Homework 9 Solutions

37.1 $$\Delta y_{\text{bright}} = \frac{\lambda L}{d} = \frac{(632.8\times10^{-9})(5.00)}{2.00\times10^{-4}}\ \text{m} = \boxed{1.58\ \text{cm}}$$

37.7 (a) For the bright fringe,

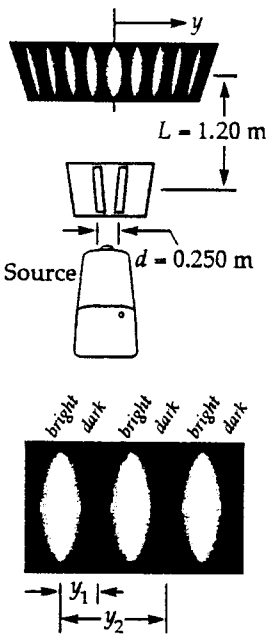
$$y_{\text{bright}} = \frac{m\lambda L}{d} \qquad \text{where} \qquad m = 1$$

$$y = \frac{(546.1\times10^{-9}\ \text{m})(1.20\ \text{m})}{0.250\times10^{-3}\ \text{m}} = 2.62\times10^{-3}\ \text{m} = \boxed{2.62\ \text{mm}}$$

(b) For the dark bands, $y_{\text{dark}} = \frac{\lambda L}{d}\left(m+\frac{1}{2}\right);\ m = 0, 1, 2, 3, \ldots$

$$y_2 - y_1 = \frac{\lambda L}{d}\left[\left(1+\frac{1}{2}\right)-\left(0+\frac{1}{2}\right)\right] = \frac{\lambda L}{d}(1) = \frac{(546.1\times10^{-9}\ \text{m})(1.20\ \text{m})}{0.250\times10^{-3}\ \text{m}}$$

$$\Delta y = \boxed{2.62\ \text{mm}}$$



Figures for Goal Solution

37.9 Location of A = central maximum,

Location of B = first minimum.

So, $$\Delta y = [y_{\text{min}} - y_{\text{max}}] = \frac{\lambda L}{d}\left(0+\frac{1}{2}\right) - 0 = \frac{1}{2}\frac{\lambda L}{d} = 20.0\ \text{m}$$

Thus, $$d = \frac{\lambda L}{2(20.0\ \text{m})} = \frac{(3.00\ \text{m})(150\ \text{m})}{40.0\ \text{m}} = \boxed{11.3\ \text{m}}$$

37.14 (a) $$\frac{I}{I_{\text{max}}} = \cos^2\left(\frac{\phi}{2}\right) \qquad \text{(Equation 37.11)}$$

Therefore, $$\phi = 2\cos^{-1}\left(\frac{I}{I_{\text{max}}}\right)^{1/2} = 2\cos^{-1}(0.640)^{1/2} = \boxed{1.29\ \text{rad}}$$

(b) $$\delta = \frac{\lambda\phi}{2\pi} = \frac{(486\ \text{nm})(1.29\ \text{rad})}{2\pi} = \boxed{99.8\ \text{nm}}$$

38.36 $2d \sin\theta = m\lambda \Rightarrow d = \dfrac{m\lambda}{2\sin\theta} = \dfrac{(1)(0.129\text{ nm})}{2\sin(8.15°)} = \boxed{0.455\text{ nm}}$

38.38 $\sin\theta_m = \dfrac{m\lambda}{2d}$: $\sin 12.6° = \dfrac{1\lambda}{2d} = 0.218$

$\sin\theta_2 = \dfrac{2\lambda}{2d} = 2(0.218)$ so $\theta_2 = 25.9°$

$\boxed{\text{Three}}$ other orders appear: $\theta_3 = \sin^{-1}(3 \times 0.218) = 40.9°$

$\theta_4 = \sin^{-1}(4 \times 0.218) = 60.8°$

$\theta_5 = \sin^{-1}(5 \times 0.218) = \text{nonexistent}$

38.44 By Brewster's law, $n = \tan\theta_p = \tan(48.0°) = \boxed{1.11}$

38.52 $x = 1.22\dfrac{\lambda}{d}D = 1.22\left(\dfrac{5.00\times10^{-7}\text{ m}}{5.00\times10^{-3}\text{ m}}\right)\left(250\times10^{3}\text{ m}\right) = \boxed{30.5\text{ m}}$

$D = 250 \times 10^3$ m
$\lambda = 5.00 \times 10^{-7}$ m
$d = 5.00 \times 10^{-3}$ m