Chapter 36 End-of-Chapter Problems

Halliday & Resnick, 10th Edition

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Hit me where it Matters

1 Problem 1

The distance between the first and fifth minima of a single-slit diffraction pattern is 0.35 mm with the screen 40 cm away from the slit, when light of wavelength 550 nm is used. (a) Find the slit width. (b) Calculate the angle θ of the first diffraction minimum.

1.1 Solution (a)

Estimate $\sin\theta \approx \theta \approx \tan\theta = \frac{y}{D}$. $D = 40\,\text{cm}$ and never changes in this case. y does change, so we can create a Δy.

$$a\sin\theta = a\frac{y}{D} = m\lambda \tag{1}$$

We can create a Δy on one side and Δm on the other, for a separation between the first and fifth fringes.

$$a\frac{y}{D} = m\lambda \tag{2}$$

$$a\frac{\Delta y}{D} = \Delta m\lambda \tag{3}$$

$$a = \frac{\Delta m}{\Delta y}\lambda D = \frac{4}{0.35\,\text{mm}} * 550\,\text{nm} * 0.4\,\text{m} = \boxed{2.51\,\text{mm}} \tag{4}$$

1.2 Solution (b)

Divide the distance between fringes by four.

$$\Delta y = \frac{0.35\,\text{mm}}{4} = 87.5 \times 10^{-6}\,\text{m} \tag{5}$$

Divide this by the distance to the screen to find the approximate angle.

$$\theta = \frac{87.5 \times 10^{-6}\,\text{m}}{0.4\,\text{m}} = \boxed{2.2 \times 10^{-4}} \tag{6}$$

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2.1 Solution

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3.1 Solution

4 Problem 13

4.1 Solution

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5.1 Solution

6 Problem 19

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