

XII

- 1) $E = \frac{\sigma}{\epsilon_0}$
 2) $\sqrt{2}m$
 3) (d) All the above
 4) $E = h\nu = \frac{hc}{\lambda}$
 $p = \frac{h}{\lambda} = \frac{h\nu}{c}$
 5) $\mu_r < 1$ or $\mu_r = 0$
 6) $E_0 = 15 \text{ V/m}$
 $B_0 = \frac{E_0}{c} = \frac{15}{3 \times 10^8} = 5 \times 10^{-8} \text{ T}$
 7) ~~(b)~~ diverging

8) (a) If E is not normal, there is a component along the tangent to the surface. Then free charge on the surface experience force and will move. But E should have no tangential component in static situation.
 OR
 V is constant on the surface, therefore E should be normal

9) $E = 0, V = 10 \text{ V}$

10) $G = 12 \text{ V}, I_g = 2.5 \times 10^{-3} \text{ A}$
 $I = 7.5 \text{ A}$
 Shunt, $S = \frac{I_g G}{I - I_g} = \frac{2.5 \times 10^{-3} \times 12}{(7.5 - 0.0025)}$
 $= 4 \times 10^{-3} \Omega$

- 10) (a) A
 (b) C

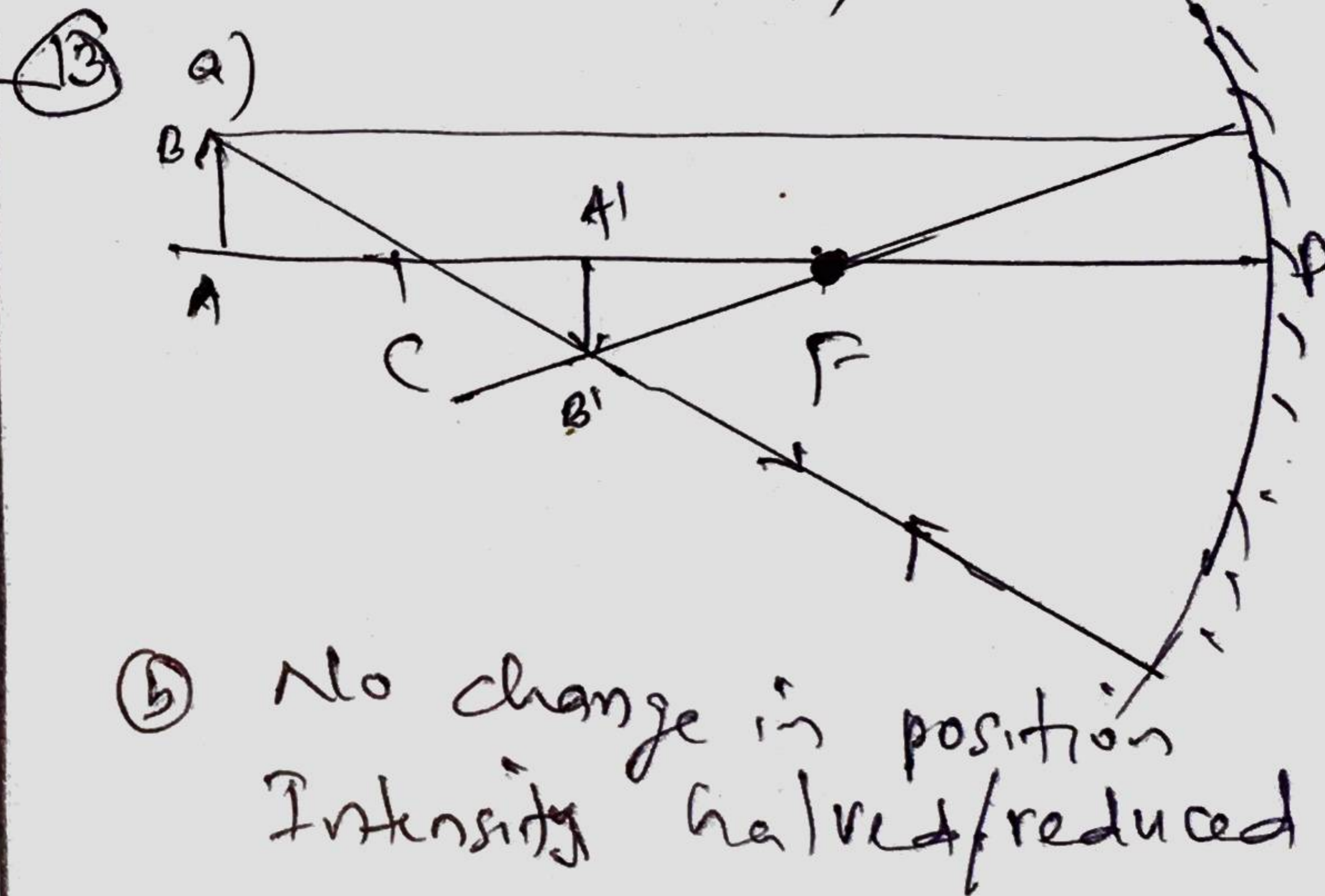
11) $V_0 = I_0 \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$

