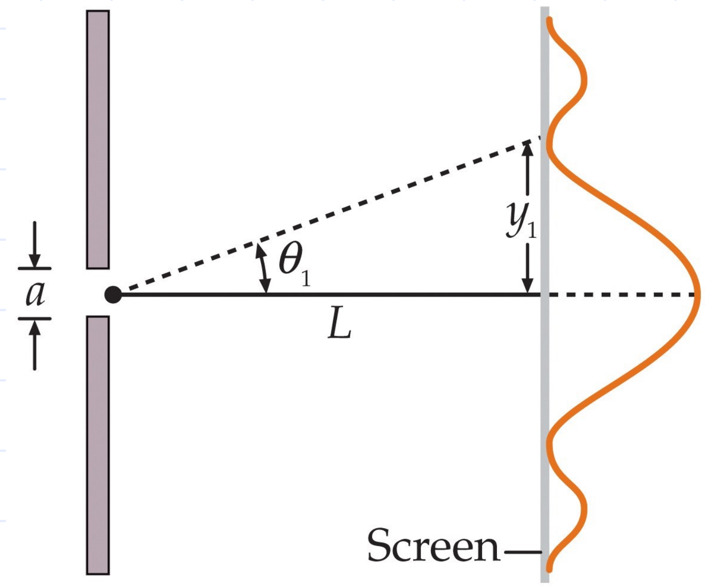
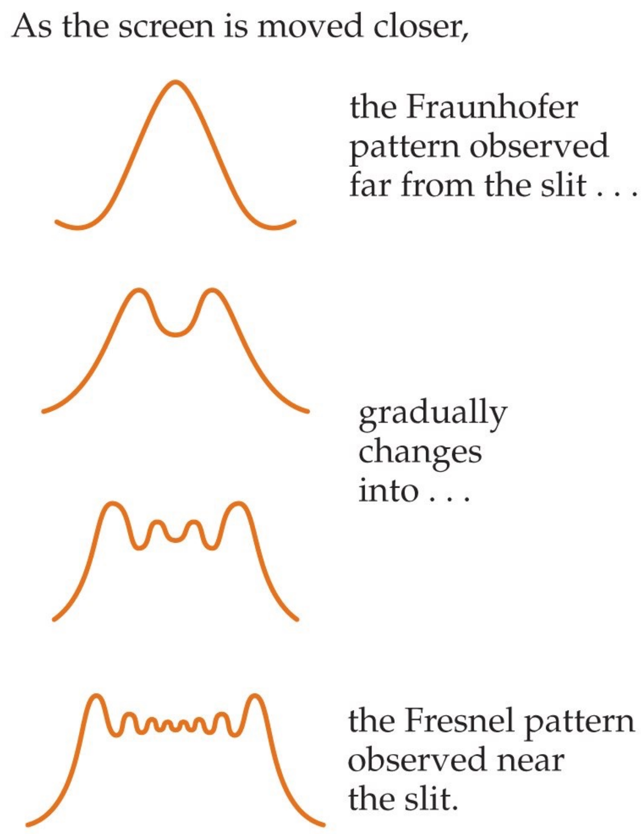
Diffraction

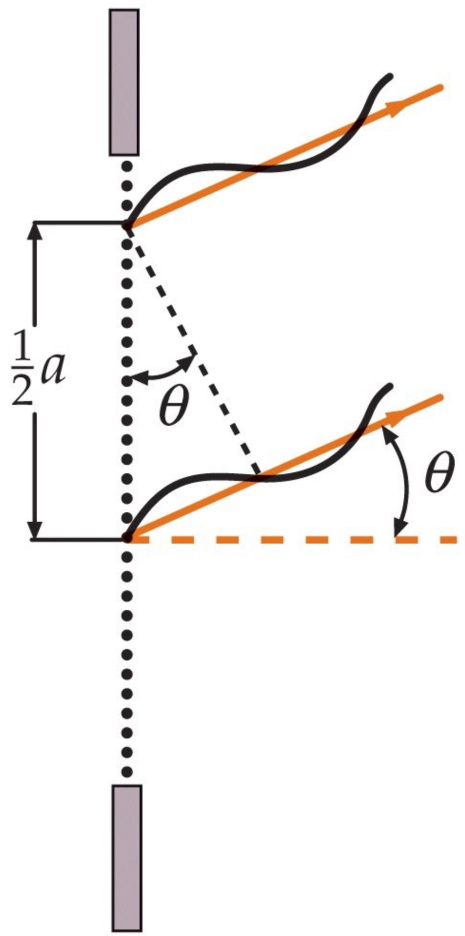
- For a single opening in a barrier, we might expect that a plane wave (light beam) would produce a bright spot the same size as the opening
- However, what we actually see is a series of light and dark fringes similar the double-slit interference
- We call this a diffraction pattern
- We will only consider the case where L is very large

