Ph 25 Problem Set 3 | Solutions

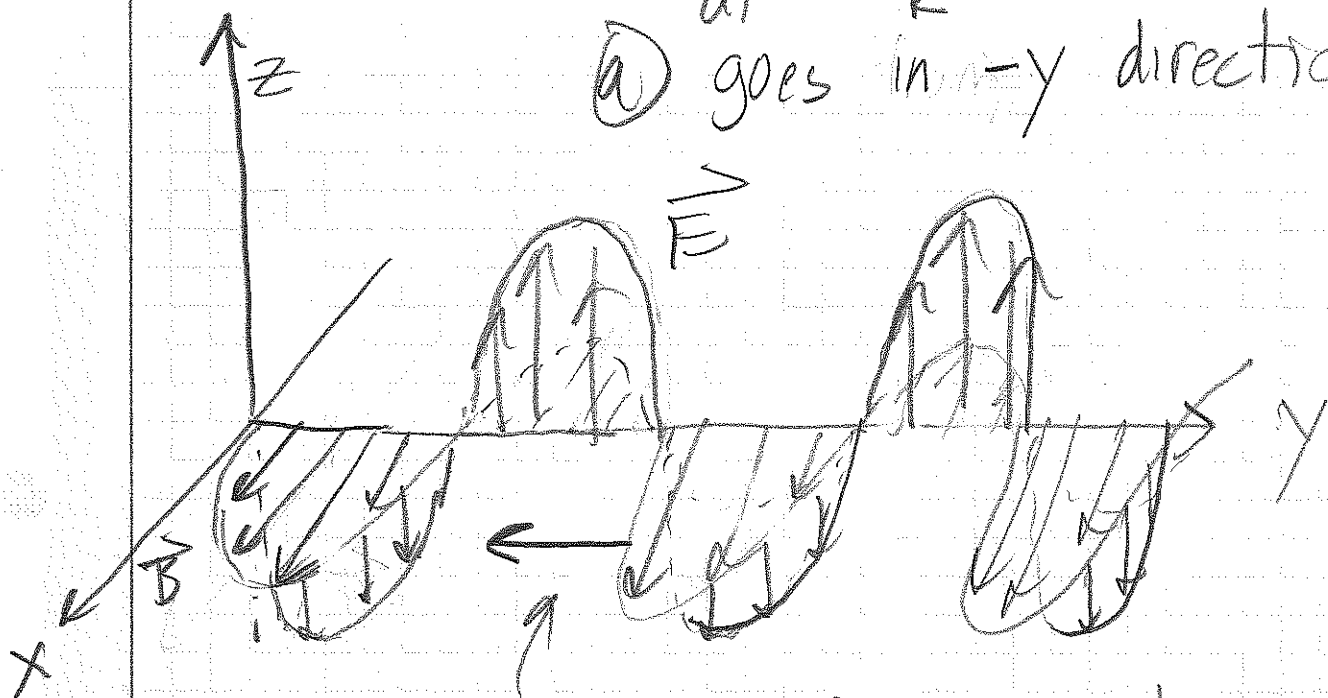
48-1 $B_x = B\sin(ky + \omega t)$ $B_y = B_z = 0$

$ky + \omega t = \text{constant}$

$y = -\frac{\omega}{k}t + \text{constant}$

$\frac{dy}{dt} = -\frac{\omega}{k} < 0$

(a) goes in −y direction



(a) direction of propagation

(b) $\vec{E} \times \vec{B}$ in direction of propagation

so, $E_z = -B\sin(ky + \omega t)$ (old units OK; MKS: cB)

$E_x = E_y = 0$

(c) Yes, in z direction

48-4 First Polarizing Sheet: $I_1 = \frac{1}{2} I_0$

Second: $I_2 = \frac{1}{3} I_0 = I_1 \cos^2\theta$

$$\frac{1}{3} \cancel{I_0} = \frac{1}{2} \cancel{I_0} \cos^2\theta$$

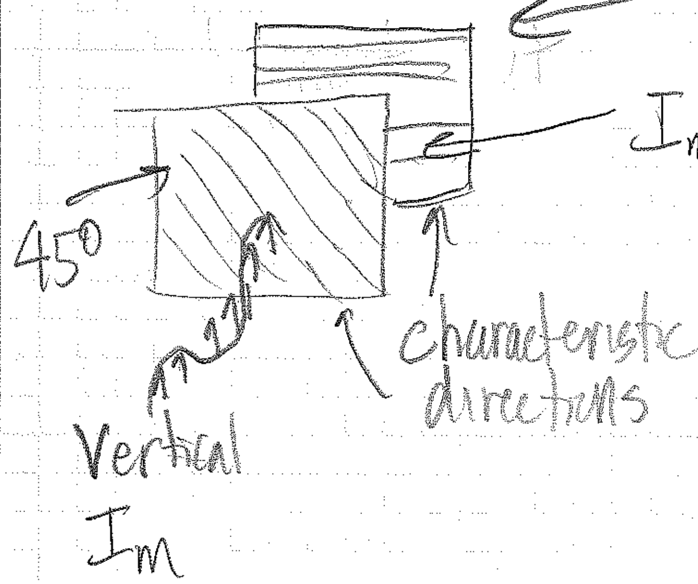
$$\cos^2\theta = \frac{2}{3}$$

$$\boxed{\cos\theta = \sqrt{\tfrac{2}{3}},\ \theta = 35.3^\circ}$$

48-12 Concept:

