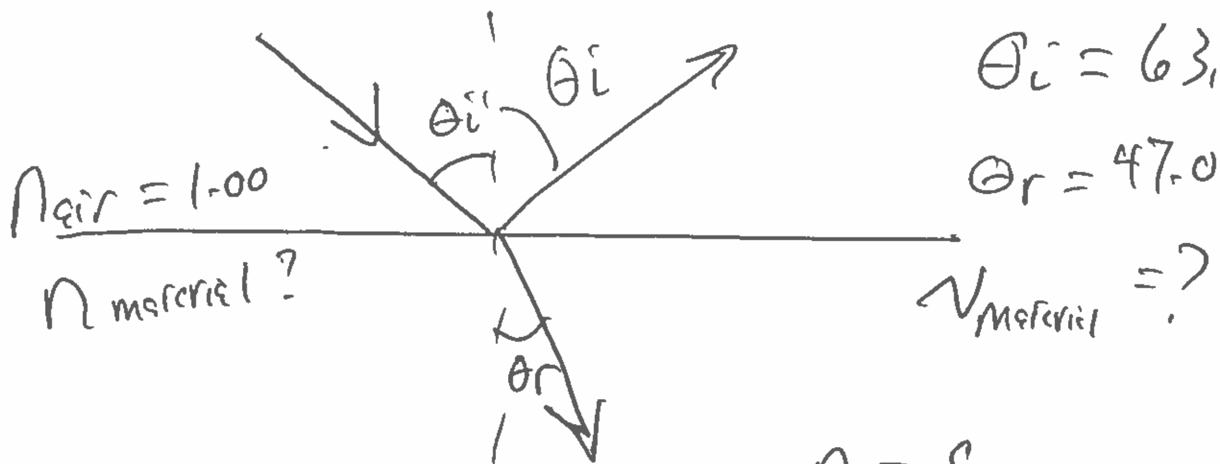
26-15



$\theta_i = 63.0^\circ$

$\theta_r = 47.0^\circ$

$$n = \frac{c}{v}$$

$$v_{material} = \frac{c}{n_{material}}$$

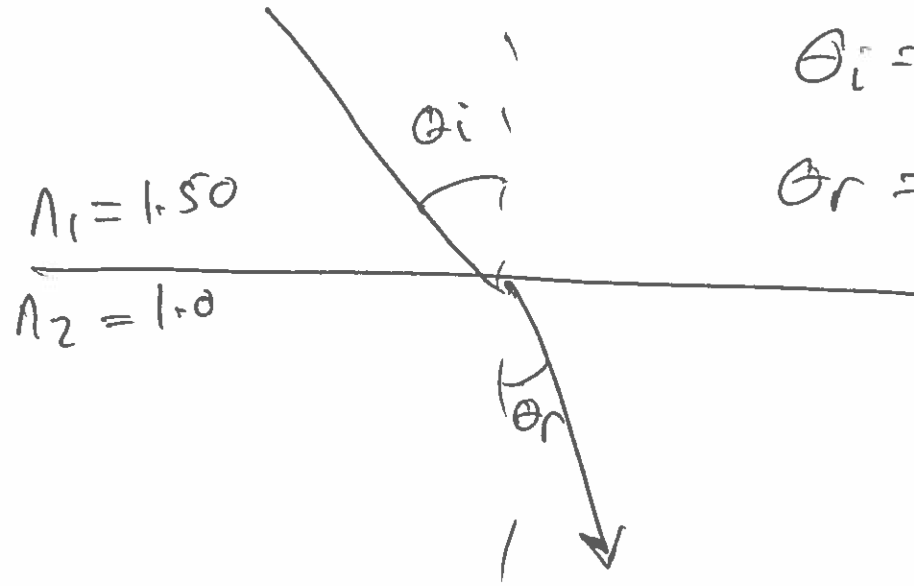
$$n_{air} \sin\theta_i = n_{mat} \sin\theta_r$$

