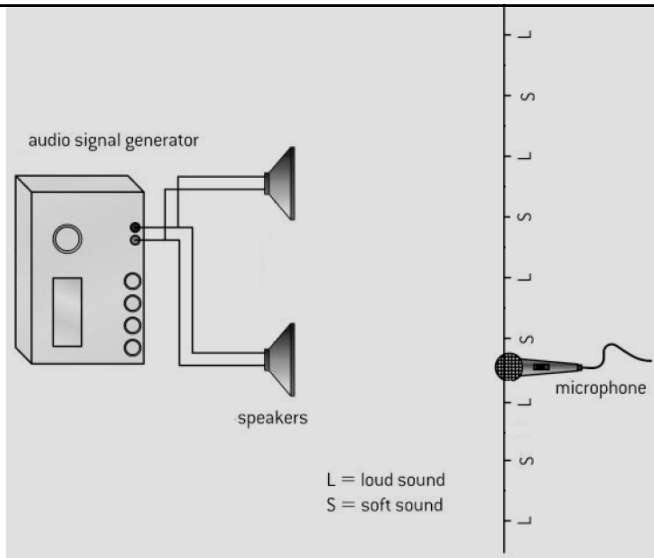
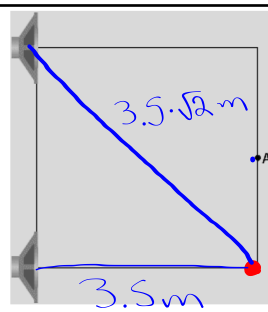


3. A square is 3.5 m on a side, and point A is the midpoint of one of its sides. On the side opposite this spot, two in-phase loudspeakers are located at adjacent corners. Standing at point A, you hear a loud sound and as you walk along the side of the square toward either empty corner, the loudness diminishes gradually but does not entirely disappear until you reach either empty corner, where you hear no sound at all. Find the wavelength of the sound waves.



$\Delta l = (n + \frac{1}{2})\lambda$

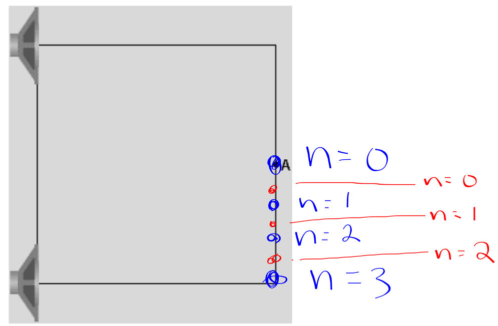
$n = 0$

$3.5 \cdot \sqrt{2}\,m - 3.5m$

$1.449m$

$\lambda = 2.9m$

4. The same set-up as above is used but now the frequency of sound emitted by both speakers is increased to 700 Hz. This time, as you walk along the side of the square from A toward an empty corner, you hear the loud sound at A repeatedly diminish to no sound and then increase to a maximum again. By the time you arrive at the corner and hear a loud sound, you have noticed the sound disappear and reappear three times. Use this information to estimate a speed for sound.

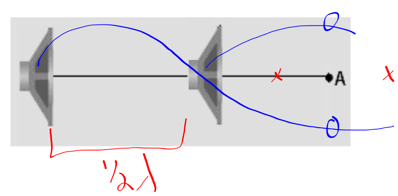


$\Delta l = n\lambda = 1.449\,m$

$\lambda = .483\,m$

$V = \lambda \cdot f = .438\,m \cdot 700\,Hz = 338\,m/s$

5. The two speakers now emit a frequency of 300 Hz and are placed in a line. Standing at location A, you can hear no sound. How far apart are the speakers?



$V = \lambda \cdot f$

338 m/s → V; 300 Hz → f

$\lambda = 1.13\,m$

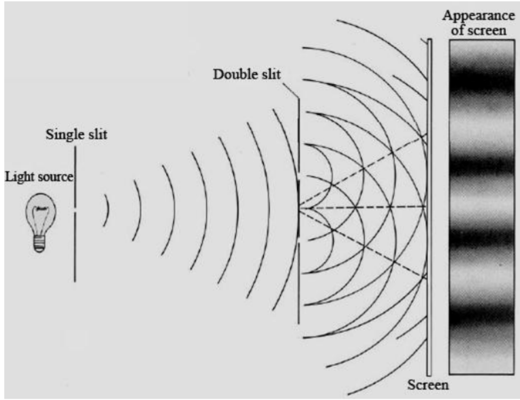
Diffraction and Interference of Light

IB 12

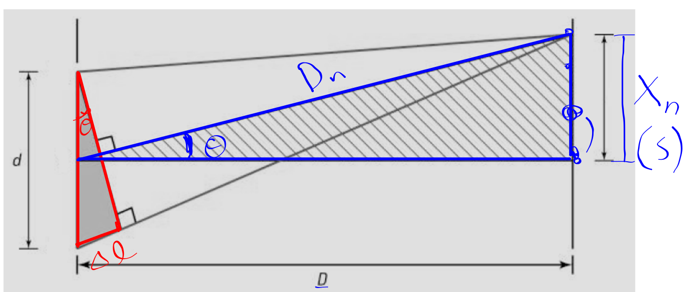
Young's Double Slit Experiment (1801)

