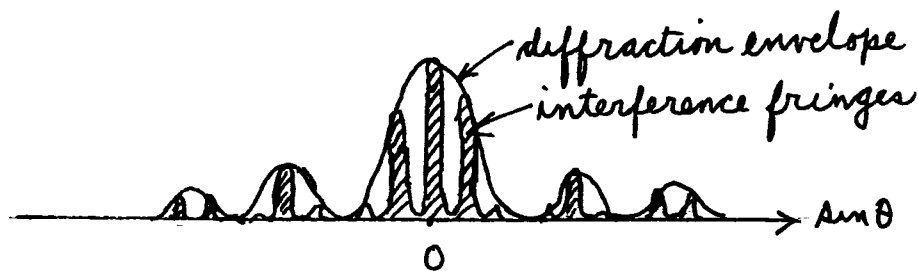


④ (CONTINUED) Part b)



For double-slit, including single-slit diffraction

$$I = 4 I_0 \left[\frac{\sin(\varphi/2)}{(\varphi/2)} \right]^2 \left(\cos \frac{\delta}{2} \right)^2$$

↙ SINGLE-SLIT
↖ INTERFERENCE
DIFF. FACTOR
FACTOR

where $\varphi = (2\pi a/\lambda) \sin \theta$ and $\delta = (2\pi d/\lambda) \sin \theta$

Recall: Double-slit interference MAX are where $d \sin \theta = m\lambda$
 If you don't recall, then derive: ($m = 0, \pm 1, \pm 2, \dots$)

$$\left(\cos \frac{\delta}{2} \right)^2 = 1 \Rightarrow \frac{\delta}{2} = m\pi \Rightarrow \frac{\pi d}{\lambda} \sin \theta = m\pi$$

INTERFERENCE MAX: $d \sin \theta = m\lambda$ with $m = 0, \pm 1, \pm 2, \dots$

At edge of screen $\theta = \theta_D$ and $m_{\text{LAST}} = \frac{d}{\lambda} \sin \theta_D = \frac{d}{\lambda} \left(\frac{3\lambda}{a} \right)$

$$m_{\text{LAST}} = 3 \frac{d}{a} = 3 \frac{(0.06 \text{ mm})}{(0.025 \text{ mm})} = 7.2$$

However, m must be an integer, so the value of m for the last interference fringe is $m = 7$.

$$\frac{I_7}{I_{\text{CENTER}}} = \frac{I_7}{4I_0} = \left[\frac{\sin \frac{1}{2} \varphi_7}{\frac{1}{2} \varphi_7} \right]^2 \left(\cos \frac{1}{2} \delta_7 \right)^2 \text{ where}$$

$$\frac{1}{2} \varphi_7 = \frac{\pi a}{\lambda} \sin \theta_7 = \pi \left(\frac{7a}{d} \right) = 7\pi \left(\frac{0.025}{0.06} \right) = 9.16 \text{ rad.}$$

$$\frac{1}{2} \delta_7 = \frac{\pi d}{\lambda} \sin \theta_7 = \pi (7) = 7\pi$$

$$\frac{I_7}{I_{\text{CENTER}}} = \left(\frac{\sin 9.16}{9.16} \right)^2 \underbrace{\left(\cos 7\pi \right)^2}_1 = \left(\frac{0.262}{9.16} \right)^2 = \underline{\underline{8.16 \times 10^{-4}}}$$