  → Fraunhofer diffraction pattern



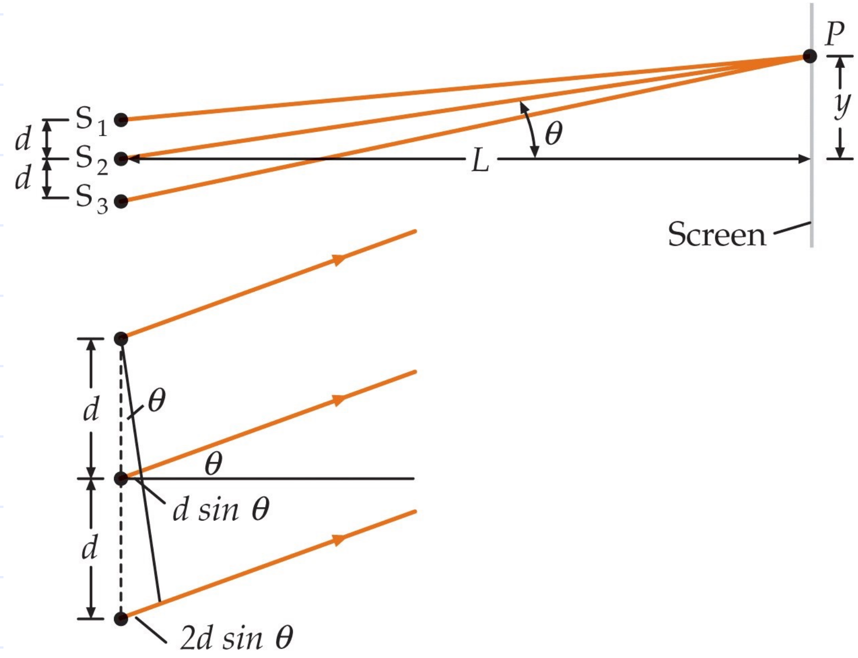
- For a screen close to the slit, a Fresnel diffraction pattern is created





- As for the double-slit problem, we take L to be large so that the rays from the slit are parallel
- Consider slit width a

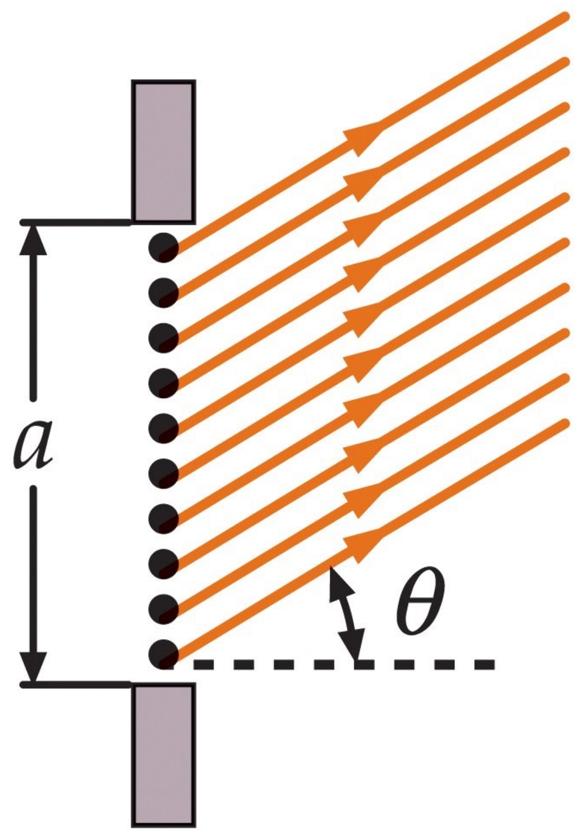
- Divide the slit into N equally space zones of width Δy. So, a=NΔy



- Using Huygen's principle, we consider each zone to be a point source emitting spherical rays

