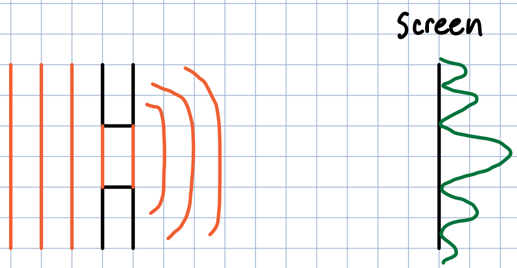
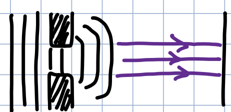
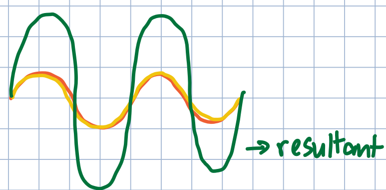
When light, behaving as a wave passes through an opening, it bends, continuing at the same velocity and with the same wave length.



Why does the intensity change at various points?

<u>Central Max</u>



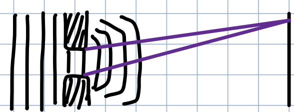


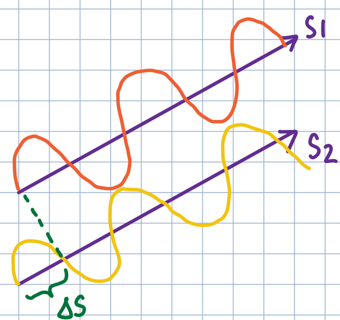
$\Delta S = 0$

(in phase)

Minima (Dark Bands)

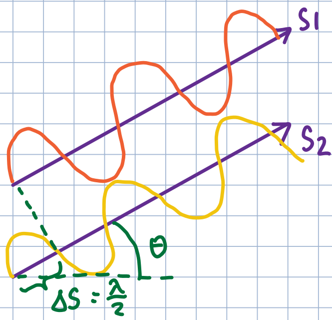
→ Total destructive interference



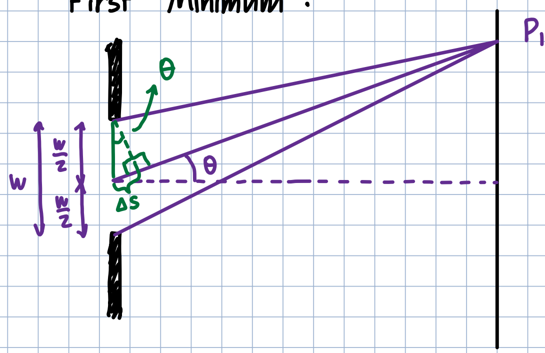


$\Delta S = \frac{\lambda}{2}$

Single slit minima formula



First Minimum :



$$\sin\theta = \frac{\Delta S}{\frac{w}{2}}$$

$$\Delta S = \frac{w}{2}\sin\theta$$

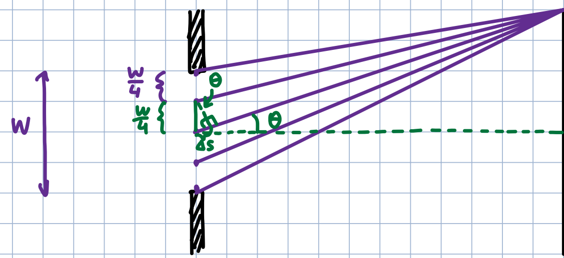
$$\frac{\lambda}{2} = \frac{w}{2}\sin\theta$$

$$\lambda = w\sin\theta$$

General Formula

$$n\lambda = w\sin\theta$$

2nd Minimum:



