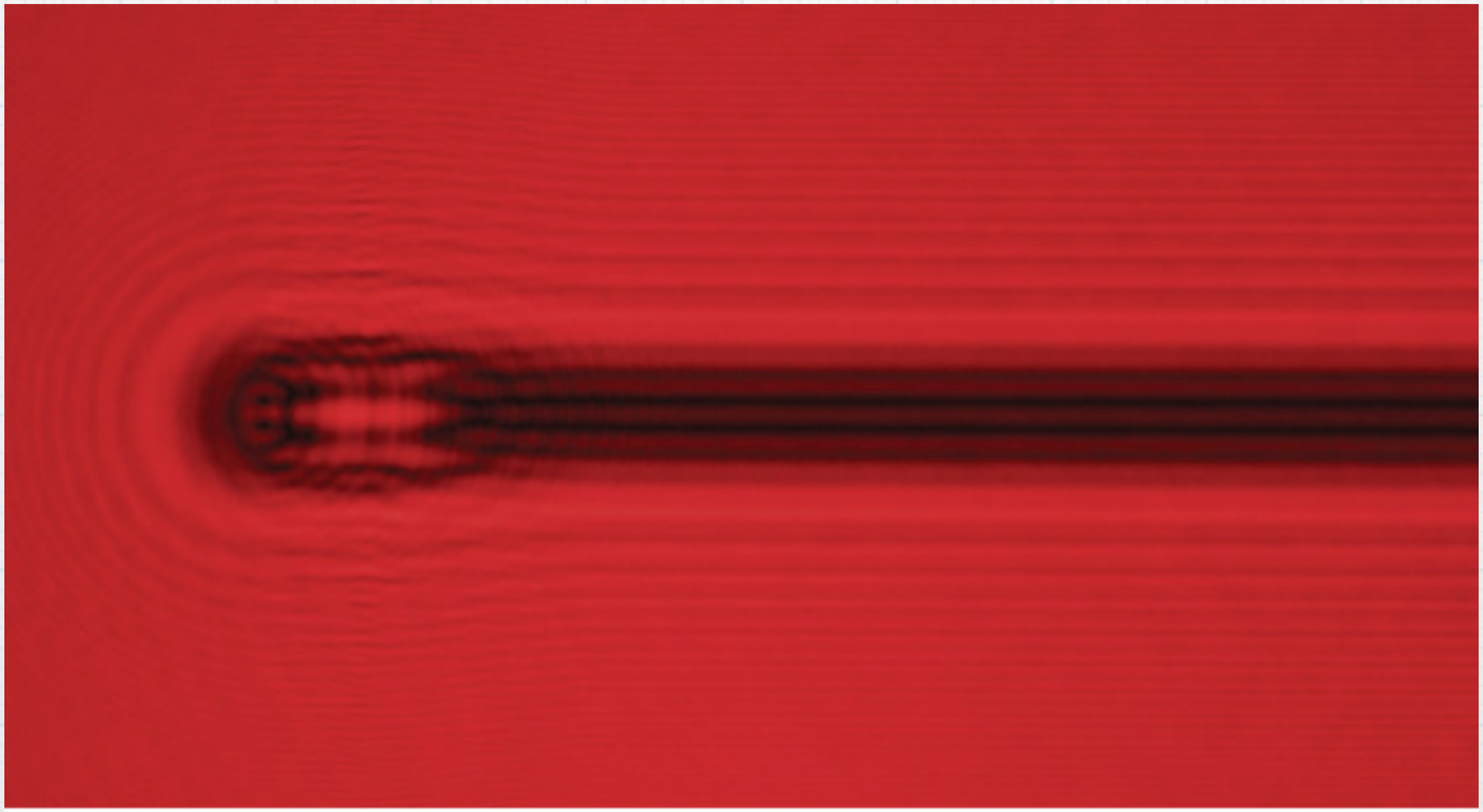
Diffraction and Interference



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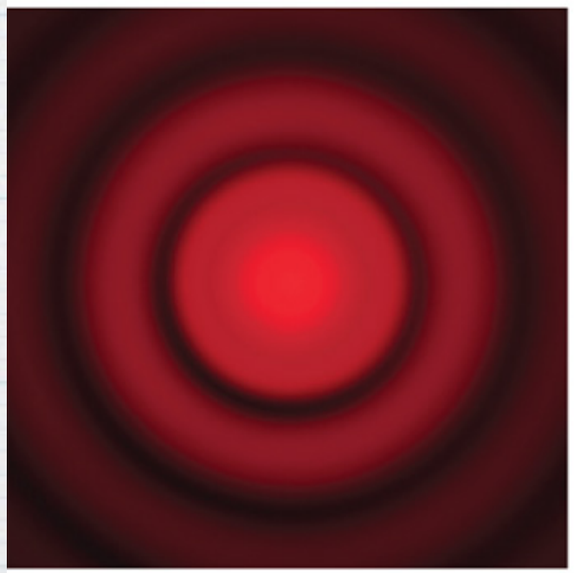
