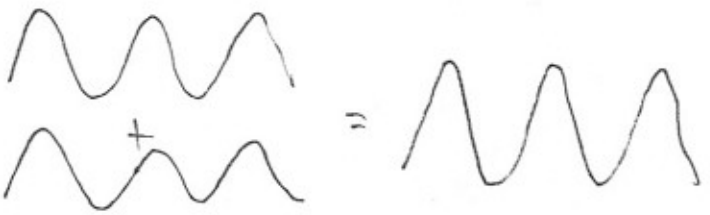
Young's Interference of Light and Two Source Interference of Waves

Consider two sources (in phase) of identical waves.

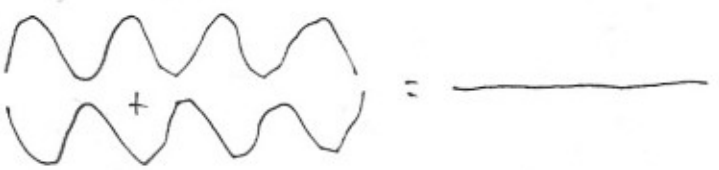
- Constructive interference



occurs when distances from two sources are equal OR when separated by an integer number of wavelengths

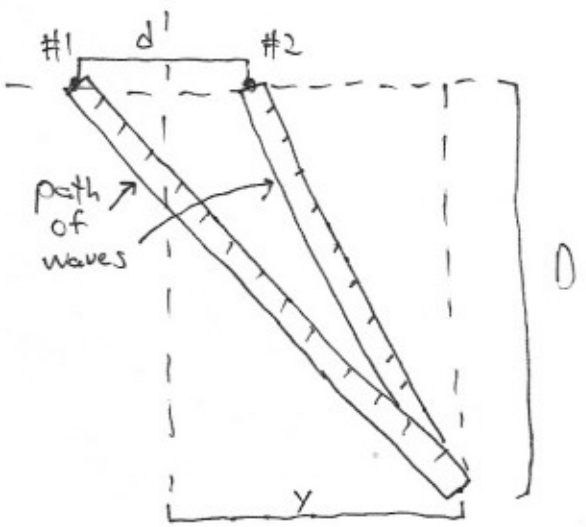
(1, -1, 2, -2, etc...)

Destructive interference

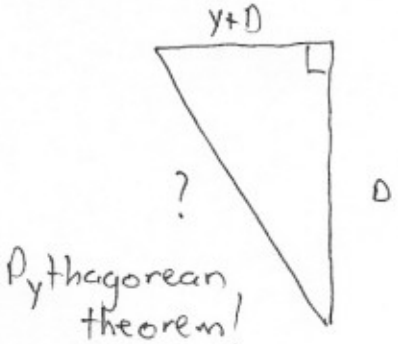


Occurs when distances are different by a half-integer wavelength

($\frac{1}{2}$, $-\frac{1}{2}$, $\frac{3}{2}$, $-\frac{3}{2}$, etc...)



Distance to source #1



Pythagorean theorem!

$$= \sqrt{D^2 + (y+d)^2}$$

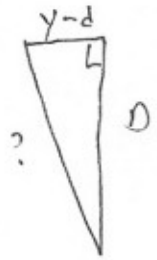
$$\approx \sqrt{D^2 + 2\left[\frac{(y+d)^2}{2}\right] + \frac{(y+d)^4}{4D^2}}$$

small if $y, d \ll D$

"much smaller than"

$$= D + \frac{(y+d)^2}{2D}$$

Distance to source #2



$$= \sqrt{D^2 + (y-d)^2}$$

$$\approx D + \frac{(y-d)^2}{2D}$$

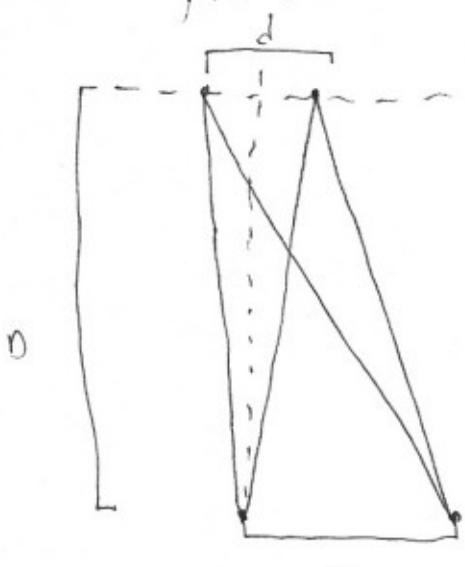
Difference in distances

$$= \cancel{D} + \frac{(y+d)^2}{2D} - \cancel{D} - \frac{(y-d)^2}{2D}$$

$$= \frac{\cancel{y^2}}{\cancel{2}D} + \frac{yd}{D} + \frac{\cancel{d^2}}{\cancel{2}D} - \frac{\cancel{y^2}}{\cancel{2}D} + \frac{yd}{D} - \frac{\cancel{d^2}}{\cancel{2}D}$$

$$= \frac{2yd}{D}$$

When the distance is one λ, this is the seperation of two "bright spots" of Young's interference



$$\lambda = \frac{2yd}{D}$$

or

$$\boxed{y = \frac{\lambda D}{2d}}$$

This holds if $y, d \ll D$ or equivalently $\lambda \ll d \ll D$