NAME : Himanshu Dixit

BATCH : B10

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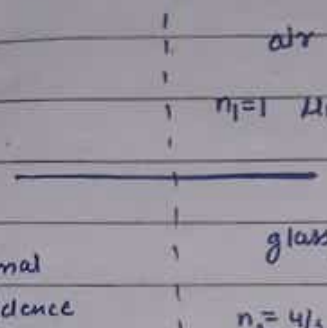
Physics - 2 (15B11PH211)

Tutorial - 5

Q.1.



$$R = \left(\frac{n_1-n_2}{n_1+n_2}\right)^2 = \left(\frac{1-4/3}{1+4/3}\right)^2 = \frac{1}{49}$$

$$T = \frac{4n_1n_2}{(n_1+n_2)^2} = \frac{4\times1\times4/3}{(1+4/3)^2} = \frac{48}{49}$$

$$R+T = \frac{48+1}{49} = 1 \checkmark$$

Q.2. 2nd medium is any dielectric medium of $\varepsilon_r = 4$

$$\frac{E_{0R}}{E_{0i}} = \frac{n_1-n_2}{n_1+n_2} \qquad \frac{E_{0T}}{E_{0i}} = \frac{2n_1}{n_1-n_2}$$

$$\therefore n_2 = \sqrt{\mu_r\varepsilon_r} = \sqrt{1\times4} = 2$$

$$\frac{E_{0R}}{E_{0i}} = \frac{1-2}{1+2} = -\frac{1}{3}, \quad \frac{E_{0T}}{E_{0i}} = \frac{2\times1}{1+2} = \frac{2}{3}$$

Q.2. (i) $\frac{c}{v} = n = \sqrt{\mu_r\varepsilon_r} = \sqrt{1\times4} = 2$

$$v = c/2 \quad -(1)$$

$$v = 1.5\times10^8 \text{ m/s}$$

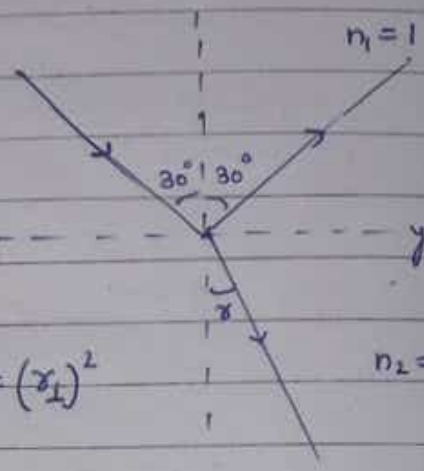
(ii) $\lambda = \frac{V}{f} = \frac{3}{2}\times 10^{8} \times \frac{1}{10} = 1.5\times 10^{7}\ m$

(iii) $\frac{E_0}{B_0} = v \rightarrow B_0 = \frac{E_0}{V} = \frac{20\times 10^{-3}\times 2}{3\times 10^{8}} = \frac{40}{3}\times 10^{-11}$ Tesla

Q.4. $\frac{\sin i}{\sin r} = \frac{n_2}{n_1} = \frac{1.5}{1}$

$\sin r = \frac{\sin 30}{1.5} = \frac{1}{3}$

$r = \sin^{-1}\left(\frac{1}{3}\right) = 19.47^\circ$



$r_\perp = \frac{n_1\cos\theta_1 - n_2\cos\theta_2}{n_1\cos\theta_1 + n_2\cos\theta_2}$, $R = (r_\perp)^2$

$T_\perp = \frac{2n_1\cos\theta_1}{n_1\cos\theta_1 + n_2\cos\theta_2}$, $T = (t_\perp)^2 \frac{n_2\cos\theta_2}{n_1\cos\theta_1} = \frac{4n_1n_2\cos\theta_1\cos\theta_2}{(n_1\cos\theta_1 + n_2\cos\theta_2)^2}$

$r_\perp = \frac{1\times\cos 30 - 1.5\cos 19.47}{1\times\cos 30 + 1.5\cos 19.47} = 0.2404$

$R = (0.2404)^2 = 0.0578$, $T = 0.9422$

$\therefore R + T = 0.0578 + 0.9422 = 1.0000$ ✓

$r_{11} = \frac{n_2\cos\theta_1 - n_1\cos\theta_2}{n_2\cos\theta_1 + n_1\cos\theta_2} = 0.158$

$t_{11} = \frac{2n_1\cos\theta_1}{n_2\cos\theta_1 + n_1\cos\theta_2} = 0.772$

$T_{11} = \left(\frac{n_2\cos\theta_2}{n_1\cos\theta_2}\right)(t_{11})^2 = 0.9732$

$R_{11} = 0.0250$

$R_{11} + T_{11} \cong 1$ ✓

Q.5. $R_{11} = 0.0252$ (Solve in previous Question)

$T_{11} = 0.9732$

$R_{11} + T_{11} \cong 1$

Q.6. $E_I = 10\ V/m$

$\varepsilon_1 = 8\varepsilon_0$, $\mu_1 = 2\mu_0$

$\varepsilon_2 = \varepsilon_0$, $\mu_2 = \mu_0$

$$\beta = \frac{\mu_1}{\mu_2} \times \frac{v_1}{v_2} = 2\sqrt{\frac{\varepsilon_2}{\varepsilon_1}} = \frac{2}{2\sqrt{2}} = \frac{1}{\sqrt{2}}$$

if $\beta = \sqrt{2}$

$E_T = 8.28\ V/m$

$E_R = -1.71\ V/m$

$$E_T = \frac{2}{\beta+1} E_I$$

$$= \frac{2}{\frac{1}{\sqrt{2}}+1} \times 10 = 11.71\ V/m$$

$$E_R = \frac{1-\beta}{1+\beta} E_I = 0.171 \times 10 = 1.71\ V/m.$$

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Q.7. $E_I = E_{I0} \exp\left(i(k_1 y - \omega t)\right) \hat{k}$

$B_I = \left(\frac{E_{I0}}{V_I}\right) \exp\left(i(k_1 y - \omega t)\right) \hat{i}$

$E_R = E_{R0} \exp\left(i(-k_1 y - \omega t)\right) \hat{k}$

$B_R = B_{R0} \exp i(-k_1 y - \omega t)(-\hat{i})$

$E_T = E_{T0} \exp i(k_2 y - \omega t) \hat{k}$

$B_T = B_{T0} \exp i(k_2 y - \omega t) \hat{i}$