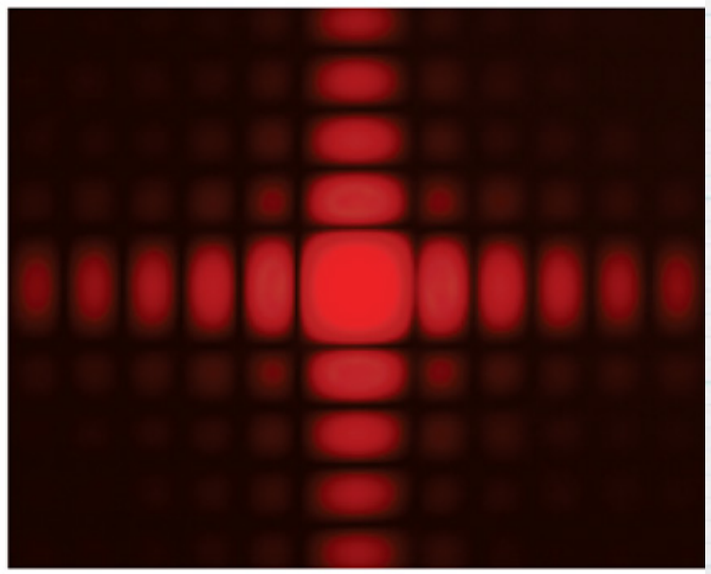
Diffraction, light passing through or around small apertures and objects



A.



B.