Significance:

1) demonstrated light acts like a wave
2) first measurement of wavelength of light



Double Slit Formulas: Derivations for bright fringes



Angular displacement from the central maximum

$\sin\theta = \frac{X_n}{D_n} = \frac{s}{D}$

$\sin\theta = \frac{\Delta l}{d}$ ← $n\lambda$ ← $(n+\frac{1}{2})\lambda$

Linear displacement from the central maximum

$\frac{X_n}{D_n} = \frac{n\lambda}{d}$

$\frac{X_n}{D_n} = \frac{(n+\frac{1}{2})\lambda}{d}$

Fringe separation

$n=1: \; s = \frac{\lambda D}{d}$

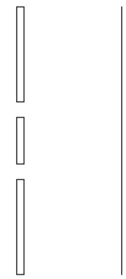
$n\lambda = d\sin\theta$

Small Angle Approximation: If θ is small then 1) $\sin\theta \approx \theta$ if θ is in radians and 2) $\sin\theta \approx \tan\theta$

1. In a double slit experiment, light whose wavelength is 6.0×10^{-7} m is shone through two slits that are 0.10 mm apart onto a screen that is 2.5 m away.

   a) At what angle from the central maximum will the first bright fringe appear?

   $\theta = \sin^{-1}\left(\frac{\lambda}{d}\right)$ 0.34°



$s = \frac{\lambda D}{d}$

$n\lambda = d\sin\theta$

   b) At what angle from the central maximum will the second bright fringe appear?

   $\theta_2 = \sin^{-1}\left(\frac{2\lambda}{d}\right)$ .69°

   c) What is the distance between the central maximum and the first bright fringe?

   $s = \frac{\lambda D}{d}$ 0.015m

   d) What is the distance between the central maximum and the second bright fringe?

   $s = \frac{2\lambda D}{d}$ .03 m

   e) What is the distance between any two adjacent bright fringes?

   0.015m

2. Will the fringes get closer together or further apart if:

   a) the slits are brought closer together?

   $\uparrow s = \frac{\lambda D}{\downarrow d}$

   b) the screen is brought closer to the slits?

   $\downarrow s = \frac{\lambda \downarrow D}{d}$

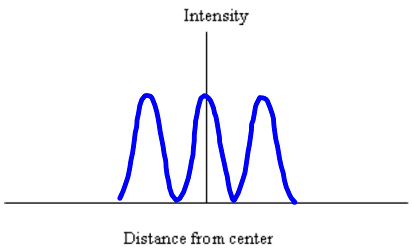
   c) a higher frequency of light is used?

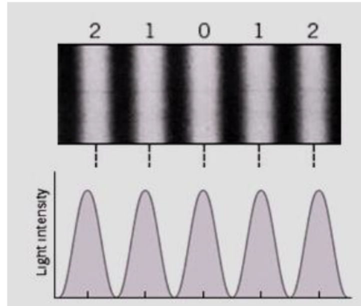
   $\downarrow s = \frac{\downarrow \lambda D}{d}$

Ideal Intensity Distributions for Double Slit Interference Patterns IB 12

Features: a) equal spacing and widths

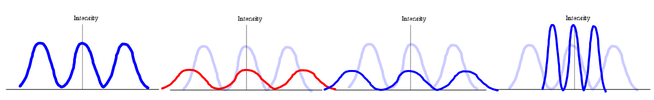
b) equal brightness

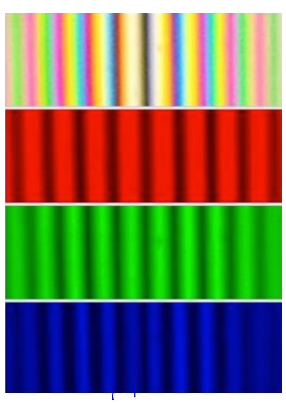




3. If the intensity distribution above is for a certain frequency of green light, sketch the following intensity plots.

a) Blue light b) Red light c) Closer slits d) Closer screen





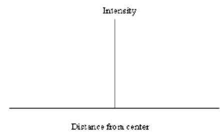
3. If the intensity distribution above is for a certain frequency of green light, sketch the following intensity plots.

a) Blue light

b) Red light

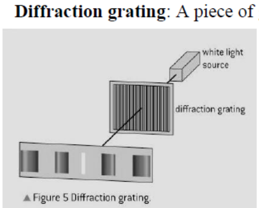
c) Closer slits

d) Closer screen

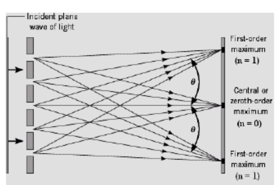


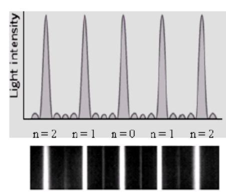
Multiple Slit Interference (Diffraction Grating)

Diffraction grating: A piece of glass or plastic with many equally spaced parallel slits on it.



▲ Figure 5 Diffraction grating





$I \propto A^2$

$I \propto n^2$

4. As the number of identical slits increases . . .

a)
maxima maintain location but become narrower and more intense

b)
minima are not totally dark