$$n_{material} = n_{air} \frac{\sin\theta_i}{\sin\theta_r}$$

$$n_{mat} = (1.00)\frac{\sin(63.0^\circ)}{\sin(47.0^\circ)} = 1.218$$

$$v_{mat} = \frac{c}{n_{mat}} = \frac{2.998 \times 10^8 \text{ m/s}}{1.218}$$

$$v_{mat} = 2.46 \times 10^8 \text{ m/s}$$



$\theta_i = 30.0^\circ$

$\theta_r = ?$

$$n_1 \sin\theta_i = n_2 \sin\theta_2$$

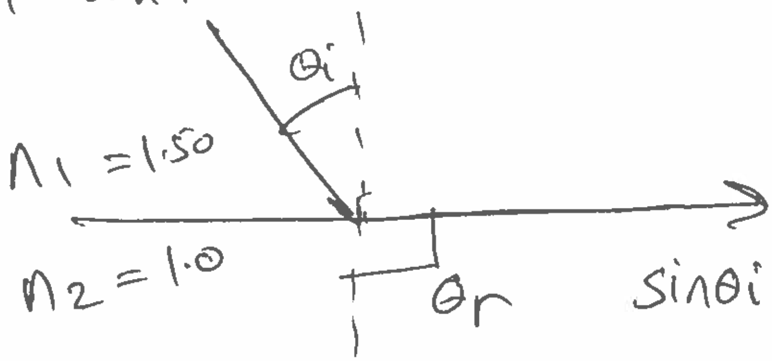
$$\sin\theta_2 = \frac{n_1}{n_2} \sin\theta_1$$

$$\sin\theta_r = \frac{(1.50)}{(1.00)} \sin(30^\circ)$$

$$\sin\theta_r = 0.75$$

$$\theta_r = \sin^{-1}(0.75) = 48.6^\circ$$

at what θ_i would $\theta_r = 90^\circ$?