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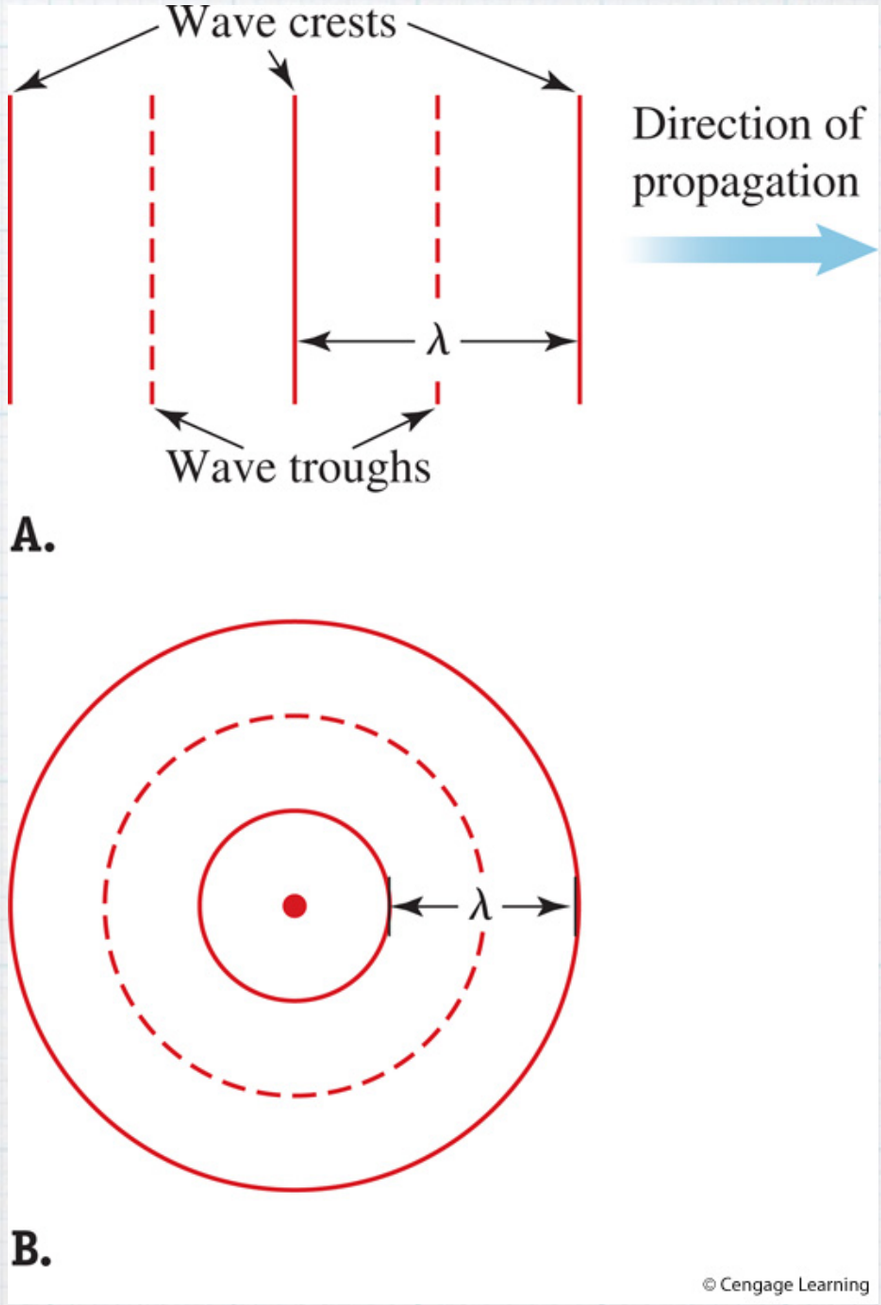