- Each contributes an electric field ΔE at point P on the screen

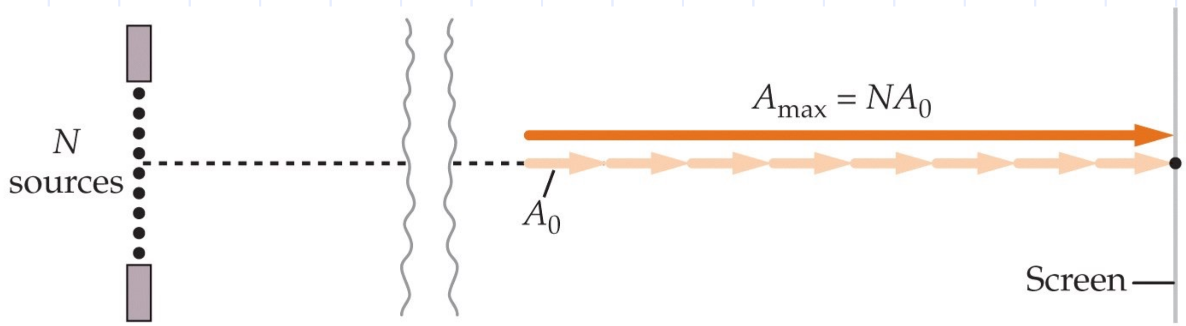
- The total electric field is the resultant from all zones

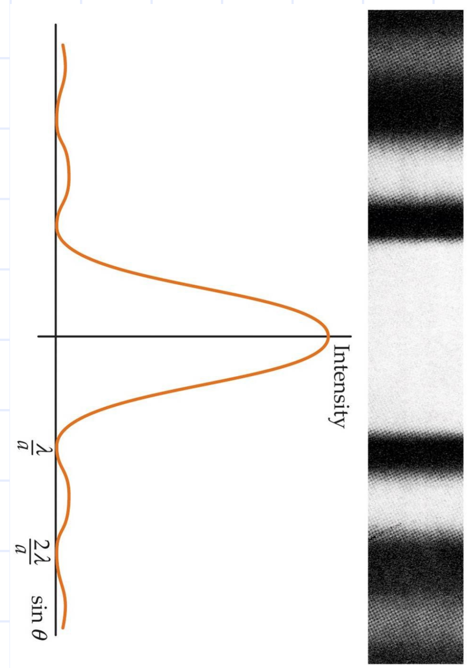


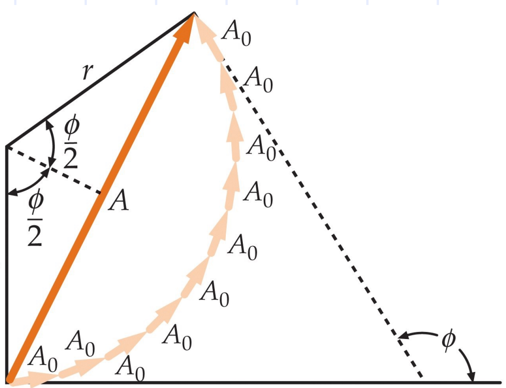
Example Problem

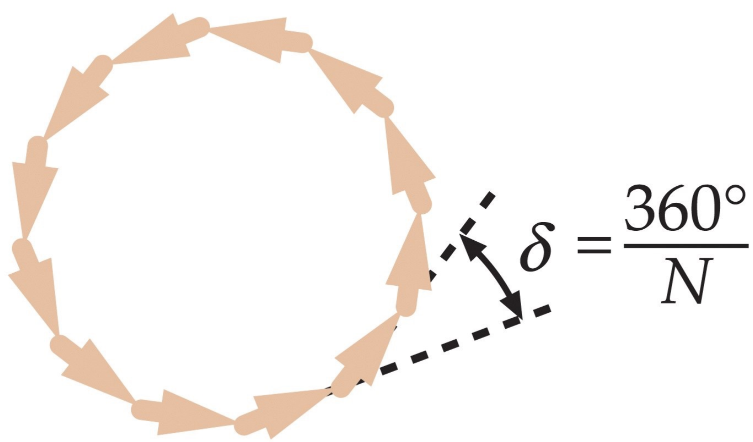
- Light of wavelength 587.5 nm illuminates a single slit 0.750 mm in width. (a) At what distance from the slit should a screen be located if the first minimum in the diffraction pattern is to be 0.850 mm from the center of the principal maximum? (b) What is the width of the central maximum?