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

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

$$\sin\theta_i = \frac{1}{1.50} \sin(90) = \frac{1}{1.50}$$

$$\theta_i = \sin^{-1}\left(\frac{1}{1.50}\right) = 41.8^\circ = \theta_c$$

Critical Angle

What if $\theta_i > \theta_c$

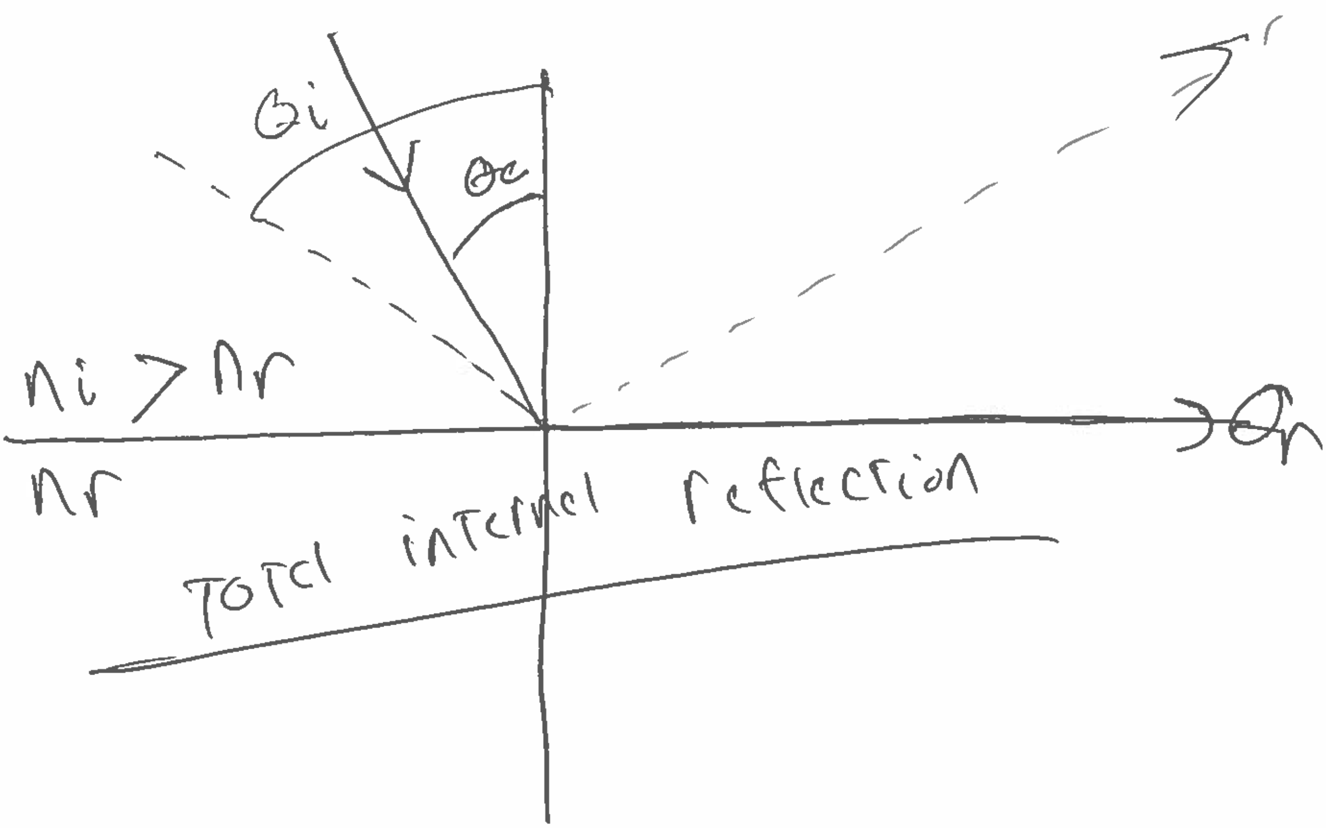
Say 45°

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

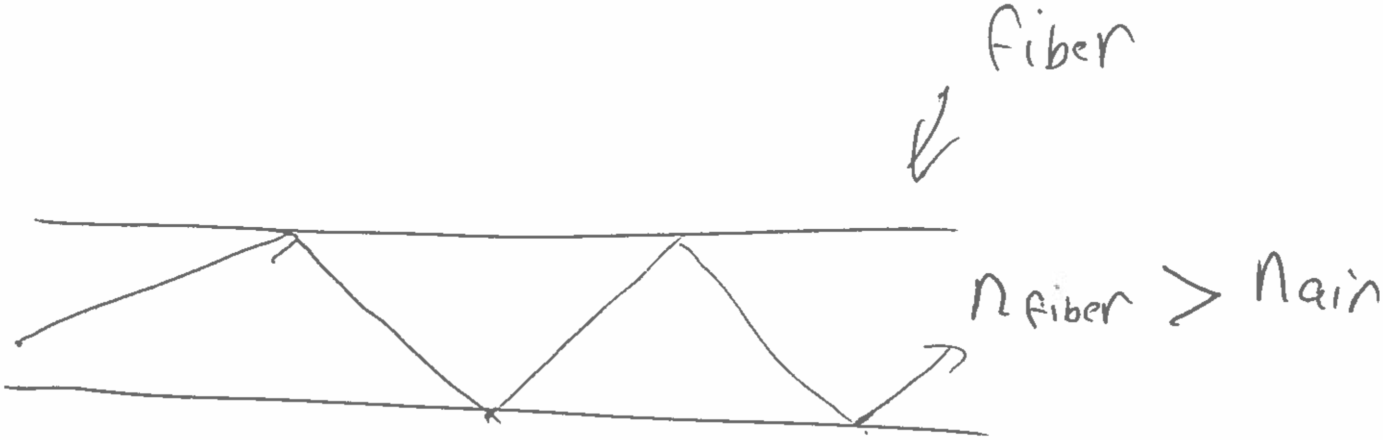
$$\sin\theta_r = \frac{1.50}{1.0}\sin(45) = 1.06$$