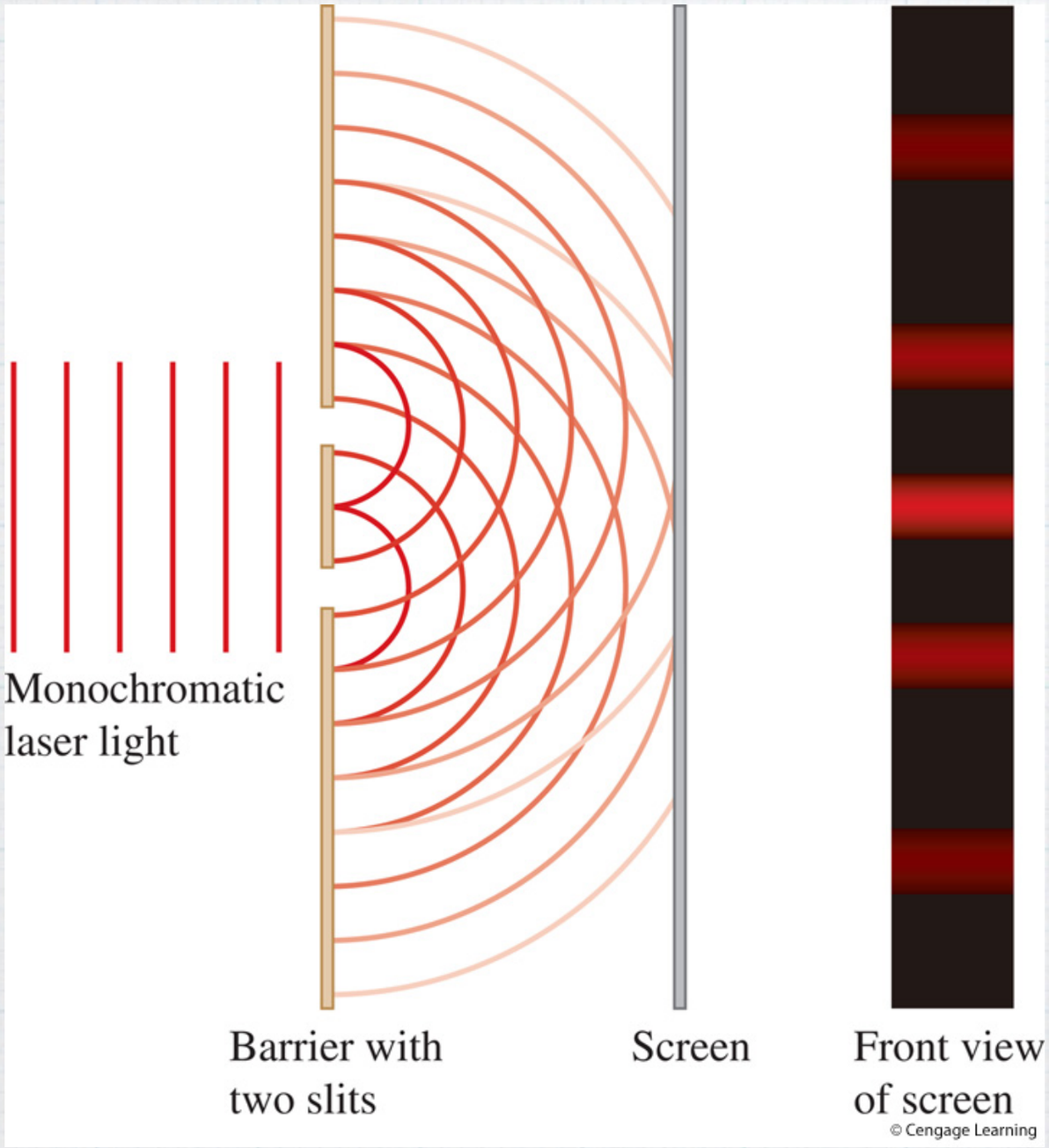
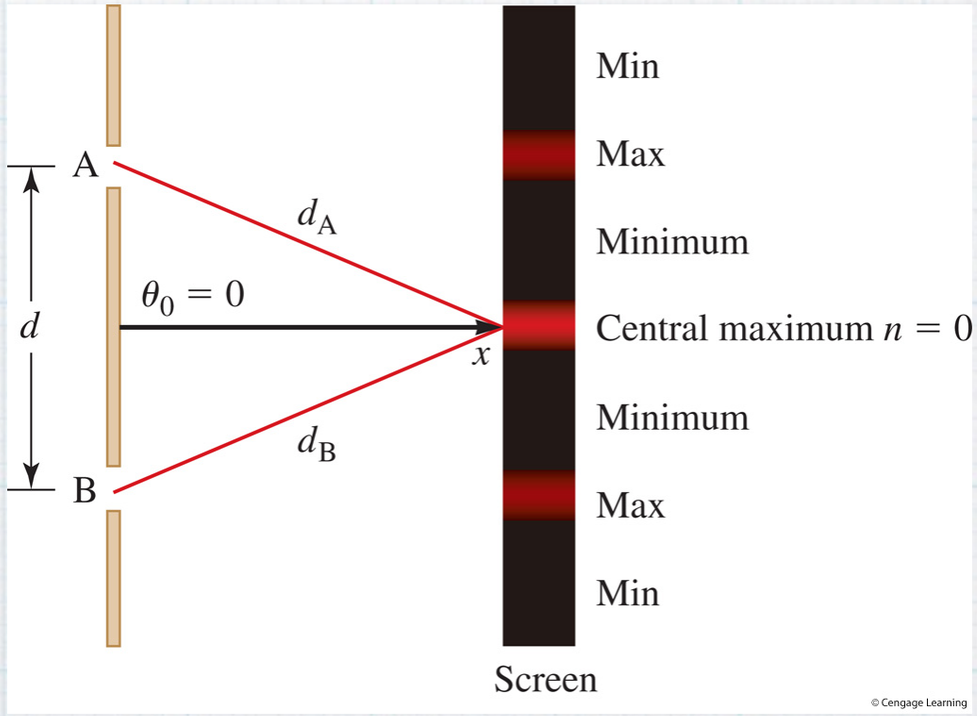
Light Propagates as a Wave