$I_0 = \frac{V_0}{\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}}$

- (a) ϵ_r introduced, $C \uparrow, \frac{1}{\omega C} \downarrow \Rightarrow I_0 \uparrow$
 \Rightarrow brightness \uparrow
 (b) $R \uparrow, I_0 \downarrow$ brightness \downarrow

12) (a) Displacement current is current due to time varying electric field

(b) $I_D = \epsilon_0 \left(\frac{d\phi_E}{dt} \right)$



- 14) D_2, RB does not conduct
 D_1, FB conduct

$R = 3 + 2.5 = 5.5$

$V = 10 \text{ V}$

$I = \frac{V}{R} = \frac{10}{5.5} = 1.82 \text{ A}$

- 15) (a) (i) Convert energy from one form to another
 (ii) Convert message signal to modulated signal for transmission
 (b) $X \rightarrow$ modulator
 $Y \rightarrow$ power amplifier

① (a) $\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$
 $= \frac{1}{2} + \frac{1}{3} + \frac{1}{4}$
 $= \frac{6+4+3}{12}$
 $= \frac{13}{12}$

$\therefore C_s = \frac{12}{13} \text{ MF} = 0.92 \text{ MF}$

② (b) $U = \frac{1}{2} CV^2$
 $C = \frac{\epsilon_0 A}{d} = \frac{8.85 \times 10^{-12} \times 20 \times 10^{-4}}{2.5 \times 10^{-3}}$
 $U = \frac{1}{2} \times \frac{8.85 \times 10^{-12} \times 20 \times 10^{-4}}{2.5 \times 10^{-3}} \times (400)^2$
 $= 56.64 \times 10^{-8} \text{ J}$

(17) $E \propto l$

Case 1 $\rightarrow E = E_1 + E_2 \propto l_1$
 Case 2 $\rightarrow E' = E_2 - E_1 \propto l_2$

① (a) $\frac{E_1 + E_2}{E_2 - E_1} = \frac{l_1}{l_2} = \frac{400}{240} = \frac{5}{3}$
 $3E_1 + 3E_2 = 5E_2 - 5E_1$
 $8E_1 = 2E_2$
 $\frac{E_1}{E_2} = \frac{2}{8} = \frac{1}{4}$

② (b) we have $\frac{E_1}{E_2} = \frac{1}{4}$
 $E_2 = 4E_1$

Case 1 $\rightarrow 5E_1 \propto l_1$
 Case 2 $\rightarrow 3E_1 \propto l_2$
 $E_1 \propto \frac{l_2}{3}$
 $\propto \frac{240}{3}$
 $\propto 80 \text{ cm}$

for E_1 only, $l = 80 \text{ cm}$

① (a) Derivation $e = Blv$
 (b) $I = \frac{e}{R} = \frac{Blv}{R}$ clockwise / Q top

② (a) $V_L = V_C / X_L = X_C / L\omega = \frac{1}{\omega}$
 (b) I_0 is maximum at resonance
 $f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi \times 14 \times \sqrt{0.1 \times 10^{-5}}}$
 $= 159.2 \text{ Hz}$

③ Derivation of Lens maker's formula
 $\frac{1}{f} = (n-1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$

④ (a) $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m_e V}}$
 (b) $\lambda = \frac{h}{\sqrt{2m_e E_K}}$
 $\lambda \propto \frac{1}{\sqrt{m}}$
 Since $m_p > m_e$ $m_e < m_p$
 $\lambda_e > \lambda_p$

⑤ (a) $BE = E_b = \Delta m c^2$
 $= (Z m_p + (A-Z) m_n - M) c^2$
 $= (20 \times 1.00783 + 20 \times 1.00867 - 39.962589) \times \frac{931 \times c^2}{c^2} \text{ MeV}$
 $= 0.367411 \times 931 \text{ MeV}$
 $= 342.06 \text{ MeV}$
 $\therefore BE / \text{nucleon}, E_{bn} = \frac{E_b}{A}$
 $= \frac{342.06 \text{ MeV}}{4}$
 $= 8.55 \text{ MeV}$

