# Dark fringes for 2 slits

$d = 6.4 \times 10^{-6}$ m $\quad \lambda = 480$ nm

find $\theta$ for the first three dark fringes

for dark fringes $\quad d \sin\theta = (m + \frac{1}{2})\lambda$

$$\sin\theta = (m + \tfrac{1}{2}) \frac{\lambda}{d} = (m + \tfrac{1}{2}) \frac{480 \times 10^{-9} \cancel{m}}{6.4 \times 10^{-6} \cancel{m}}$$

$$\sin\theta = (m + \tfrac{1}{2})(7.50 \times 10^{-2})$$

1rst dark fringe $\quad m = 0$

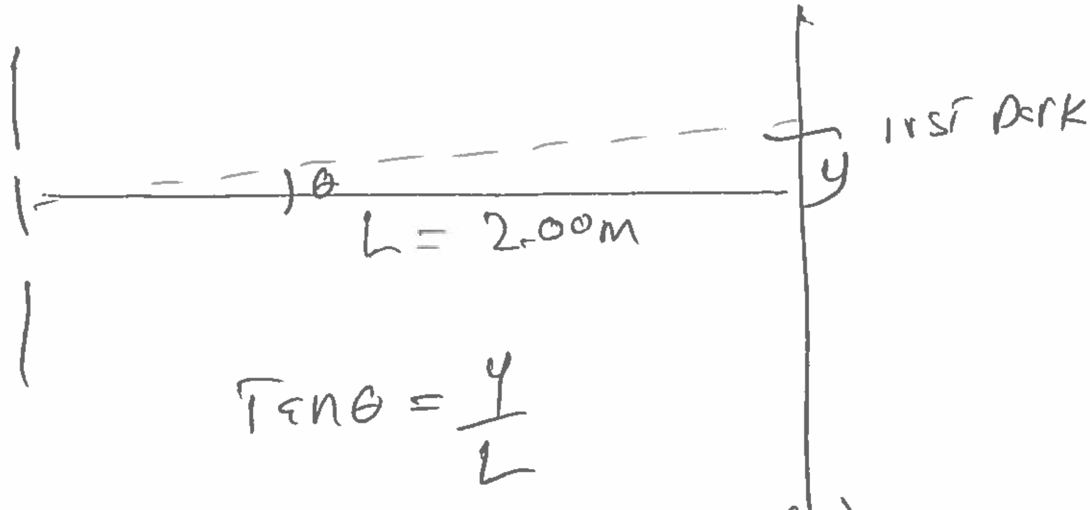
$$\sin\theta_1 = \tfrac{1}{2}(0.075) = 0.0375$$

$m=0 \quad \theta_1 = \sin^{-1}(0.0375) = 2.15^\circ$

$m=1 \quad \theta_2 = \sin^{-1}(0.1125) = 6.46^\circ$

$m=2 \quad \theta_3 = \sin^{-1}(0.1875) = 10.81^\circ$

put fringes on a screen 2.00 m away




$$\tan\theta = \frac{y}{L}$$

$$y_1 = L\tan\theta = 2.00\,m\ \tan(\theta_1)$$

$$y_1 = (2.00\,m)\tan(2.15^\circ) = 0.075\,m$$

$$\underline{7.5\,cm}$$

$$y_2 = (2.00\,m)\tan(6.46^\circ) = 0.226\,m$$

$$\underline{22.6\,cm}$$

$$y_3 = (2.00\,m)\tan(10.81^\circ) = 0.382\,m$$

$$\underline{38.2\,cm}$$

remember for 2 slits Interference

Bright fringes $d\sin\theta = m\lambda$

Dark fringes $d\sin\theta = (m+\frac{1}{2})\lambda$

what happens If I have a 2 slit Interference set up and I put it in a water tank?

what happens?

$d = 6.4 \times 10^{-6} m$ $\lambda = 480\, nm$

$\theta_{1\,Dark} = 2.15°$

Remember light travels slower in water Then in vacuum (Air)

$$n = \frac{c}{v_{med}}$$

$$v_{med} = \frac{c}{n}$$

$$f_m \lambda_m = \frac{f_0 \lambda_0}{n}$$ usually $f_m = f_0$

$$\lambda_m = \frac{\lambda_0}{n} \qquad \lambda_n = \frac{\lambda_0}{n}$$

Condition for Dark fringe

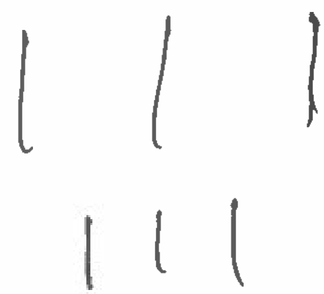
$$d \sin\theta = \left(m+\tfrac{1}{2}\right)\lambda_n$$

