Answer on Question #75229, Physics / Optics

The diffraction pattern due to a single slit of width 0.4 cm is obtained with the help of a lens of focal length 30 cm. If wavelength of the light used is 589 nm, calculate the distance of the first dark fringe and the consecutive bright fringe from the axis.

Solution:

Given :

$d = 0.4\,cm = 4 \times 10^{-3}$ m

$f = 0.3\,m$

$\lambda = 589 \times 10^{-9}\,m$

To Find :

$(x_1)_{min} = ?$

$(x_2)_{max} = ?$

For first dark band the condition of minima is

$$\sin\theta = \frac{\lambda}{d}$$

$$\sin\theta \approx \theta$$

and

$$\theta = \frac{(x_1)_{min}}{f}$$

or

$$(x_1)_{min} = f\theta = f\frac{\lambda}{d} = \frac{(0.3\,m)(589 \times 10^{-9}\,m)}{4 \times 10^{-3}\,m} = 44.2 \times 10^{-6}\,m$$

For first secondary maximum,

$$d\sin\theta' = \frac{3}{2}\lambda$$

$$\sin\theta' \approx \theta'$$

So,

$$(x_2)_{max} = f\theta' = \frac{3}{2}\frac{\lambda f}{d} = \frac{3}{2}\frac{(0.3\,m)(589 \times 10^{-9}\,m)}{4 \times 10^{-3}\,m} = 66.3 \times 10^{-6}\,m$$

Answer: $44.2 \times 10^{-6}\,m$; $66.3 \times 10^{-6}\,m$.