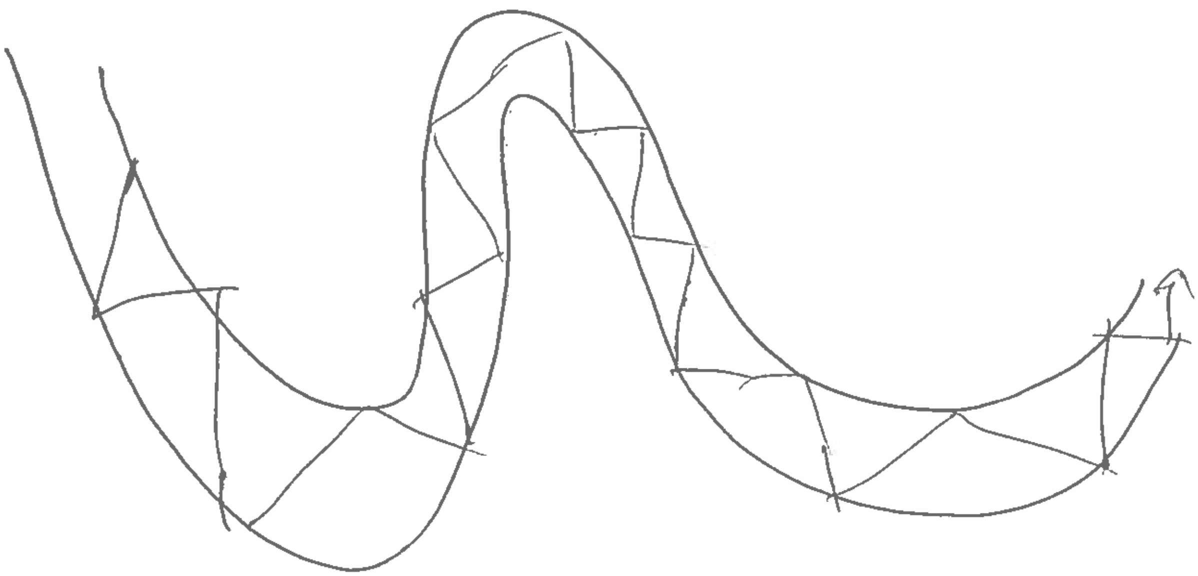
$$\theta_r = \sin^{-1}(1.06) \Rightarrow \text{Not possible!}$$

$\sin\theta \leq 1$



Fiber optics





Total internal reflection

Prisms for

Binnoculars

Gem sparkles

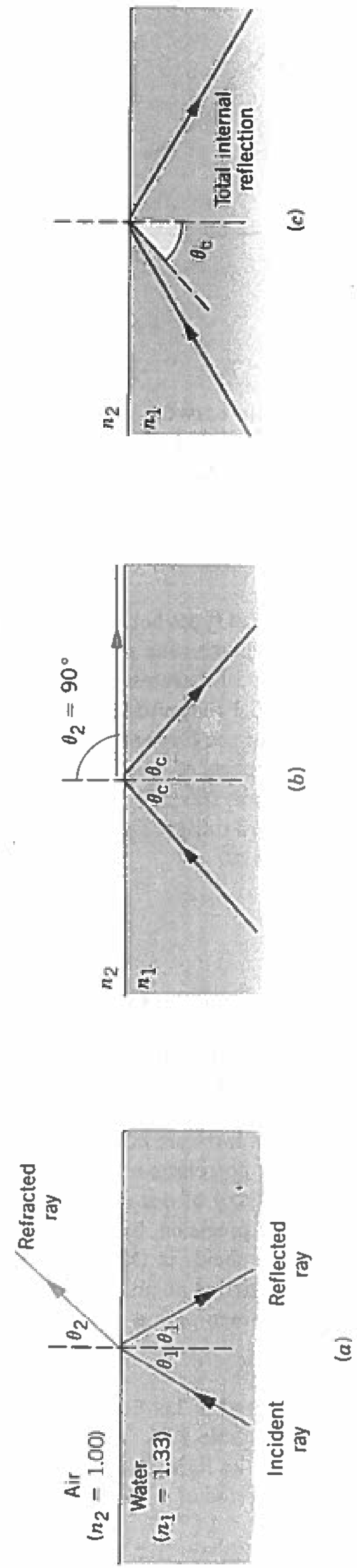
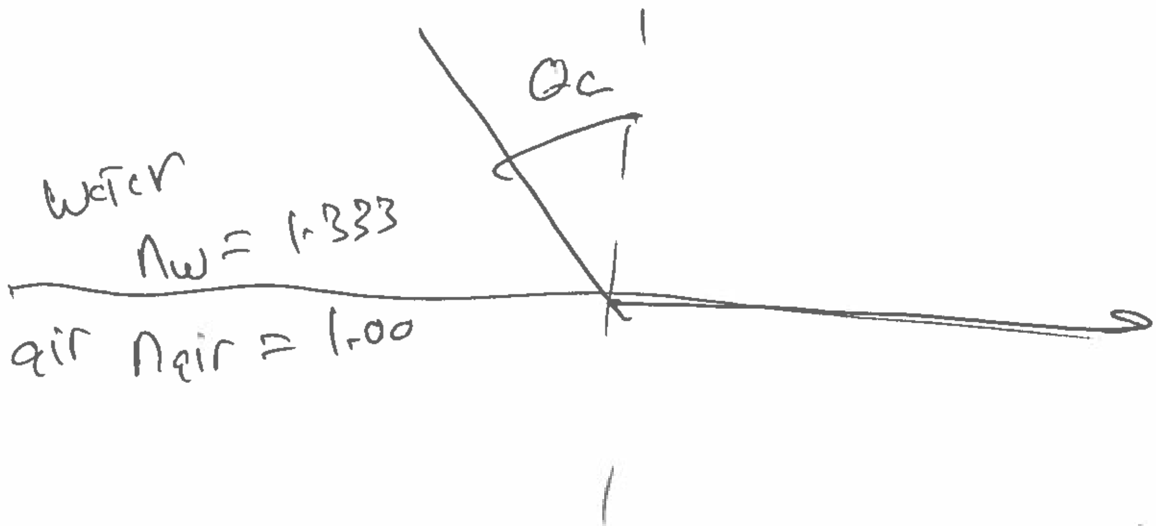