$$d \sin\theta = \left(m+\tfrac{1}{2}\right)\frac{\lambda_0}{n}$$

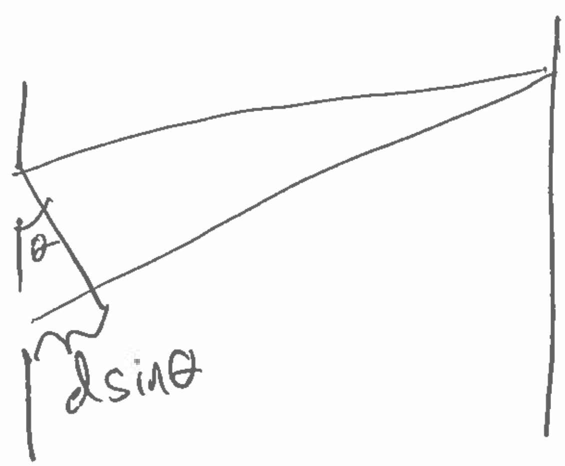
$$\sin\theta_n = \frac{\left(m+\tfrac{1}{2}\right)}{n}\frac{\lambda_0}{d} = \frac{\sin\theta_0}{n}$$

In vacuum

in water



$$n d \sin\theta = \left(m+\tfrac{1}{2}\right)\lambda$$



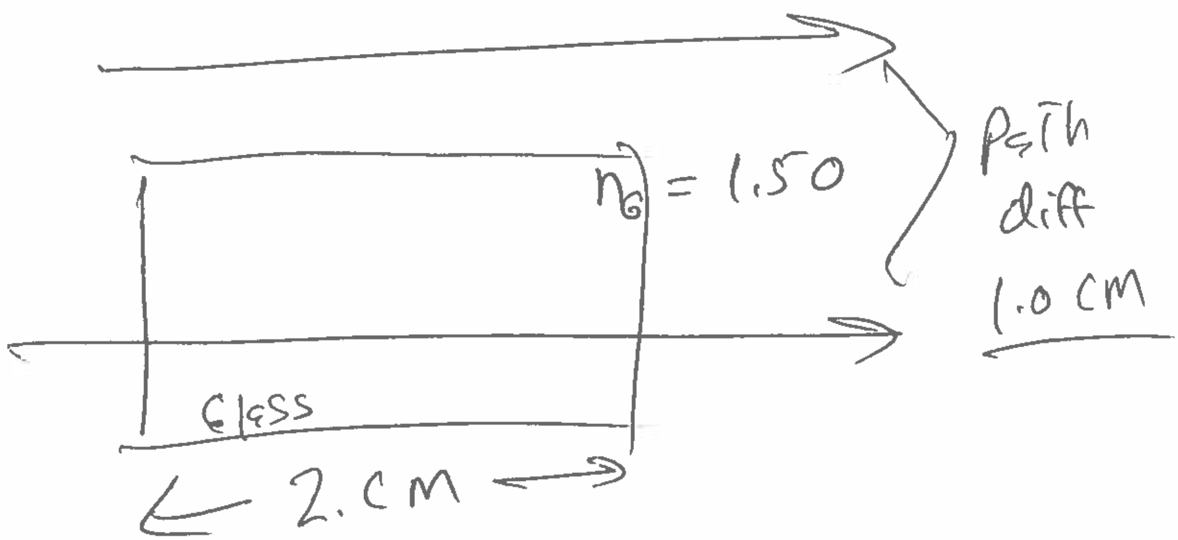

$$\frac{n d \sin\theta}{\text{optical path}}$$

Physical path is the distance between 2 points.

