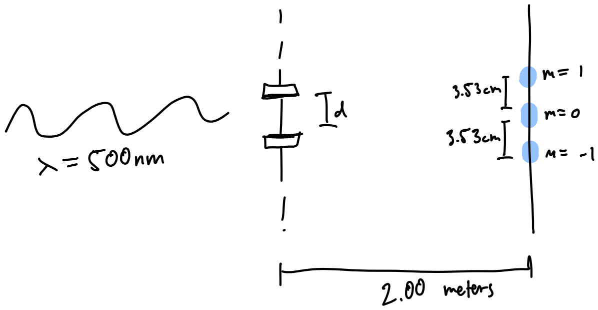
Physics 1C - Discussion 9 Name: UID:

Problem 1. Coherent light of wavelength 500 nm is incident on two very narrow and closely spaced slits. The interference pattern is observed on a very tall screen that is 2.00 m from the slits. Near the center of the screen the separation between two adjacent interference maxima is 3.53 cm. What is the distance on the screen between the $m = 49$ and $m = 50$ maxima?



$$Y_m = R\frac{m\lambda}{d}$$

$\Rightarrow$ $3.53\times10^{-2} = 2\,\frac{500\times10^{-9}}{d}$

$\therefore\ d \approx 2.83\times10^{-5}$ [m]

then, $Y_{49} = 2\,\frac{49\cdot500\times10^{-9}}{2.83\times10^{-5}} \approx 1.73$ [m]

$Y_{50} = 2\,\frac{50\cdot500\times10^{-9}}{2.83\times10^{-5}} \approx 1.77$ [m]

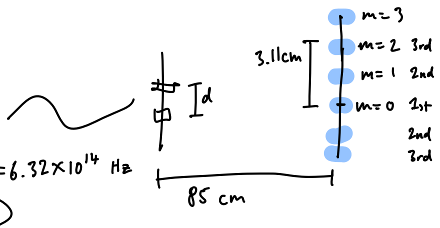
Assuming θ_{49}, θ_{50} are small

$\therefore\ Y_{50} - Y_{49} = 1.77 - 1.73\ \boxed{\approx 0.04\ [m]}$

Assuming 1st is the center

Problem 2. Coherent light of frequency 6.32×10^{14} Hz passes through two thin slits and falls on a screen 85.0 cm away. You observe that the $\boxed{\text{third}}$ bright fringe occurs at ± 3.11 cm on either side of the central bright fringe. (a) How far apart are the two slits? (b) At what distance from the central bright fringe will the third dark fringe occur?

Assuming $R >> d$



$f = 6.32 \times 10^{14}$ Hz

$c = \lambda f$

$\Rightarrow \lambda = \frac{c}{f} \approx 4.75 \times 10^{-7}$ [m]

(constructive)

$Y_m = R \frac{m\lambda}{d}$

$\Rightarrow Y_2 = 3.11 \times 10^{-2} = 85 \times 10^{-2} \frac{2 \cdot 4.75 \times 10^{-7}}{d}$

$\Rightarrow \boxed{\text{(a)} \ d \approx 2.60 \times 10^{-5} \text{ [m]}}$

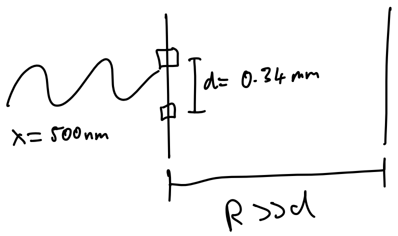
(Young's destructive)

$Y_m = R \frac{(m + \frac{1}{2})\lambda}{d}$

3rd dark fringe $\Rightarrow m = 2$

$Y_m = 85 \times 10^{-2} \frac{\frac{5}{2} \cdot 4.75 \times 10^{-7}}{2.6 \times 10^{-5}} \approx \boxed{3.88 \times 10^{-2} \text{ [m]} \quad \text{(b)}}$

Problem 3. Coherent light with wavelength 500 nm passes through narrow slits separated by 0.340 mm. At a distance from the slits large compared to their separation, what is the phase difference (in radians) in the light from the two slits at an angle of 23.0° from the centerline?



$$\phi = \frac{2\pi}{\lambda}(r_2 - r_1)$$

s.t. $r_2 - r_1 = d\sin\theta = 0.34\times10^{-3}\sin(23^\circ) \approx 1.33\times10^{-4}$ [m]

$$\therefore \phi = \frac{2\pi}{500\times10^{-9}}(1.33\times10^{-4}) \approx \boxed{1.67\times10^{3} \text{ [rad]}}$$

Problem 4. A researcher measures the thickness of a layer of benzene (n=1.50) floating on water by shining monochromatic light onto the film and varying the wavelength of the light. She finds that light of wavelength 575 nm is reflected most strongly from the film. What does she calculate for the minimum thickness of the film?

$n=1.33$

$2t = m\lambda$ $\qquad m=1 \Rightarrow 2t = 575 \times 10^{-9}$ $\qquad \Rightarrow \boxed{t = 2.875 \times 10^{-7}\ [m]}$