FIGURE 26.7 a, b, c

For total internal reflection

you must have $n_i > n_r$

What is critical angle for water/air?



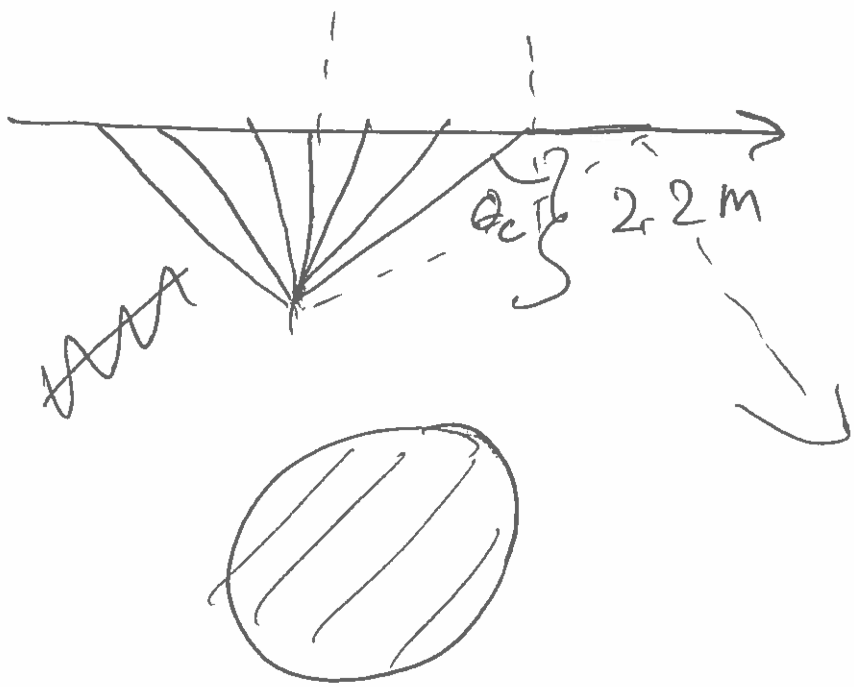
$$n_w \sin\theta_c = n_{air} \sin 90^\circ$$

$$\sin\theta_c = \frac{n_{air}}{n_w} = \frac{1.00}{1.333}$$

$$\theta_c = \sin^{-1}\left(\frac{1}{1.333}\right) = \underline{48.8^\circ}$$

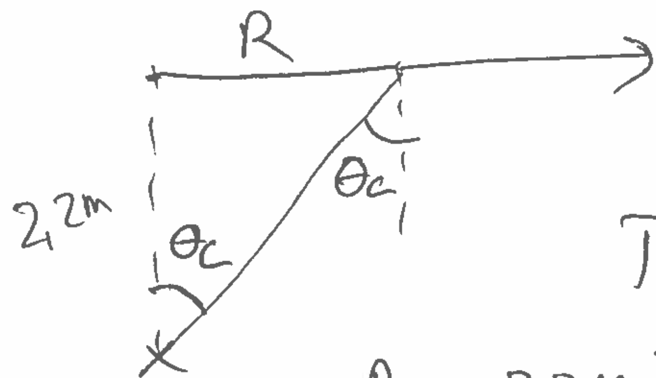
26-28

PT source of light. 2.2 m below surface of lake. emits rays in all direction what is area of illuminated surface?



