Chapter-37

1. Light of wavelength 540 nm passes through a slit of width 0.200 mm. (a) The width of the central maximum on a screen is 8.10 mm. How far is the screen from the slit? (b) Determine the width of the first bright fringe to the side of the central maximum.

 In a single slit diffraction pattern, with the slit having width *a*, the dark fringe of order *m* occurs at angle , where  and . The location, on a screen located distance *L* from the slit, of the dark fringe of order *m* (measured from *y* = 0 at the center of the central maximum) is



 (a) The central maximum extends from the *m* = +1 dark fringe on one side to the *m* = –1 dark fringe on the other side, so the width of this central maximum is

 

 Therefore,

 

 (b) The first order bright fringe extends from the *m* = 1 dark fringe to the *m* = 2 dark fringe, or

 

 Note that the width of the first order bright fringe is exactly one half the width of the central maximum.

1. Yellow light of wavelength 589 nm is used to view an object under a microscope. The objective lens diameter is 9.00 mm. (a) What is the limiting angle of resolution? (b) Suppose it is possible to use visible light of any wavelength. What color should you choose to give the smallest possible angle of resolution, and what is this angle? (c) Suppose water fills the space between the object and the objective. What effect does this change have on the resolving power when 589-nm light is used?

 (a) The limiting angle for the resolution of the microscope is



 (b) For a smaller angle of diffraction we choose the smallest visible wavelength, violet at 400 nm, to obtain

 

 (c) The wavelength in water is shortened to its vacuum value divided by the index of refraction. The resolving power is improved, with the minimum resolvable angle becoming

 

 Better than water for many purposes is oil immersion.

1. A grating with 250 grooves/mm is used with an incandescent light source. Assume the visible spectrum to range in wavelength from 400 nm to 700 nm. In how many orders can one see (a) the entire visible spectrum and (b) the short-wavelength region of the visible spectrum?

 The grating spacing is



 Solving for m in Equation 38.7 gives

 

 (a) The number of times a complete order is seen is the same as the number of orders in which the long wavelength limit is visible.

 

 or 

 (b) The highest order in which the violet end of the spectrum can be seen is:

 

 or 

1. *Why is the following situation impossible?* A technician is measuring the index of refraction of a solid material by observing the polarization of light reflected from its surface. She notices that when a light beam is projected from air onto the material surface, the reflected light is totally polarized parallel to the surface when the incident angle is 41.0°

 In Equation 37.10, , the index of refraction *n*2 of the solid material must be larger than that of air (*n*1 = 1.00). Therefore, we must have . For this to be true, we must have , so  is not possible.

 **P37.29** For the polarizing angle,

 

 For the critical angle for total internal reflection,

 

 Therefore,

 