, $r_1 = r_2 = r$ and $\delta = \delta_m$

From eq. (3)

$A = r_1 + r_2 \Rightarrow A = 2r$

$\Rightarrow \quad \boxed{r = A/2} \quad \ldots(5)$

From eq. (4)

$\delta_m = 2i - A \Rightarrow \boxed{i = \dfrac{\delta_m + A}{2}} \quad \ldots(6)$

From snell's law -

$_a\mu_g = \dfrac{\sin i}{\sin r_1} \Rightarrow \mu = \dfrac{\sin i}{\sin r} \begin{cases} \text{At minimum deviation} \\ r_1 = r_2 = r \end{cases}$

$\boxed{\mu = \dfrac{\sin\left(\dfrac{\delta_m + A}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}}$ This is the prism formula. **[2½]**

(b) For total internal reflection i = c

$45^o \geq c$

$\text{Sin}(45) \geq \sin c$

$\dfrac{1}{\sqrt{2}} \geq \dfrac{1}{n}$

i.e. $n \geq \sqrt{2}$

Hence minimum value of refractive index must be $\sqrt{2}$. **[2]**

32. (a) Average velocity acquired by the electrons in the conductor in the presence of external electric field. **[1]**

(b) We know that $v_d = \dfrac{-eE\tau}{m}$

Where $E = \dfrac{V}{\ell}$

$v_d = \dfrac{-eV\tau}{m\ell}$

Current $I = nAe\, v_d = \dfrac{nAe^2V\tau}{m\ell}$

$\dfrac{I}{V} = \dfrac{nAe^2\tau}{m\ell} \Rightarrow \dfrac{1}{R} = \dfrac{nAe^2\tau}{m\ell} \Rightarrow R = \dfrac{m\ell}{nAe^2\tau} \Rightarrow \dfrac{\rho\ell}{A} = \dfrac{m\ell}{ne^2\tau A} \Rightarrow \rho = \dfrac{m}{ne^2\tau}$ **[3]**

Resistivity of the material of a conductor depends on the relaxation time, i.e., temperature and the number density of electrons.

(c) Because constantan and manganin show very weak dependence of resistivity on temperature **[1]**

OR

(a) KVL → The algebraic sum of voltages across closed loop is always equal to zero.

$\Sigma IR + \Sigma E = 0$ **[2]**

(b) Apply KVL in loop ABDAB

$10 I_1 + 5 I_2 - 5(I - I_1) = 0$ …(1)

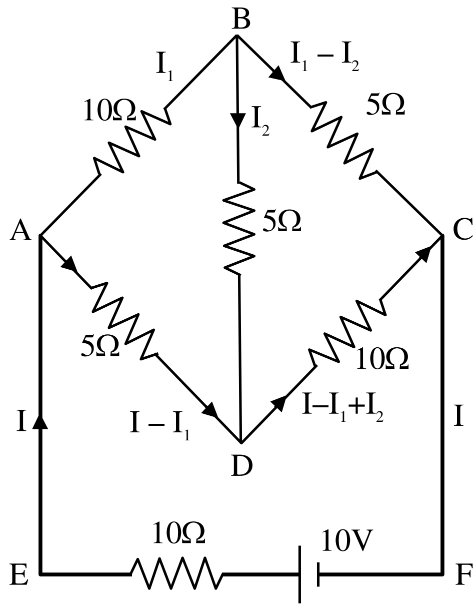
Apply KVL in loop BCDBC

$5(I_1 - I_2) - 10(I - I_1 + I_2) - 5 I_2 = 0$ …(2)

Apply KVL in loop ADCFEA

$5(I - I_1) + 10(I - I_1 + I_2) + 10 I = 10$ …(3)

by solving equation (1), (2) & (3)



Current in branch $AB = \frac{4}{17}A$

In branch $BC = \frac{6}{17}A$

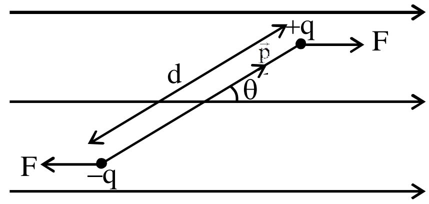
In branch $CD = \frac{-4}{17}A$

In branch $AD = \frac{6}{17}A$

In branch $BD = \left(\frac{-2}{17}\right)A$

Total current $= \frac{4}{17} + \frac{6}{17} + \frac{-4}{17} + \frac{6}{17} + \frac{-2}{17} = \frac{10}{17}A$ **[3]**

33. (a) Torque on an Electric dipole in a uniform electric field



We consider a dipole with charges +q and -q forming a dipole since they are at distance 'd' away from each other. Let it be placed in a uniform electric field of strength E such that the axis of the dipole forms an angle θ with the electric field.

