14. (a) For the maximum adjacent to the central one, we set $m = 1$ in Eq. 35-14 and obtain

$$\theta_1 = \sin^{-1}\left(\frac{m\lambda}{d}\right)\bigg|_{m=1} = \sin^{-1}\left[\frac{(1)(\lambda)}{100\lambda}\right] = 0.010\,\text{rad}.$$

(b) Since $y_1 = D \tan \theta_1$ (see Fig. 35-10(a)), we obtain

$$y_1 = (500\text{ mm}) \tan(0.010\text{ rad}) = 5.0\text{ mm}.$$

The separation is $\Delta y = y_1 - y_0 = y_1 - 0 = 5.0$ mm.

15. The angular positions of the maxima of a two-slit interference pattern are given by $d\sin\theta = m\lambda$, where d is the slit separation, λ is the wavelength, and m is an integer. If θ is small, sin θ may be approximated by θ in radians. Then, $\theta = m\lambda/d$ to good approximation. The angular separation of two adjacent maxima is $\Delta\theta = \lambda/d$. Let λ' be the wavelength for which the angular separation is greater by10.0%. Then, $1.10\lambda/d = \lambda'/d$. or

$$\lambda' = 1.10\lambda = 1.10(589\text{ nm}) = 648\text{ nm}.$$

20. (a) We use Eq. 35-14 with $m = 3$:

$$\theta = \sin^{-1}\left(\frac{m\lambda}{d}\right) = \sin^{-1}\left[\frac{2(550\times10^{-9}\text{ m})}{7.70\times10^{-6}\text{ m}}\right] = 0.216\,\text{rad}.$$

(b) $\theta = (0.216)(180°/\pi) = 12.4°$.

26. (a) We use Eq. 35-14 to find d:

$$d\sin\theta = m\lambda \quad \Rightarrow \quad d = (4)(450\text{ nm})/\sin(90°) = 1800\text{ nm}.$$

For the third order spectrum, the wavelength that corresponds to $\theta = 90°$ is

$$\lambda = d\sin(90°)/3 = 600\text{ nm}.$$

Any wavelength greater than this will not be seen. Thus, $600\text{ nm} < \theta \le 700$ nm are absent.

(b) The slit separation d needs to be decreased.

(c) In this case, the 400 nm wavelength in the $m = 4$ diffraction is to occur at 90°. Thus

$$d_{\text{new}} \sin\theta = m\lambda \quad \Rightarrow \quad d_{\text{new}} = (4)(400 \text{ nm})/\sin(90°) = 1600 \text{ nm} .$$

This represents a change of

$$|\Delta d| = d - d_{\text{new}} = 200 \text{ nm} = 0.20 \text{ μm}.$$