Practice

Understanding Concepts

1. Calculate the angle at which 7.50×10^2 nm light produces a second minimum if the single-slit width is 2.0 μm.

2. The first dark fringe in a certain single-slit diffraction pattern occurs at an angle of 15° for light with a wavelength of 580 nm. Calculate the width of the slit.

3. Red light passing through a single narrow slit forms an interference pattern. If the red light were replaced by blue, the spacing of the intensity maxima (where constructive interference takes place) would be different. In what way? Why?

4. Helium–neon laser light ($\lambda = 6.328 \times 10^{-7}$ m) passes through a single slit with a width of 43 μm onto a screen 3.0 m away. What is the separation of adjacent minima, other than those on either side of the central maximum?

5. Monochromatic light falls onto a slit 3.00×10^{-6} m wide. The angle between the first dark fringes on either side of the central maximum is 25.0°. Calculate the wavelength.

6. A single slit, 1.5×10^{-5} m wide, is illuminated by a ruby laser ($\lambda = 694.3$ nm). Determine the angular position of the second maximum.

7. The first dark fringe in the diffraction pattern of a single slit is located at an angle of $\theta_a = 56°$. With the same light, the first dark fringe formed with another single slit is located at $\theta_b = 34°$. Calculate the ratio $\frac{w_a}{w_b}$ of the widths of the two slits.

Answers

1. 49°
2. 2.2×10^{-6} m
4. 4.4 cm
5. 6.49×10^{-7} m
6. 6.6°
7. 0.67

Section 10.2 Questions

Understanding Concepts

1. You are photographing a single-slit diffraction pattern from monochromatic light. How would your pattern differ if the wavelength were doubled? if the both the wavelength and slit width doubled at the same time?

2. Monochromatic light falls on a single slit with a width of 2.60×10^{-6} m. The angle between the first dark fringes on either side of the central maximum is 12°. Calculate the wavelength.

3. The ninth dark fringe in a single-slit diffraction pattern, from a source of wavelength 6.94×10^{-7} m, lies at an angle of 6.4° from the central axis. Calculate the width of the slit.

4. A single slit 2.25×10^{-6} m wide, illuminated with monochromatic light, produces a second-order bright fringe at 25°. Calculate the wavelength of the light.

5. A narrow, single slit with a width of 6.00×10^{-6} m, when illuminated by light of wavelength $\lambda = 482$ nm, produces a diffraction pattern on a screen 2.00 m away. Calculate (a) the angular width of the central maximum in degrees and (b) the width in centimetres.

6. What would be the angular width in question 5 if the entire setup were immersed in water ($n_w = 1.33$) instead of air ($n_a = 1.00$)?

7. A helium–neon laser operating at 632.7 nm illuminates a single slit 1.00×10^{-5} m wide. The screen is 10.0 m away. Calculate the separation of adjacent maxima, other than the central maximum.

8. A beam from a krypton ion laser ($\lambda = 461.9$ nm) falls on a single slit, producing a central maximum 4.0 cm wide on a screen 1.50 m away. Calculate the slit width.

9. Sodium-vapour light with an average wavelength of 589 nm falls on a single slit, 7.50×10^{-6} m wide.
   (a) At what angle is the second minimum?
   (b) What is the highest-order minimum produced?

10. Alcor and Mizar are two stars in the handle of the Big Dipper (Ursa Major). They look like one star to the unaided eye (unless the conditions are really good); through binoculars or a telescope they are easily distinguished as two. Explain why this is the case.

Applying Inquiry Skills

11. Predict what you will see if you hold a paper clip between your thumb and forefinger in the beam of a helium–neon laser. Try it!

Do not let direct laser beams or reflected beams go straight into anyone's eyes.

12. Digital images are made up of "picture units," or pixels. The picture of the woman in **Figure 12** is 84 pixels wide and 62 pixels high. How could you improve the resolution? (*Hint:* Consider aperture and distance.)

Figure 12