The force on the charges is

$F_{+q} = +qE$ → towards the direction of electric field

$F_{-q} = -qE$ → against the direction of electric field

Since the magnitudes of forces are equal and they are separated by a distance d, then the torque on the dipole is given by :

Torque (τ) = Force × perpendicular distance between both forces

$\tau = F \cdot d \sin\theta$

Since dipole moment is given by

$p = qd$ **[2]**

So $\tau = pE.\sin\theta \Rightarrow \boxed{\vec{\tau} = \vec{p} \times \vec{E}}$

Direction of torque is perpendicular to $\vec{p}$ and $\vec{E}$.

(b) If the field is non uniform the net force on the dipole will not be zero. There will be translatory motion of the dipole. **[1]**

(c) (i) Net force will be in the direction of increasing electric field.

(ii) Net force will be in the direction opposite to the increasing field or in the direction of decreasing field **[1]**

(d) The torque on a dipole in electric field is given by:

$\tau = pE\sin\theta = q2aE\sin\theta$

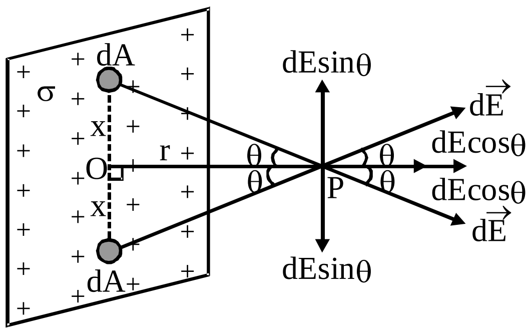
$$q = \frac{\tau}{2aE\sin\theta} = \frac{5}{\left(0.05 \times 3 \times 10^4 \times \sin 30°\right)} = 6.7 \text{ mC}$$

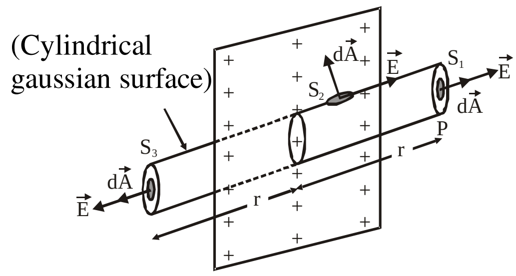
Hence, charge on the dipole is 6.7 mC. **[1]**

OR

Electric Field due to uniformly charged infinite plane sheet of charge :

Let infinite sheet of charge has surface charge density σ. The electric field at a point due to charged plane sheet is directed perpendicular to the sheet.





[1]

Assuming a cylindrical Gaussian surface of length 2r and area of cross section A to find electric field at point P.

From Gauss's law -

$$\oint E\,dA\cos\theta = \frac{\Sigma q}{\varepsilon_0}$$

$$\int_{S_1} E\,dA\cos 0° + \int_{S_2} E\,dA\cos 90° + \int_{S_3} E\,dA\cos 0° = \frac{\sigma A}{\varepsilon_0} \quad \left\{\Sigma q = \sigma A\right.$$

$$E\int_{S_1} dA + 0 + E\int_{S_3} dA = \frac{\sigma A}{\varepsilon_0}$$

$$EA + EA = \frac{\sigma A}{\varepsilon_0} \Rightarrow \boxed{E = \frac{\sigma}{2\varepsilon_0}}$$ **[2]**

If we place another similar cone on this, net flux = Q/ε_0

Flux with the upper cone = $Q/\varepsilon_0 - 3Q/5\varepsilon_0 = 2Q/5\varepsilon_0$

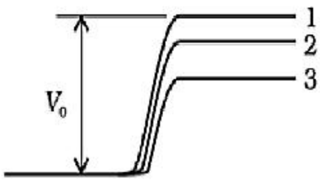
This must also be the flux associated with the lower when charge is raised through a height 2H because of symmetry. **[2]**

SECTION E

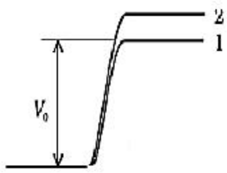
34. (i) No, Any slab, howsoever flat, will have roughness much larger than the inter-atomic crystal spacing (~2 to 3Å) and hence continuous contact at the atomic level will not be possible. **[1]**

(ii) No. P semiconductor material didn't lost or gains electrons. Hence it is neutral material. **[1]**

(iii)



Forward Bias

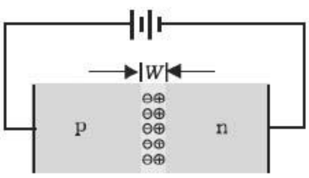


Reverse bias

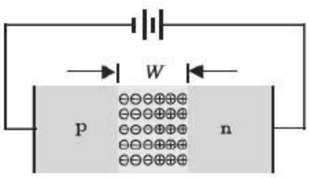
[2]

OR

(iii) **[2]**



Forward bias



Reverse bias

35. (i) Diamagnetic material **[1]**

(ii) Material A is ferromagnetic because here its slope is more. Hence material A is suitable for making permanent magnet. **[1]**

(iii) The core of electromagnet should have high permeability, low retentivity and low coercivity. Hence soft iron is used to wake core. **[2]**

OR

(iii) Keep the device in an iron cavity and move. Iron has high permeability hence it converges all the magnetic filed through it and the device will be safe. **[2]**