⑥ (a) $\Phi = \int_0^l E \cdot ds = \frac{1}{\epsilon_0} Q$
 (b) Derivation $E = \frac{\sigma}{2\epsilon_0}$
 $\therefore E$ independent of distance

24 a) $I = neAV_d$ — (1)

$V_d = \frac{eE}{m} \tau$

$\therefore I = \frac{ne^2 A \tau E}{m}$ — (2) $E = \frac{V}{l}$

$I = \frac{ne^2 A \tau V}{m l}$ — (3)

$V = \frac{m l}{ne^2 A \tau} I$ — (3)

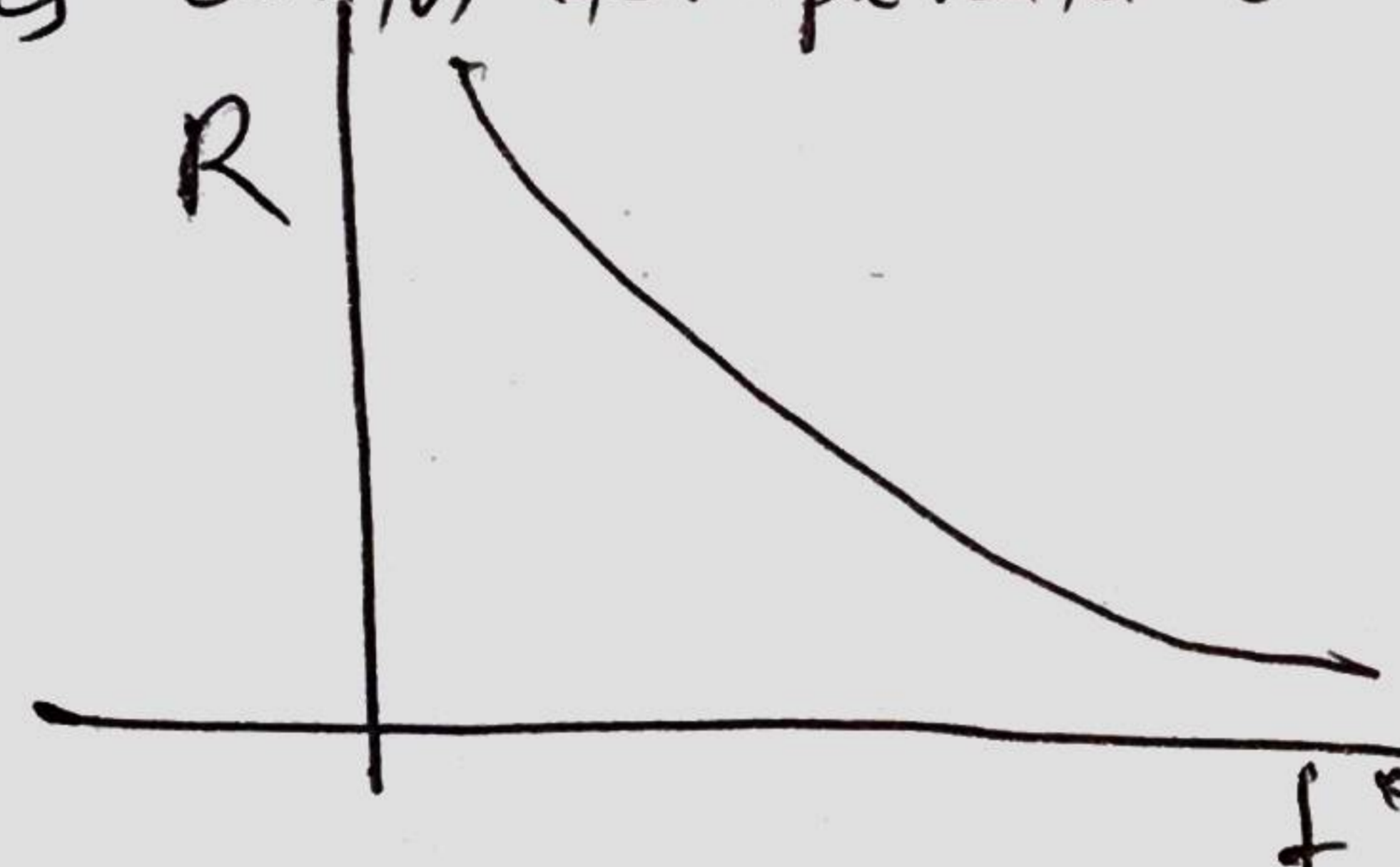
$V = \frac{m l}{ne^2 \tau} J$ — (4)