side view

Top view



$$\tan\theta_c = \frac{R}{2.2m}$$

$$R = 2.2m \tan\theta_c$$

$$n_w \sin\theta_c = n_{air} \sin 90^\circ$$

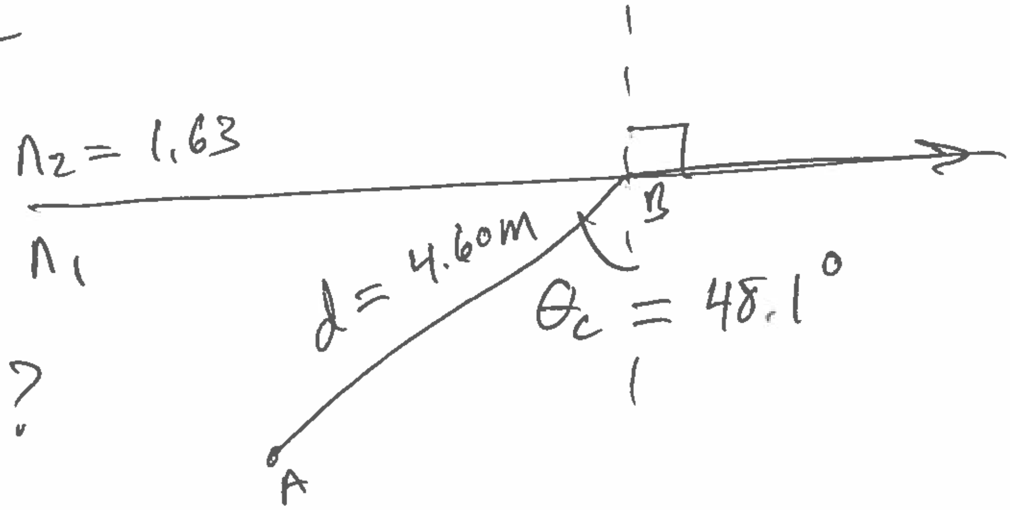
$$\sin\theta_c = \frac{n_{air}}{n_w} = \frac{1}{1.333} = 0.75$$

$$\theta_c = 48.6^\circ$$

$$R = 2.2\,m \tan(48.6^\circ)$$

$$\boxed{R = 2.5\,M}$$

26-34



$$t_{A\to B} = ?$$

$$t_{A\to B} = \frac{d_{A\to B}}{v} \qquad v = \frac{c}{n}$$

$$t_{A\to B} = \frac{d_{A\to B}}{\frac{c}{n_1}} = \frac{n_1 d_{A\to B}}{c}$$

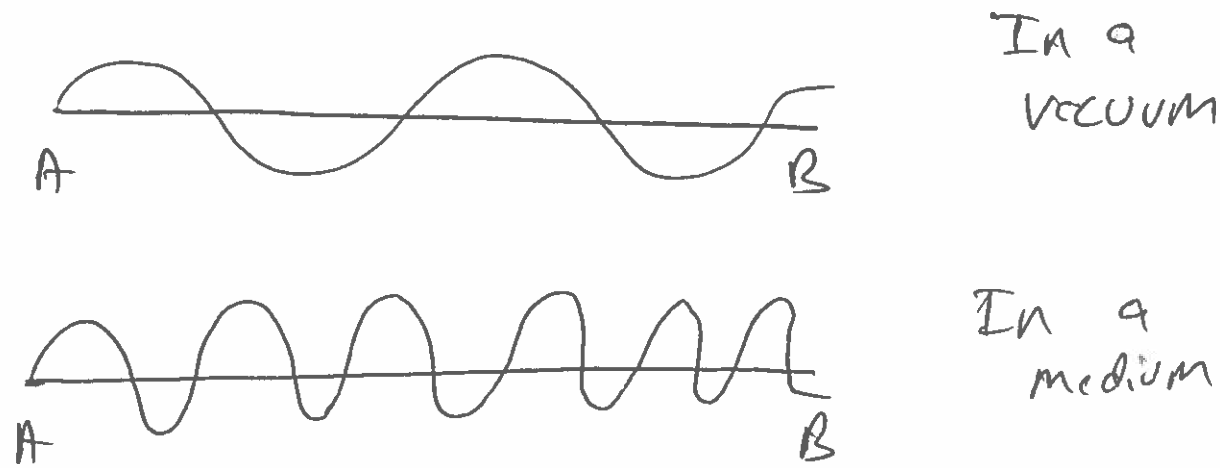
$$n_1 \sin\theta_c = n_2 \sin 90^\circ$$