$$\sin\theta = \frac{\Delta S}{\frac{w}{4}}$$

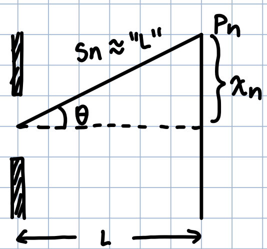
$$\Delta S = \frac{w}{4}\sin\theta$$

$$\frac{\lambda}{2} = \frac{w}{4}\sin\theta$$

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

$$2\lambda = w\sin\theta$$

Additional Approximation



$$\sin\theta = \frac{x_n}{L}$$

$$\frac{n\lambda}{w} = \frac{x_n}{L}$$

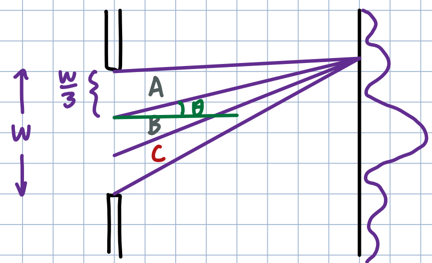
$$\tan\theta = \frac{x_n}{L}$$

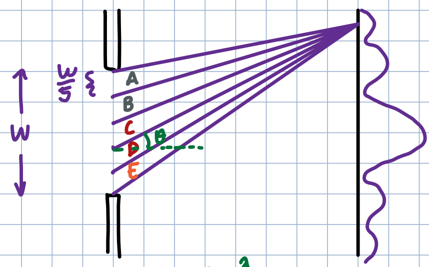
small angle

$$\sin\theta = \tan\theta$$

$$\sin\theta = \frac{x_n}{L}$$

Single Slit Maxima Formula





$$\Delta S = \frac{\lambda}{2}$$

$$\sin\theta = \frac{\Delta S}{\frac{W}{3}}$$

$$\frac{W}{3}\sin\theta = \Delta S$$

$$\frac{W}{3}\sin\theta = \frac{\lambda}{2}$$

$$\frac{3\lambda}{2} = W\sin\theta \qquad m=1$$

$$\Delta S = \frac{\lambda}{2}$$

$$\sin\theta = \frac{\Delta S}{\frac{W}{5}}$$

$$\frac{W}{5}\sin\theta = \Delta S$$

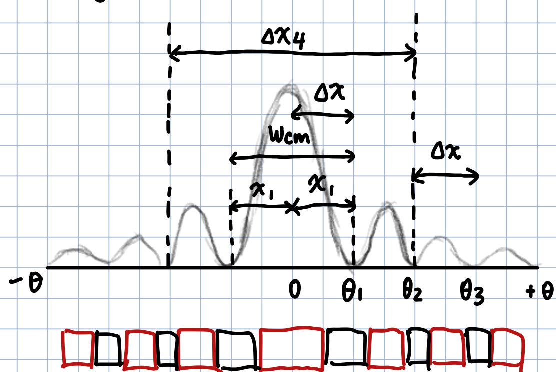
$$\frac{W}{5}\sin\theta = \frac{\lambda}{2}$$

$$W\sin\theta = \frac{5\lambda}{2} \qquad m=2$$

General Formula

$$\frac{(2m+1)\lambda}{2} = W\sin\theta$$

Single Slit : More Formulas



$$W_{cm} = 2x_1 = 2\Delta x_1$$

under line, we can't see intensity

Adjacent nodes:

$$x_n = \frac{n\lambda L}{w}$$

$$\Delta x = x_{n+1} - x_n$$

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

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

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

Nodes 2 intervals apart

$$\Delta x_2 = x_{n+2} - x_n$$

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

$$= 2\frac{\lambda L}{w}$$

Summary:

$n\lambda = w\sin\theta$

$\frac{2(m+1)\lambda}{2} = w\sin\theta$

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

$\Delta x_2 = 2\frac{\lambda L}{w}$

Approx:

$\frac{n\lambda}{w} = \frac{x_n}{L}$

$\sin\theta = \frac{x_n}{L}$

Example:

Find the distance between adjacent nodes and the width of the central max for a 633nm monochromatic light passing through a slit of width 50um onto a screen 2m away.

$\lambda = 633 \times 10^{-9} m$

$w = 50 \times 10^{-6} m$

$L = 2m$

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

$\Delta x = \frac{633\times10^{-9}(2)}{50\times10^{-6}}$

$= 0.0253m$