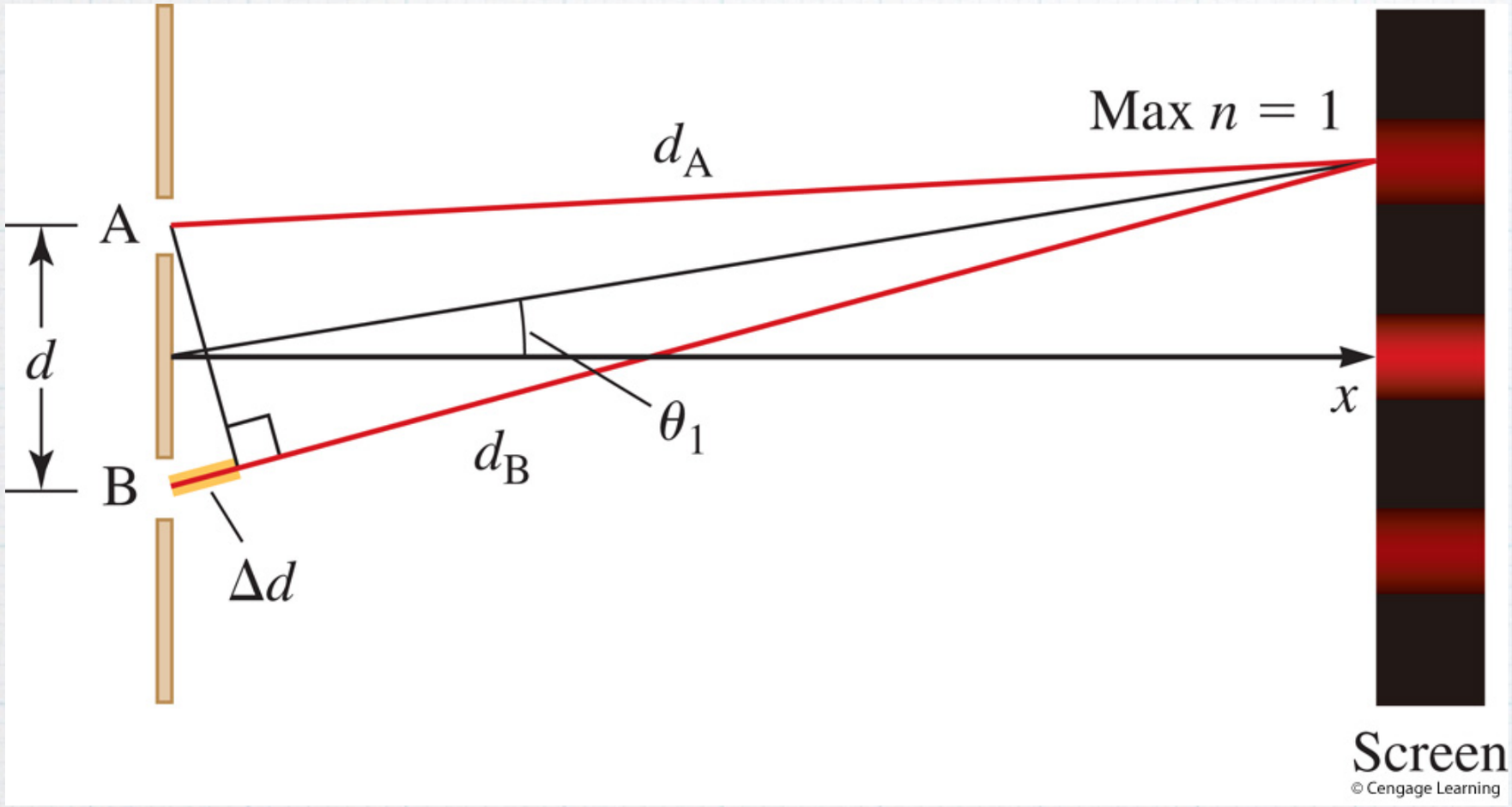
Either planar or spherical

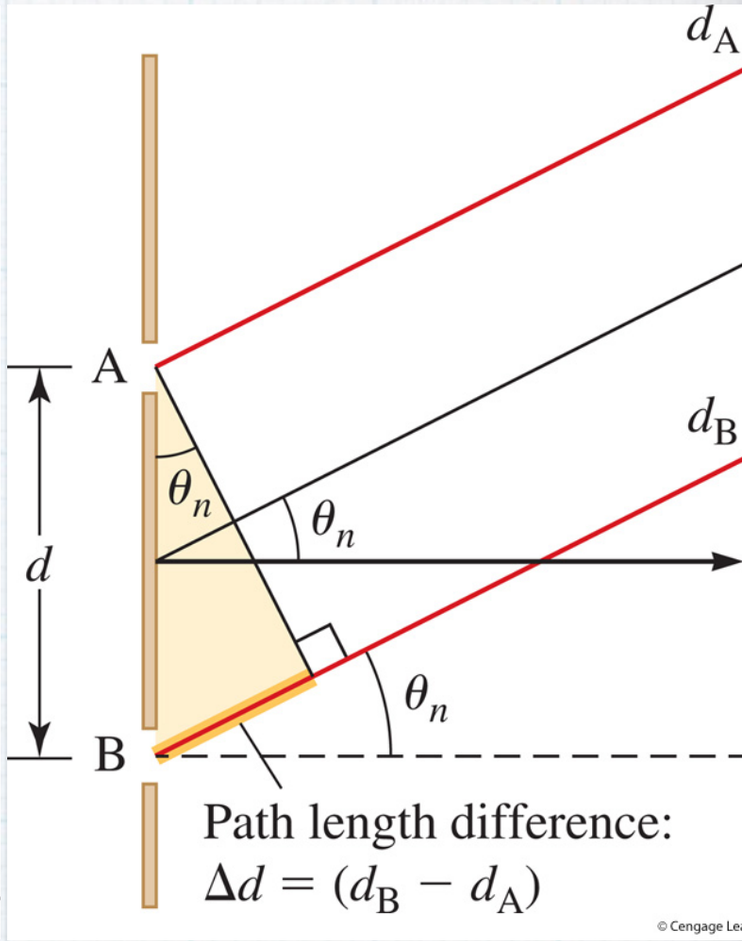
Double Slit Diffraction





Derivation





$$dsin(\theta_n) = n\lambda$$

Constructive

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

Destructive

$$n = 0, \pm1, \pm2, \pm3, \pm4, ...$$

location of modes/orders different for different wavelengths

Example

Small Angle Approximation

For small angles, say less than a few degrees

$$sin(\theta) \approx tan(\theta) = \frac{y}{L} \qquad L=x$$

$$d(\frac{y_n}{x}) \approx n\lambda$$

Constructive

$$d(\frac{y_n}{x}) \approx (n + \frac{1}{2}\lambda)$$

Destructive

Example

Intensity Double Slit Diffraction

$$I = I_{max} cos^2(\frac{\psi}{2}) = \frac{2E_0^2}{\mu_0 c} cos^2(\frac{\psi}{2})$$

$$\psi = \frac{2\pi}{\lambda}\Delta d = \frac{2\pi}{\lambda} dsin(\theta)$$ phase difference