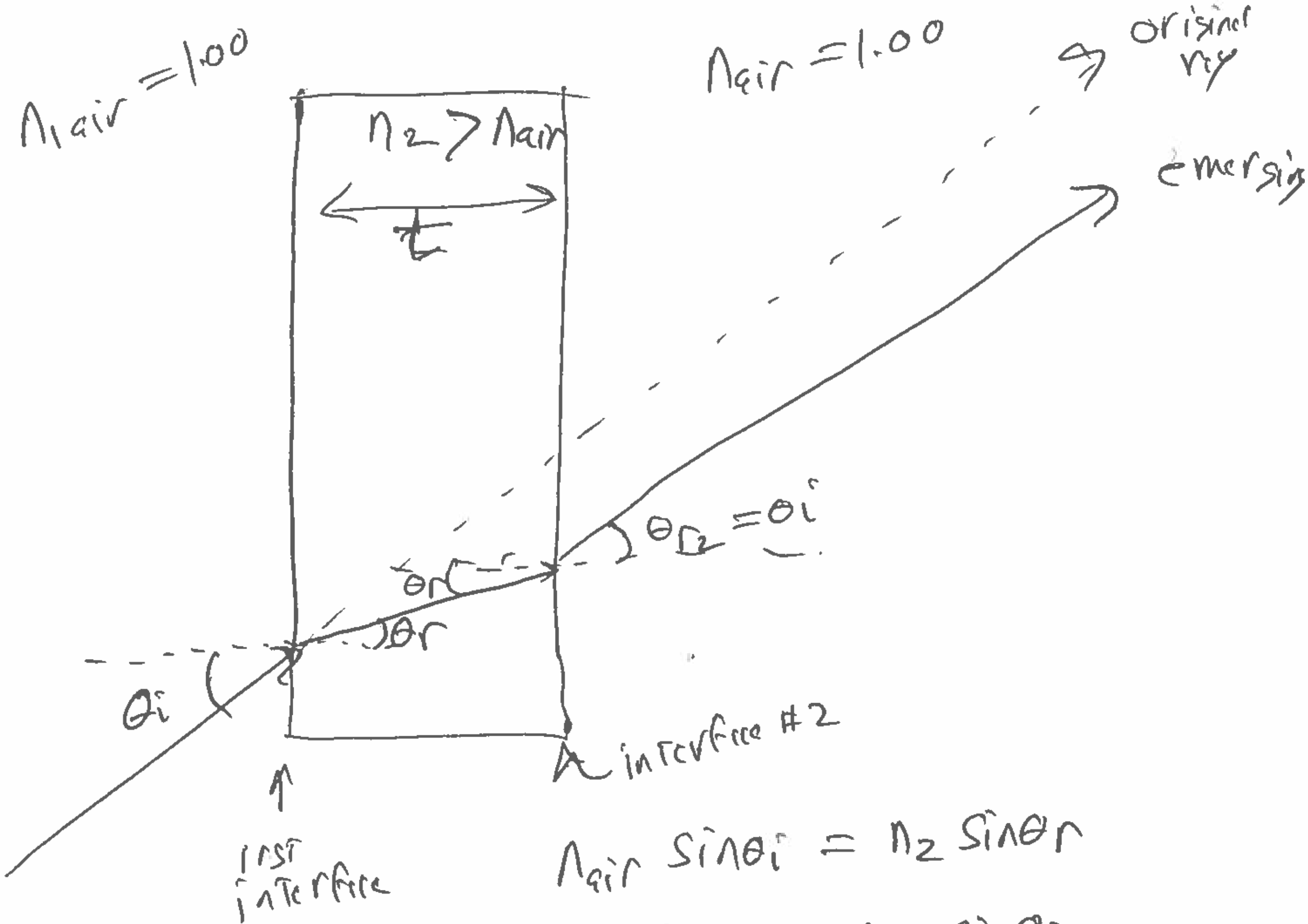
$$n_1 = \frac{n_2}{\sin\theta_c} = \frac{1.63}{\sin(48.1^\circ)} = 2.19$$