$\frac{1}{2} I_m \times \cos^2 45^\circ = \frac{1}{4} I_m$

$I_m \cos^2(45^\circ) = \frac{1}{2} I_m$

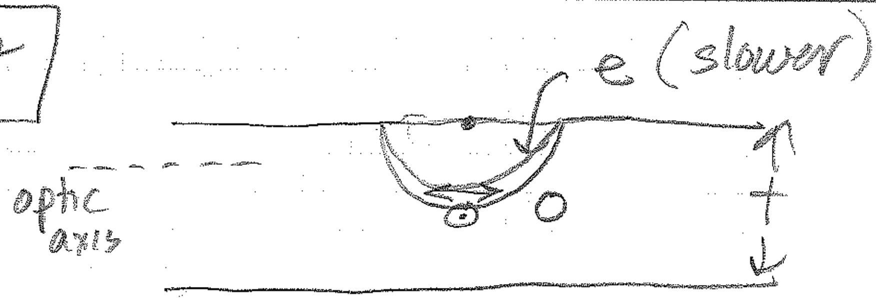


(a) put n sheets in front, rotated successively by $\frac{90^\circ}{n+1}$

Final intensity: $\cos^{2(n+1)}\left(\frac{90^\circ}{n+1}\right) > 0.95$

numerically, I get $\boxed{n_{min} = 48}$

48-17



Wurzite : $n_e = 2.378 \Leftarrow$ slower

$n_0 = 2.356 \Leftarrow$ faster

Linear → Linear : • well $t = 0$ works but is trivial

• $\frac{1}{2}$ wave Δ .... $\frac{1}{2} = \left| \frac{t}{\lambda}(n_e - n_o) \right|$ ← 0.022

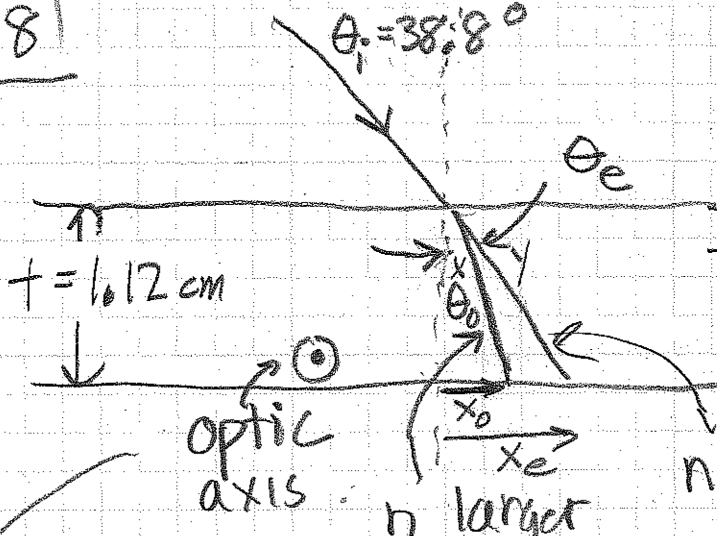
$$t = \frac{\lambda}{2} \frac{1}{|n_e - n_o|}$$

$$= \frac{525\,nm}{2} \frac{1}{0.022}$$

$$\boxed{t = 11.9\,\mu m}$$

Chapter 48
Problem 18

(a)

