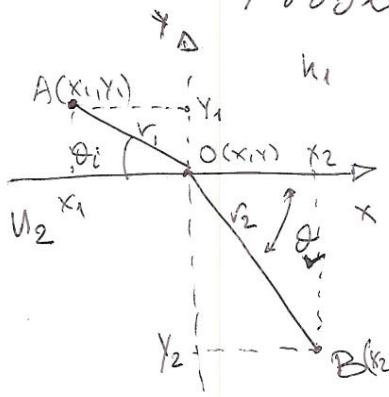
MAS.862 P.I.T.

Problem Set Chapter 9

(9.1)



Total time to go from A→B is

$$T_{AB} = t_{AO} + t_{OB} = \frac{r_1}{v_1} + \frac{r_2}{v_2}, \quad (1)$$

where v_1, v_2 the velocities in each medium.

we know $v_1 = \frac{c}{n_1}$ and $v_2 = \frac{c}{n_2}$

From the plot: $r_1 = \sqrt{(y_1-y)^2 + x_1^2}$, $r_2 = \sqrt{(y_2-y)^2 + x_2^2}$

So (1) $\Rightarrow$ $T_{AB} = \frac{n_1}{c}\sqrt{(y_1-y)^2+x_1^2} + \frac{n_2}{c}\sqrt{(y_2-y)^2+x_2^2}$

To minimize T_{AB}: $\frac{dT_{AB}}{dy} = \frac{n_1}{c}\underbrace{\frac{|y-y_1|}{r_1}}_{\sin\theta_i} - \frac{n_2}{c}\underbrace{\frac{|x_2-x|}{r_2}}_{\sin\theta_r} = 0$

$$\frac{n_1}{c}\sin\theta_i = \frac{n_2}{c}\sin\theta_r$$

or $\frac{n_1}{n_2} = \frac{\sin\theta_r}{\sin\theta_i}$ which is Snell's law

□

(9.2)

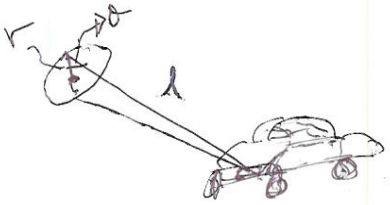
(9.5) (a) $\theta = \frac{\lambda}{\pi n w_0}$ (9.52)

$$\Rightarrow \theta = \frac{790\times10^{-9}\,m}{\pi\times 1\times10^{-6}\,m} = 0.25\,rad \simeq 14^\circ$$

(b) Similarly $\lambda = \theta\cdot\pi n w_0 = 0.25\times\pi\times 1\times 10^{-7}\,m \simeq 78\,nm$

(c) First we need to find the divergence angle.

$$\theta = \frac{\lambda}{\pi n w_0} = \frac{600\times10^{-9}\,m}{\pi\times 1\times 10^{-2}\,m} \simeq 1.9\times10^{-5}\,rad$$



we have $r = l\tan\theta \simeq 4\,m$