Show

$$E_A = E_0 sin(\omega t)$$

$$E_B = E_0 sin(\omega t + \psi)$$

$$E_{tot} = E_A + E_B$$

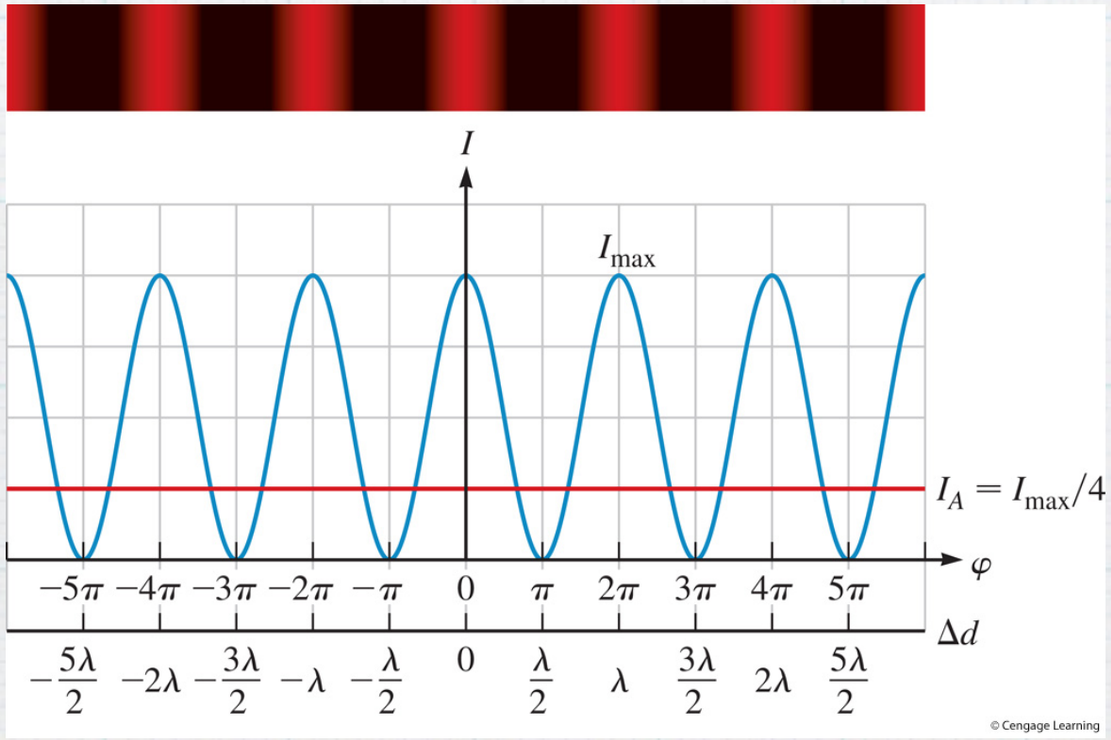
$$sin(\alpha) \pm sin(\beta) = 2sin(\frac{1}{2}(\alpha \pm \beta))cos(\frac{1}{2}(\alpha \mp \beta))$$

$$E_{tot} = 2E_0 cos(\frac{\psi}{2}) sin(\omega t + \frac{\psi}{2})$$

$$E_{max} = 2E_0 cos(\frac{\psi}{2})$$

$$E_{tot} = E_{max} sin(\omega t + \frac{\psi}{2})$$

$$I = \frac{E_{max}^2}{2\mu_0 c} = \frac{2E_0^2}{\mu c} cos^2(\frac{\psi}{2}) = I_{max} cos^2(\frac{\psi}{2})$$



Examples