$$t_{A\to b} = \frac{(4.60\,m)(2.19)}{2.99\times10^8\,m/s} = \boxed{3.36\times10^{-8}\,s}$$

nd = optical path length

Optical path length is what the effective distance in a vacuum would be of a distance in a medium.



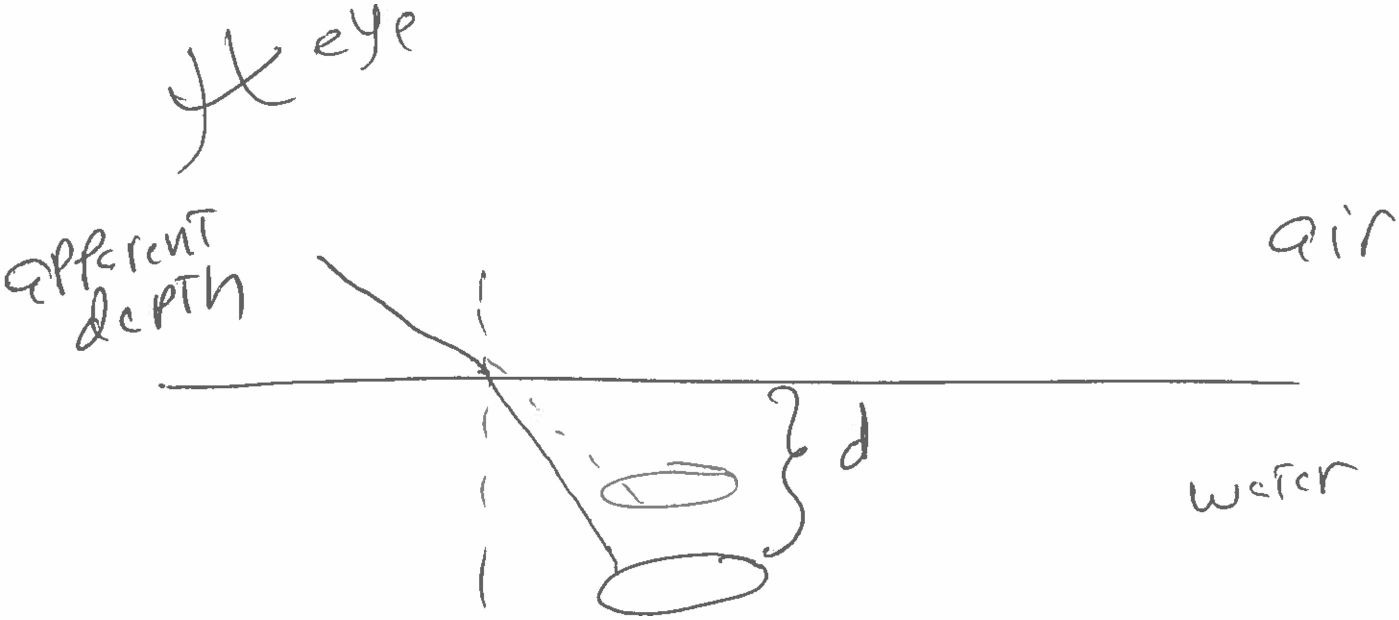


$$n_{air} \sin\theta_i = n_2 \sin\theta_r$$

$$n_2 \sin\theta_r = n_{air} \sin\theta_{r2}$$

$$\theta_{r2} = \theta_i$$

Slab translates beam parallel to original direction amount $\propto \theta_i$ and thickness of slab


eye
apparent depth
air
d
water