Homework 9 Solutions

37.1 $$\Delta y_{\text{bright}} = \frac{\lambda L}{d} = \frac{(632.8 \times 10^{-9})(5.00)}{2.00 \times 10^{-4}}\ \text{m} = \boxed{1.58\ \text{cm}}$$

37.7 (a) For the bright fringe,

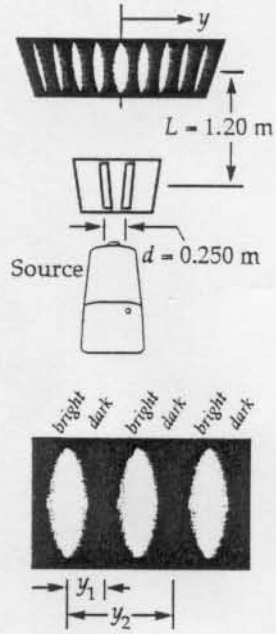
$$y_{\text{bright}} = \frac{m\lambda L}{d} \qquad \text{where} \qquad m = 1$$

$$y = \frac{(546.1 \times 10^{-9}\ \text{m})(1.20\ \text{m})}{0.250 \times 10^{-3}\ \text{m}} = 2.62 \times 10^{-3}\ \text{m} = \boxed{2.62\ \text{mm}}$$

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

$$y_2 - y_1 = \frac{\lambda L}{d}\left[\left(1 + \frac{1}{2}\right) - \left(0 + \frac{1}{2}\right)\right] = \frac{\lambda L}{d}(1) = \frac{(546.1 \times 10^{-9}\ \text{m})(1.20\ \text{m})}{0.250 \times 10^{-3}\ \text{m}}$$

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



Figures for Goal Solution

37.9 Location of A = central maximum,

Location of B = first minimum.

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

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

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

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

37.17 (a) From Equation 37.8,

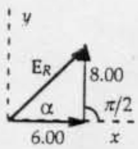
$$\phi = \frac{2\pi d}{\lambda}\sin\theta = \frac{2\pi d}{\lambda}\cdot\frac{y}{\sqrt{y^2+D^2}}$$

$$\phi \approx \frac{2\pi yd}{\lambda D} = \frac{2\pi(0.850\times10^{-3}\text{ m})(2.50\times10^{-3}\text{ m})}{(600\times10^{-9}\text{ m})(2.80\text{ m})} = \boxed{7.95\text{ rad}}$$

(b) $$\frac{I}{I_{max}} = \frac{\cos^2\left(\frac{\pi d}{\lambda}\sin\theta\right)}{\cos^2\left(\frac{\pi d}{\lambda}\sin\theta_{max}\right)} = \frac{\cos^2\frac{\phi}{2}}{\cos^2 m\pi}$$

$$\frac{I}{I_{max}} = \cos^2\frac{\phi}{2} = \cos^2\left(\frac{7.95\text{ rad}}{2}\right) = \boxed{0.453}$$

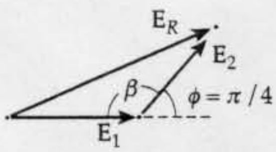
37.21 $\mathbf{E}_R = 6.00\mathbf{i} + 8.00\mathbf{j} = \sqrt{(6.00)^2+(8.00)^2}$ at $\tan^{-1}(8.00/6.00)$



$\mathbf{E}_R = 10.0$ at $53.1° = 10.0$ at 0.927 rad

$E_P = \boxed{10.0\sin(100\pi t + 0.927)}$

37.26 $E_R^2 = E_1^2 + E_2^2 - 2E_1E_2\cos\beta,$ where $\beta = 180 - \phi.$



Since $I \propto E^2$,

$$I_R = \boxed{I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi}$$

37.31 Treating the anti-reflectance coating like a camera-lens coating, $2t = \left(m + \frac{1}{2}\right)\frac{\lambda}{n}$

Let $m = 0$: $t = \frac{\lambda}{4n} = \frac{3.00\text{ cm}}{4(1.50)} = \boxed{0.500\text{ cm}}$

This anti-reflectance coating could be easily countered by changing the wavelength of the radar—to 1.50 cm—now creating maximum reflection!

37.42 Distance $= 2(3.82\times10^{-4}\text{ m}) = 1700\lambda$ $\lambda = 4.49\times10^{-7}\text{ m} = \boxed{449\text{ nm}}$

The light is $\boxed{\text{blue}}$