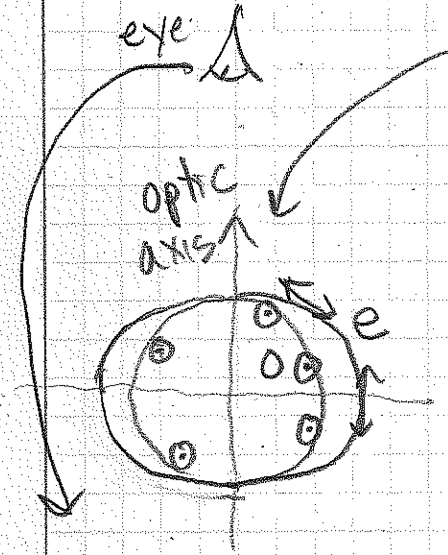


$\tan\theta_0 = \frac{x_0}{t}$

$\tan\theta_e = \frac{x_e}{t}$

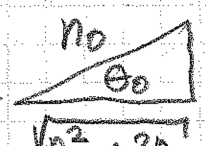
$n_e = 1.48$

$n_0 = 1.658$

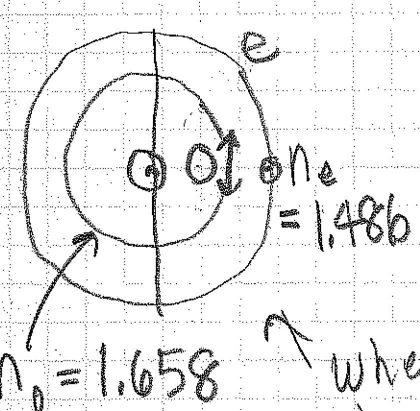


$\sin\theta_i = n_0 \sin\theta_0$ $\quad$ $\sin\theta_i = n_e \sin\theta_e$

$\sin\theta_0 = \frac{\sin\theta_i}{n_0}$ $\quad$ $\sin\theta_e = \frac{\sin\theta_i}{n_e}$



$\tan\theta_0 = \frac{\sin\theta_i}{\sqrt{n_0^2 - \sin^2\theta_i}}$ $\quad$ $\tan\theta_e = \frac{\sin\theta_i}{\sqrt{n_e^2 - \sin^2\theta_i}}$



when circular, snell respected

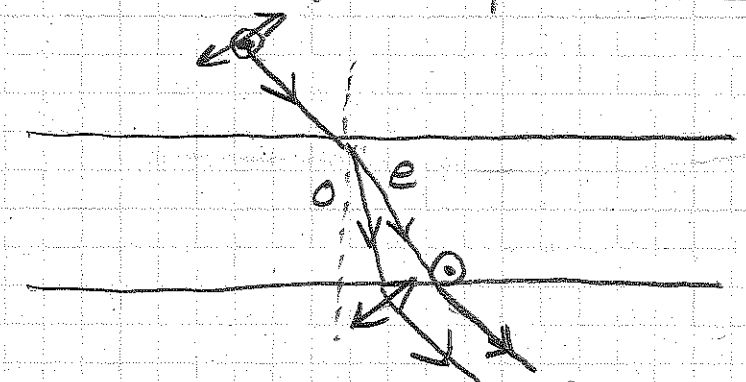
$x_0 = t\tan\theta_0 = \frac{t\sin\theta_i}{\sqrt{n_0^2 - \sin^2\theta_i}}$ $\quad$ $x_e = t\tan\theta_e = \frac{t\sin\theta_i}{\sqrt{n_e^2 - \sin^2\theta_i}}$

$x_0 = 0.457$ cm $\quad$ $x_e = 0.521$ cm

distance $= x_e - x_0 = 0.064$ cm

(b) o-ray has bigger index, bent more, so,
o-ray was X, e-ray was Y

(c)



(d) would see o polarization if polarizer in the plane of page, e if ⊥ to plane of page

48-20 Dolomite: $n_e - n_o = -0.181$

$$\frac{1}{4} = \frac{t}{\lambda} |n_e - n_o|$$

$$t = \frac{\lambda}{4} \frac{1}{|n_e - n_o|} = \frac{488\,nm}{4} \frac{1}{0.181}$$

$$= 674\ nm = 0.674\ \mu m$$

$$L = 0.250\ mm = 250\ \mu m$$

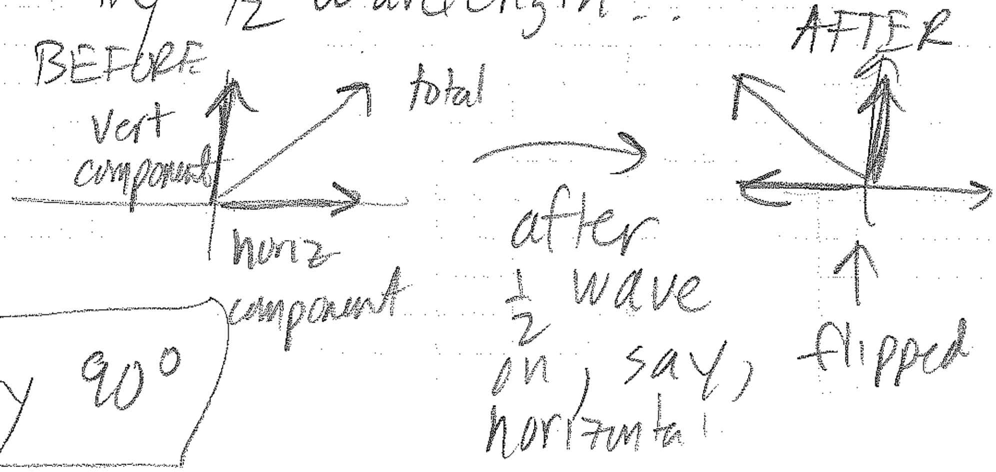
$$n = \frac{L}{t} = \frac{250}{0.674} = 370.9$$

