651.

Problem 46.3 (RHK)

Monochromatic light of wavelength 441 nm falls on a narrow slit. On a screen 2.16 m *away, the distance between the second minimum and the central maximum is* 1.62 cm. (a) *We have to calculate the angle of diffraction* θ *of the second minimum*. (b) *We have to find the width of the slit*.

Solution:

Let the slit width be a. For a monochromatic light of wavelength λ the condition for diffraction minima is

$a\sin\theta = m\lambda,\ m = 1, 2, 3....$

Data of the problem are:

The distance between the second minimum and central maximum is

$y_2 = 1.62$ cm.

And, the distance of the screen from the slit is

$D = 2.16$ m.

The angle from the line joining the centre of the slit with the central maximum θ_2 will be

$$\theta_2 = \frac{1.62\times10^{-2}}{2.16}\ \text{rad} = 0.0075\ \text{rad} = 0.43^0.$$

The angle θ_2 is small, and we may approximate

$\sin\theta_2$; $\tan\theta_2$; θ_2.

We note that

$$a\sin\theta_2 = 2\lambda,$$

or

$$a\theta_2 = 2\lambda,$$

or

$$a = \frac{2\lambda}{\theta_2} = \frac{2\times441}{0.0075}\ \text{nm} = 118\ \mu\text{m}.$$