3 $\Rightarrow V = \frac{m}{ne^2 \tau} \frac{l}{A} I$

$V = \rho \frac{l}{A} I$ — (5)

24 b) $R_t = R_0 (1 + \alpha t)$

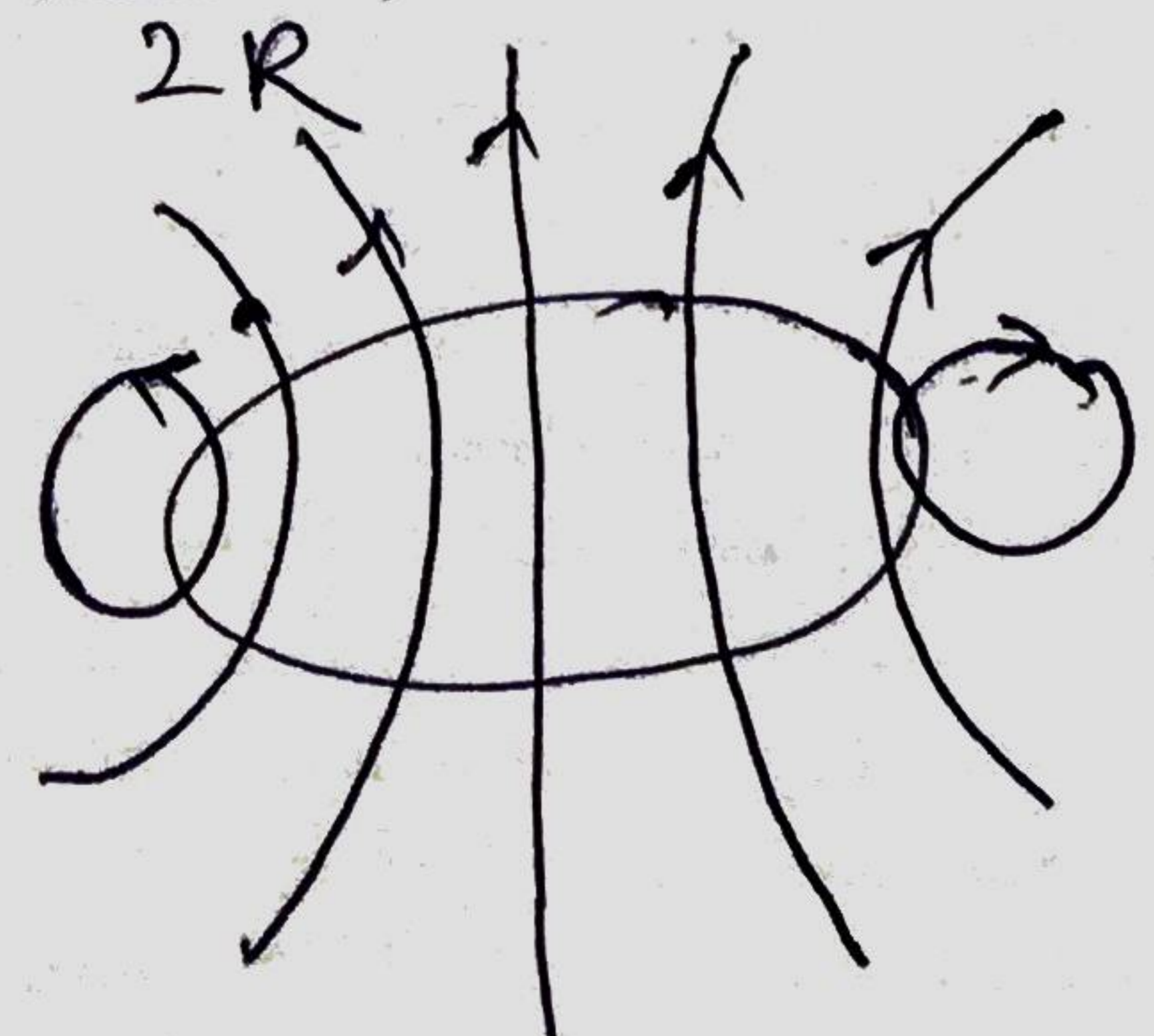
α is -ve for semiconductor
Resistance decreases with temperature.