Optical path is physical path times index of refraction

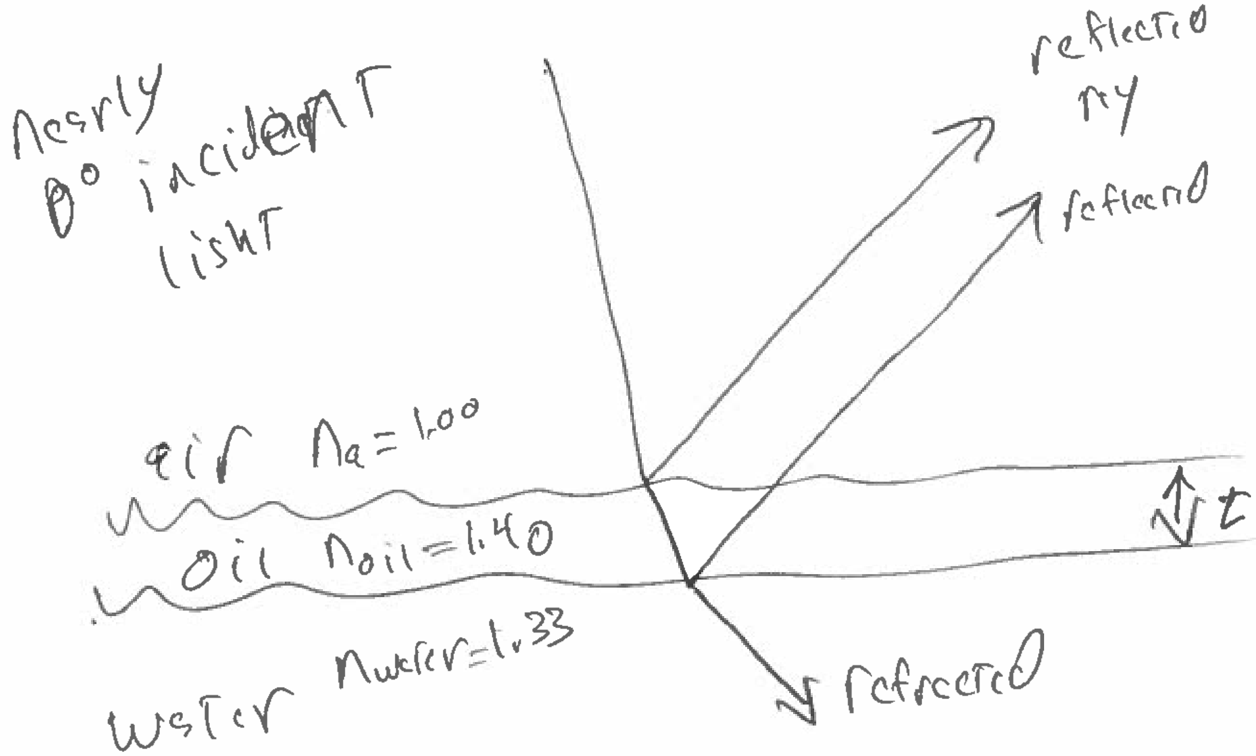
Optical path is equivalent path now taken, because the path is more optically dense,

Optical path $OP = n(PP)$ PP is physical path




$PP = 2.0$ cm

$OP = (1.50)(2.0\text{ cm}) = \underline{3.0\text{ cm}}$




Thin-film Interference

$$\frac{\text{Phase difference}}{\text{between 2 primary rays}}$$

1) optical path difference

Physical path difference $= 2t$

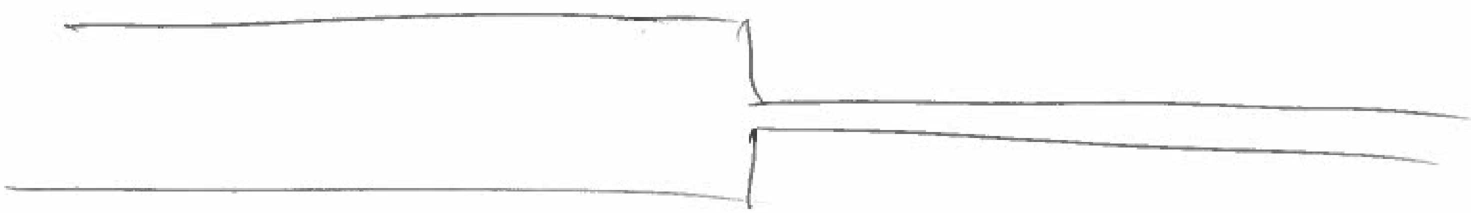
optical path diff $= n_{oil}(2t) = 2n_{oil}t$

