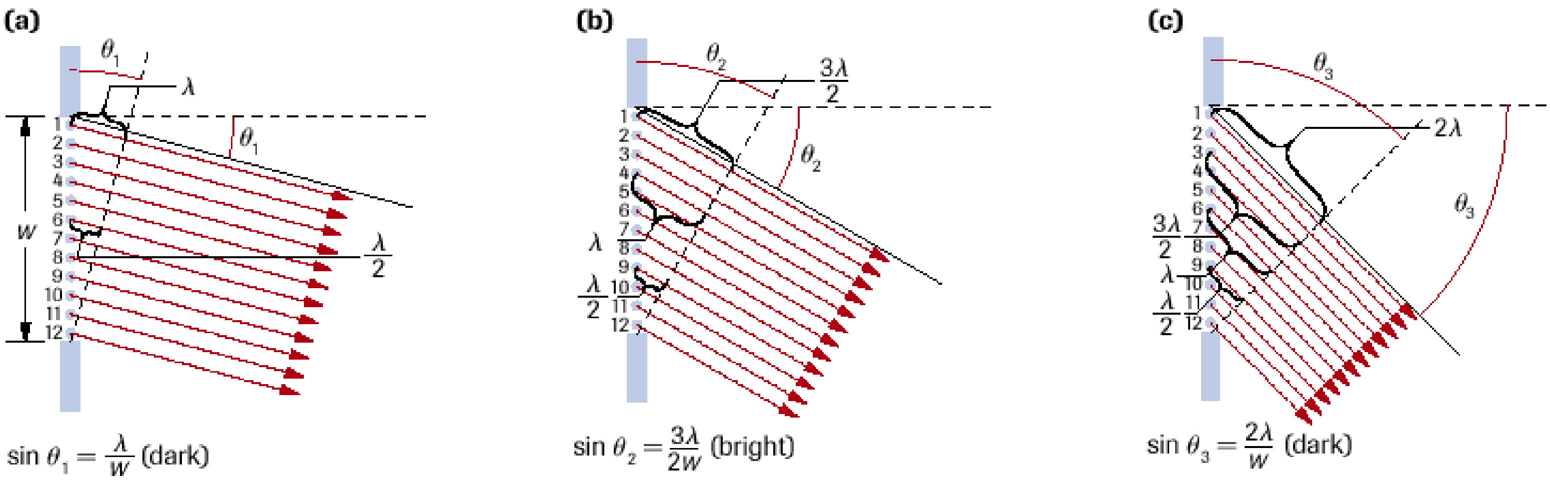
Diffraction Through a Single Slit

Light passing through a single, narrow slit is diffracted. The amount the light is diffracted depends on

- The wavelength of the light
- The width of the slit
- The distance from the slit to the screen



For the first dark fringe, adjacent to the central maximum,

$$\sin\theta_1 = \frac{\lambda}{w}$$

And for the next dark fringe,

$$\sin\theta_2 = \frac{2\lambda}{w}$$

So in general, for dark fringes,

$$\sin\theta_n = \frac{n\lambda}{w}$$

So if y_n is the distance from the central maximum to the n^{th} nodal fringe, (n = 1,2,3 ...)

$$y_n = \frac{nL\lambda}{w}$$

And for bright fringes (maxima),

$$\sin\theta_n = \frac{(n+\frac{1}{2})\lambda}{w}$$

And thus ...

$$y_n = \frac{(n+\frac{1}{2})L\lambda}{w}$$

And for the distance between successive like fringes,

$$\Delta y = \frac{L\lambda}{w}$$

Example: A narrow, single slit with a width of 6.8×10^{-6} m is illuminated by light of wavelength 610 nm and a diffraction pattern is produced on a screen 3.4 m away. Determine the

a) angular width of the central maximum.
b) width of the central maximum.

a) To find the angular width of the central max, find the angle for the 1st order dark fringe and double it.

$$\sin\theta_n = \frac{n\lambda}{w} \longrightarrow \sin\theta_1 = \frac{(1)(6.10\times 10^{-7})}{6.8\times 10^{-6}}$$

$$\theta_1 = 5.1^o$$

So the angular width of the central max is 10.2°

b) To find the width of the central max, use distances.

$$y_n = \frac{nL\lambda}{w} \longrightarrow y_1 = \frac{(1)(3.4)(6.1\times 10^{-7})}{6.8\times 10^{-6}}$$

$$y_1 = 0.31\,m$$

So the width of the central max is 0.62 m or 62 cm.