Huygens, Hooke and Young

1665 – Robert Hooke proposed the wave theory of light, a sharp contrast to Newton's accepted particle theory.

~ 1685 - Christiaan Huygens added to wave theory:

Huygen's Principle:

Every point on a wave front can be considered as a point source of tiny secondary wavelets that spread out in front of the wave, with the same speed and frequency as the wave itself.

Huygen's principle explains why diffraction occurs:

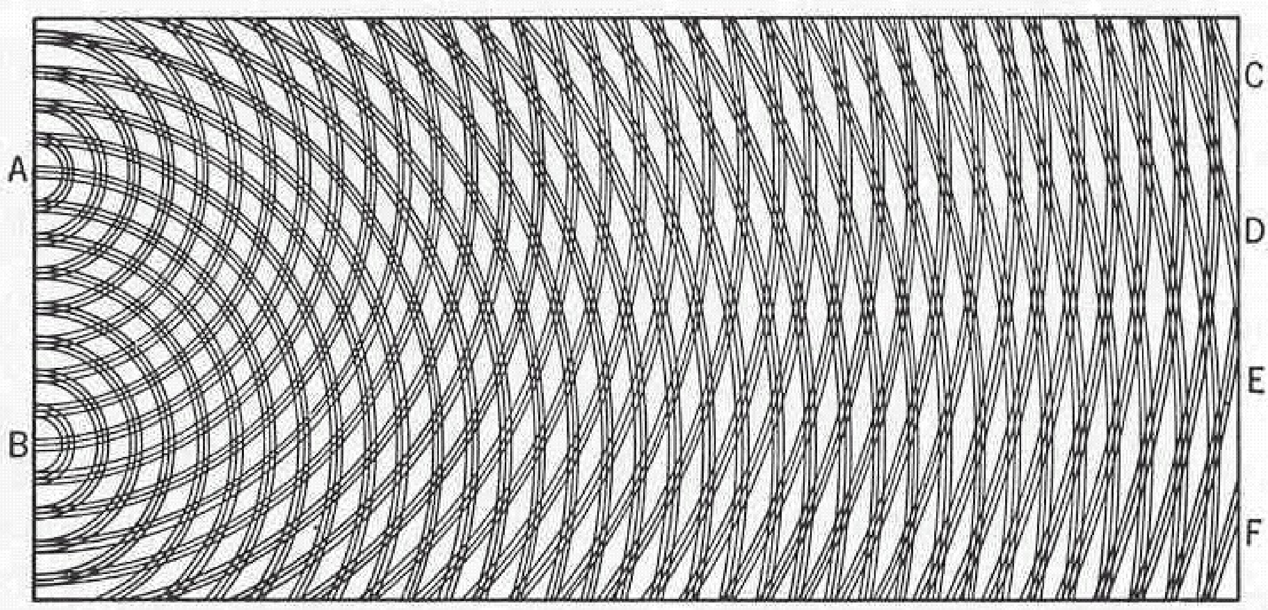
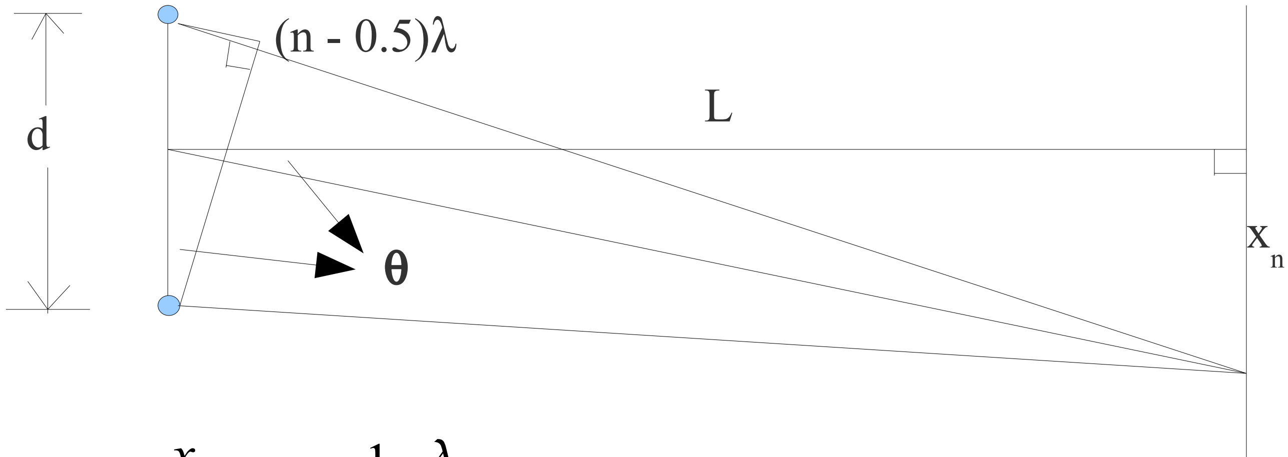


FIG. 1

Wavelets at A and B are identical, so interference is seen on the screen at CDEF (nodes/antinodes).



$$\sin\theta_n = \frac{x_n}{L} = (n - \frac{1}{2})\frac{\lambda}{d}$$ (because sin ~ tan for small angles)

where n = 1, 2, 3 ....

The above formula works for dark fringes (nodal) ONLY!!

For bright fringes,

$$\sin\theta_n = \frac{x_n}{L} = \frac{n\lambda}{d}$$

and from the above relationships we can derive an equation for the distance between successive nodes (or antinodes),

$$x_n = (n - \frac{1}{2})\frac{L\lambda}{d}$$, so

$$x_{n+1} - x_n = (n + 1 - \frac{1}{2})\frac{L\lambda}{d} - (n - \frac{1}{2})\frac{L\lambda}{d}$$

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

Examples:

1. A laser is used in Young's double-slit experiment and produces a fourth order nodal fringe at an angle of 4°. Find the wavelength of the light if the slits are 0.05 mm apart.

$$\sin\theta_n = (n - \frac{1}{2})\frac{\lambda}{d}$$

$$\sin 4^o = (4 - \frac{1}{2})\frac{\lambda}{5\times10^{-5}}$$

λ = 9.97 × 10^{-7} m (note – this is not visible light)

2. Monochromatic light falls on two narrow slits 0.07 mm apart. Successive antinodal fringes are seen 4 cm apart on a screen 4.3 m away. Determine the wavelength of the light.

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

$$4\times10^{-2} = \frac{(4.3)\lambda}{7\times10^{-5}}$$

λ = 6.5 × 10^{-7} m