round down

$$\boxed{n = 370}$$

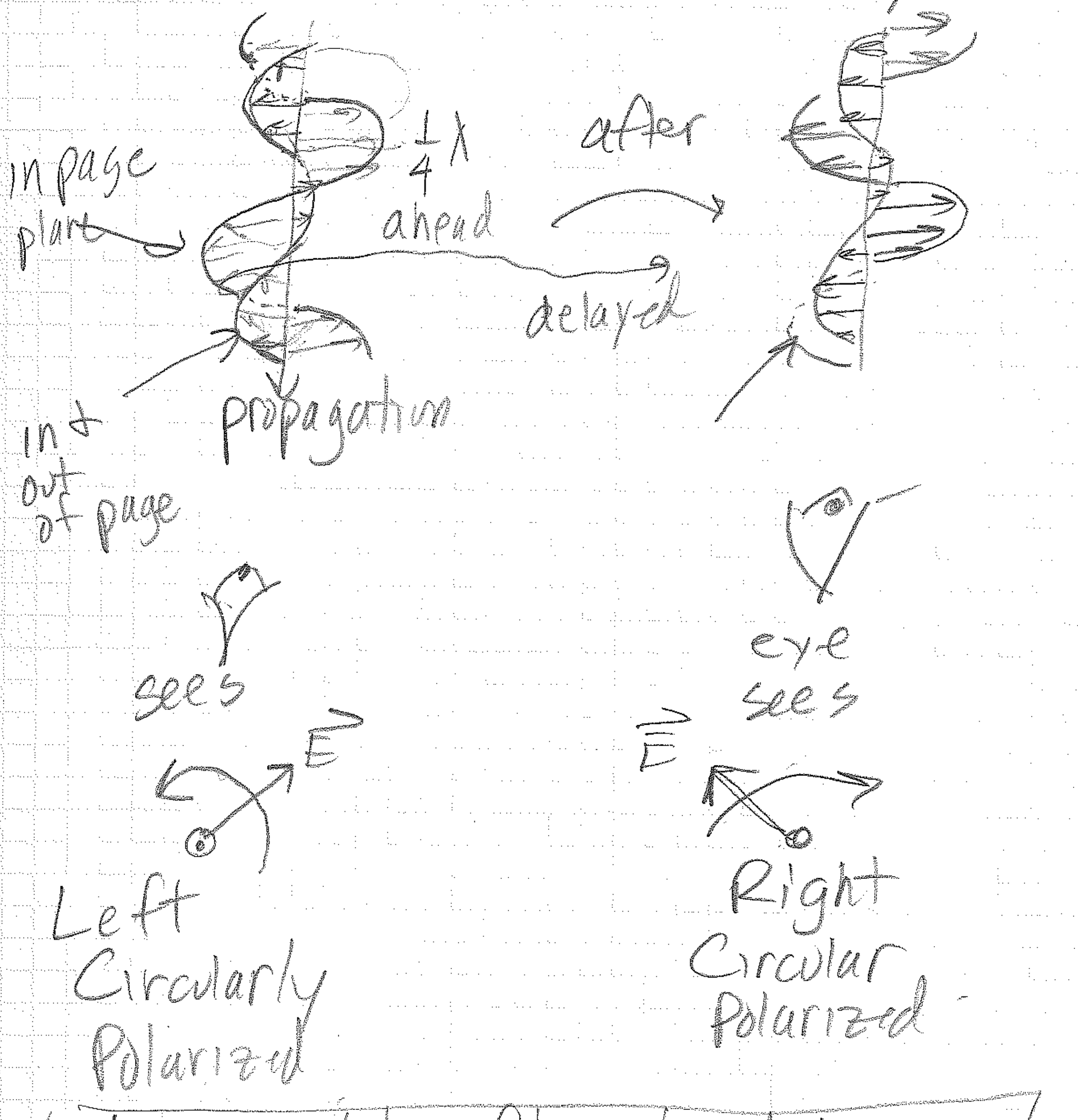
48-21 (a) Delays one component by ½ wavelength...

for example



Rotates by 90°

(b) If one component was <u>leading</u> by $\frac{1}{4}\lambda$ to make circularly polarized light of one handedness, it gets changed to <u>trailing</u> by $\frac{1}{4}\lambda$



$\frac{1}{2}$ wave plate flips handedness of circular polarization

(c) Unpolarized → remains unpolarized