Phys102 Written Assignment #8

Textbook (Giancoli, SFU edition), page 947, question #19.

19. Two 0.010-mm-wide slits are 0.030mm apart (center to center). Determine (*a*) the spacing between interference fringes for 580 nm light on a screen 1.0 m away and (*b*) the distance between the two diffraction minima on either side of the central maximum of the envelope.

[Solution]

(*a*) The angle to each of the maxima of the double slit are given by Eq. 34-2a. The distance of a fringe on the screen from the center of the pattern is equal to the distance between the slit and screen multiplied by the tangent of the angle. For small angles, we can set the tangent equal to the sine of the angle. The fringe spacing is found by subtracting the distance between two adjacent fringes.

$$\sin\theta_m = \frac{m\lambda}{d} \qquad y_m = l\tan\theta_m \approx l\sin\theta_m = l\frac{m\lambda}{d}$$

$$\Delta y = y_{m+1} - y_m = l\frac{(m+1)\lambda}{d} - l\frac{m\lambda}{d} = \frac{l\lambda}{d} = \frac{(1.0\,\text{m})(580\times10^{-9}\,\text{m})}{0.030\times10^{-3}\text{m}} = 0.019\,\text{m} = \boxed{1.9\,\text{cm}}$$

(*b*) We use Eq. 35-1 to determine the angle between the center and the first minimum. Then by multiplying the distance to the screen by the tangent of the angle we find the distance from the center to the first minima. The distance between the two first order diffraction minima is twice the distance from the center to one of the minima.

$$\sin\theta_1 = \frac{\lambda}{D} \;\rightarrow\; \theta_1 = \sin^{-1}\frac{\lambda}{D} = \sin^{-1}\frac{580\times10^{-9}\,\text{m}}{0.010\times10^{-3}\text{m}} = 3.325^\circ$$

$$y_1 = l\tan\theta_1 = (1.0\,\text{m})\tan 3.325^\circ = 0.0581\text{ m}$$

$$\Delta y = 2y_1 = 2(0.0581\text{m}) = 0.116\,\text{m} \approx \boxed{12\,\text{cm}}$$