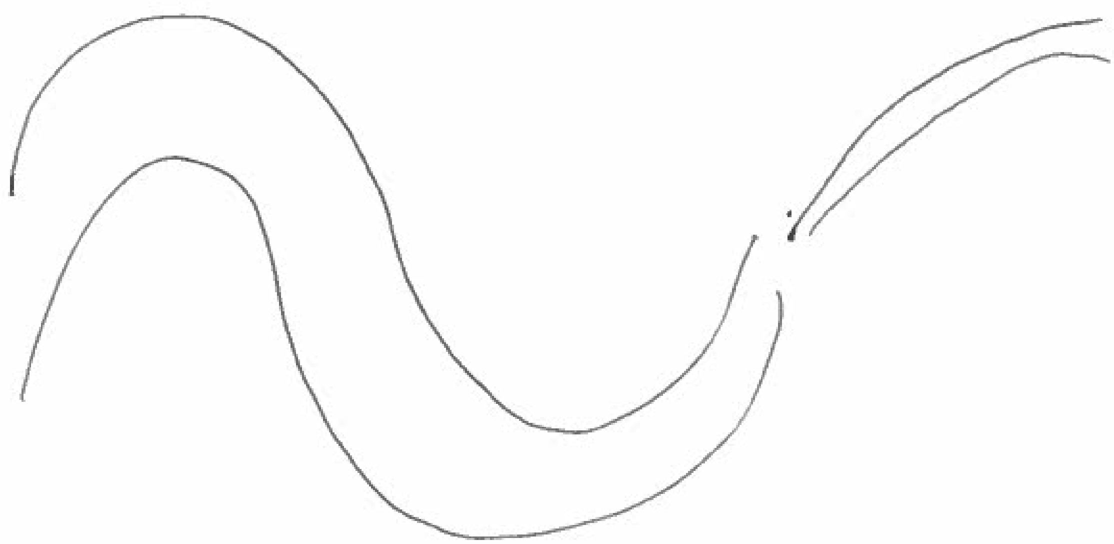
2) Phase shifts

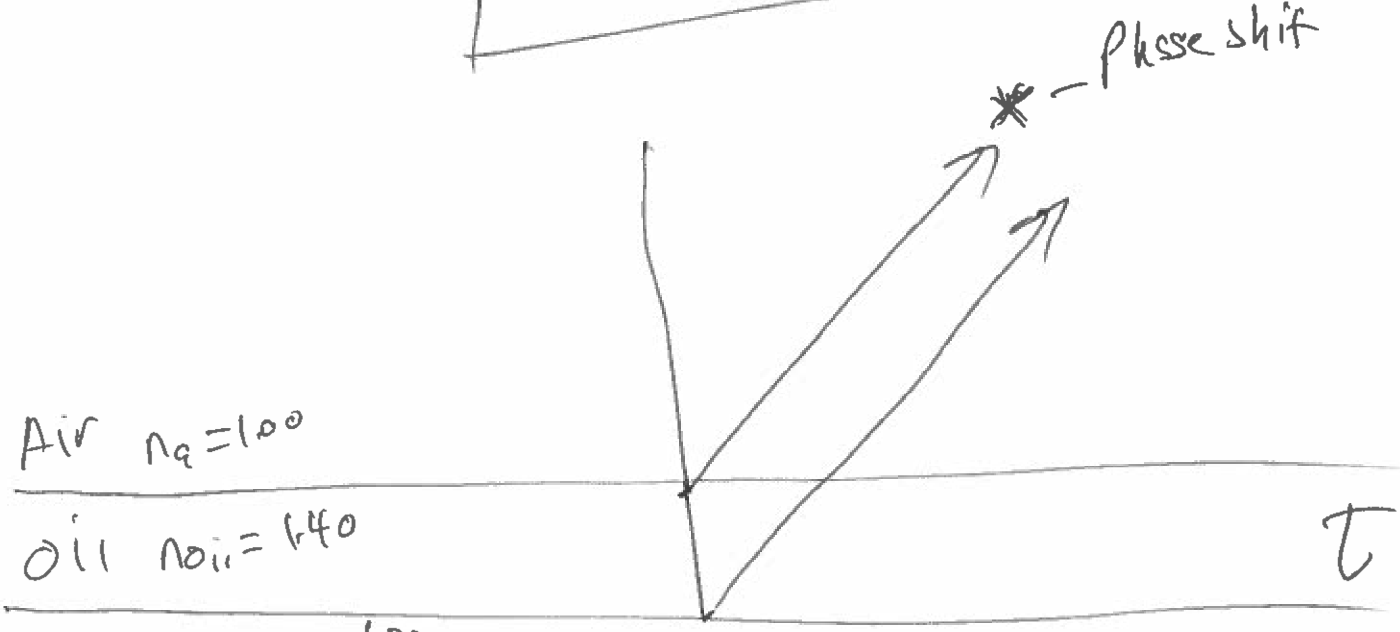
when light reflects off a surface

if the reflected surface has a higher index of refraction the reflected wave is $\frac{1}{2}\lambda$ shifted

if the reflected surface has a lower index of refraction there is no phase shift.








Phase diff = optical path diff + Phase shifts

Phase Diff $= 2 n_{oil} t + \frac{1}{2}\lambda$

for Bright constructive $\quad$ Phase Diff $= m\lambda$

for Dark Destructive $\quad$ Phase Diff $= (m+\frac{1}{2})\lambda$

~~for~~ oil on water is Given

$$2 n_{oil} t + \frac{1}{2}\lambda = m\lambda \quad \text{bright}$$

$$2 n_{oil} t = (m+\tfrac{1}{2})\lambda \quad \text{bright}$$