25 a) $B = \frac{\mu_0}{4\pi} \frac{2IA}{(x^2 + R^2)^{3/2}}$

b) At centre $x=0$

$B_0 = \frac{\mu_0 I}{2R}$

c) 

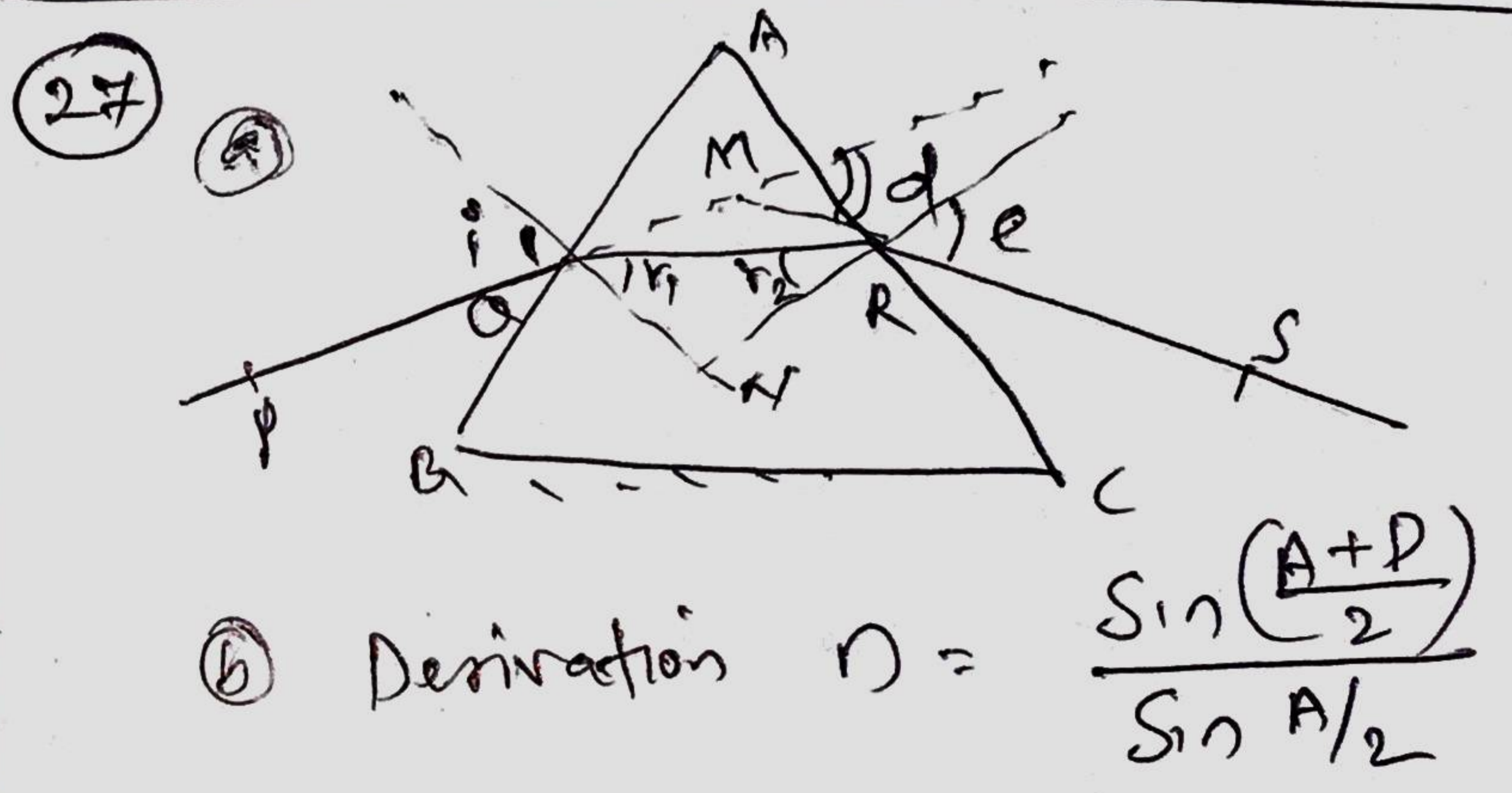
26 a) Zener diode

Any change in input voltage results in change in voltage drop across R_s without any change in voltage across Zener diode

b) When V_i increases, main current increases, I_z increases with no change in load current I_L - so that $V_o = V_z = I_L R_L$.

when V_i decreases, I_z decreases with no change in I_L .

c) Reverse biasing



28 a) cylindrical

b) diagram + derivation $\beta = \frac{\pi D}{d}$

29 a) $\gamma_n = \frac{n^2 h^2 \epsilon_0}{\pi m e^2}$

$E_n = \frac{-e^2}{8\pi \epsilon_0 \gamma_n} = \frac{-m e^4}{8 \epsilon_0^2 h^2 n^2} J$