Phasor diagrams



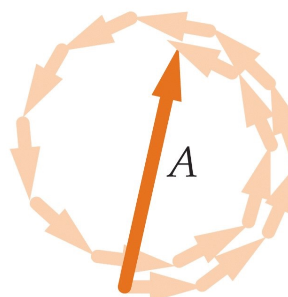






Circumference $C = \frac{2}{3} NA_0$

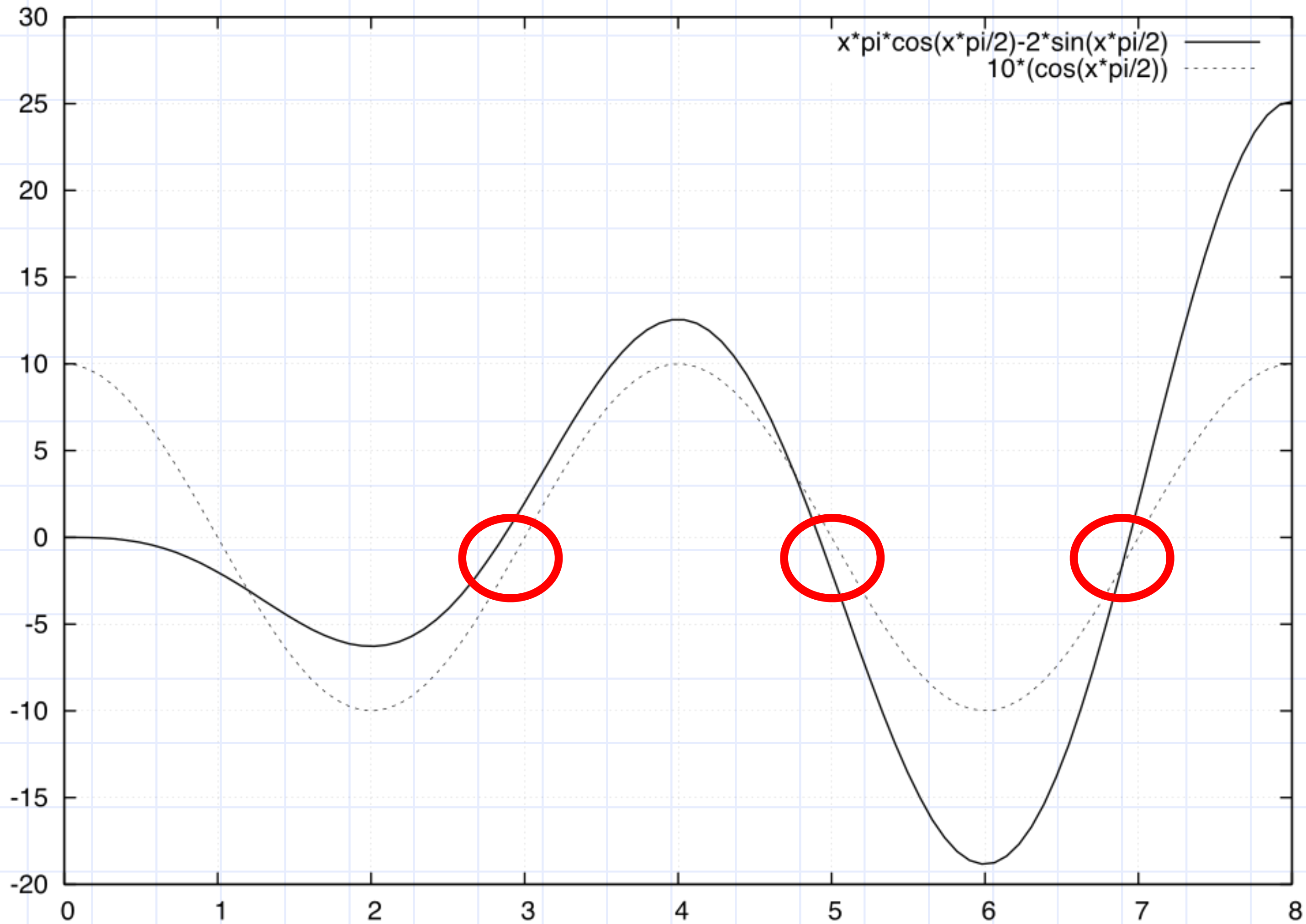
$= \frac{2}{3} A_{max} = \pi A$



$$A = \frac{2}{3\pi} A_{max}$$

$$A^2 = \frac{4}{9\pi^2} A_{max}^2$$

Maxima for single slit diffraction



Beta (Pi radians)