**38.2** The positions of the first-order minima are $y/L \approx \sin\theta = \pm\lambda/a$. Thus, the spacing between these two minima is $\Delta y = 2(\lambda/a)L$ and the wavelength is

$$\lambda = \left(\frac{\Delta y}{2}\right)\left(\frac{a}{L}\right) = \left(\frac{4.10\times10^{-3}\text{ m}}{2}\right)\left(\frac{0.550\times10^{-3}\text{ m}}{2.06\text{ m}}\right) = \boxed{547\text{ nm}}$$

**38.12** $\theta_{\min} = \frac{y}{L} = 1.22\frac{\lambda}{D}$

$y$ = radius of star-image
$L$ = length of eye
$\lambda$ = 500 nm
$D$ = pupil diameter
$\theta$ = half angle

$$y = \frac{(1.22)(5.00\times10^{-7})(0.0300)}{7.00\times10^{-3}} = \boxed{2.61\ \mu\text{m}}$$

**38.14** $\theta_{\min} = 1.22\frac{\lambda}{D} = \frac{d}{L}$ $\quad 1.22\left(\frac{5.80\times10^{-7}\text{ m}}{4.00\times10^{-3}\text{ m}}\right) = \frac{d}{1.80\text{ mi}\left(\frac{1\text{ mi}}{1609\text{ m}}\right)}$ $\quad d = \boxed{0.512\text{ m}}$

The shortening of the wavelength inside the patriot's eye does not change the answer.

**38.29** (a) From Equation 38.12, $R = Nm$ where $N = (3000\text{ lines/cm})(4.00\text{ cm}) = 1.20\times10^{4}$ lines.

In the 1st order, $R = (1)(1.20\times10^{4}\text{ lines}) = \boxed{1.20\times10^{4}}$

In the 2nd order, $R = (2)(1.20\times10^{4}\text{ lines}) = \boxed{2.40\times10^{4}}$

In the 3rd order, $R = (3)(1.20\times10^{4}\text{ lines}) = \boxed{3.60\times10^{4}}$

(b) From Equation 38.11, $R = \frac{\lambda}{\Delta\lambda}$:

In the 3rd order, $\Delta\lambda = \frac{\lambda}{R} = \frac{400\text{ nm}}{3.60\times10^{4}} = 0.0111\text{ nm} = \boxed{11.1\text{ pm}}$

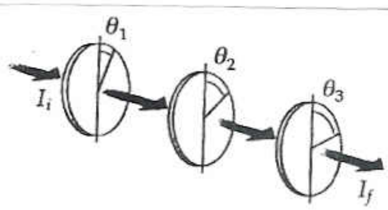
***38.40** Figure 38.25 of the text shows the situation. $\quad 2d\sin\theta = m\lambda \quad$ or $\quad \lambda = \frac{2d\sin\theta}{m}$

$$m=1 \Rightarrow \lambda_1 = \frac{2(2.80\text{ m})\sin 80.0^\circ}{1} = \boxed{5.51\text{ m}}$$

$$m=2 \Rightarrow \lambda_2 = \frac{2(2.80\text{ m})\sin 80.0^\circ}{2} = \boxed{2.76\text{ m}}$$

$$m=3 \Rightarrow \lambda_3 = \frac{2(2.80\text{ m})\sin 80.0^\circ}{3} = \boxed{1.84\text{ m}}$$

**38.42** (a) $\theta_1 = 20.0^\circ$, $\quad \theta_2 = 40.0^\circ$, $\quad \theta_3 = 60.0^\circ$




$$I_f = I_i\cos^2(\theta_1 - 0^\circ)\cos^2(\theta_2 - \theta_1)\cos^2(\theta_3 - \theta_2)$$

$$I_f = (10.0\text{ units})\cos^2(20.0^\circ)\cos^2(20.0^\circ)\cos^2(20.0^\circ) = \boxed{6.89\text{ units}}$$

(b) $\theta_1 = 0^\circ$, $\quad \theta_2 = 30.0^\circ$, $\quad \theta_3 = 60.0^\circ$

$$I_f = (10.0\text{ units})\cos^2(0^\circ)\cos^2(30.0^\circ)\cos^2(30.0^\circ) = \boxed{5.63\text{ units}}$$

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

**38.47** Complete polarization occurs at Brewster's angle $\quad \tan\theta_p = 1.33 \quad \theta_p = 53.1^\circ$

Thus, the Moon is $\boxed{36.9^\circ}$ above the horizon.