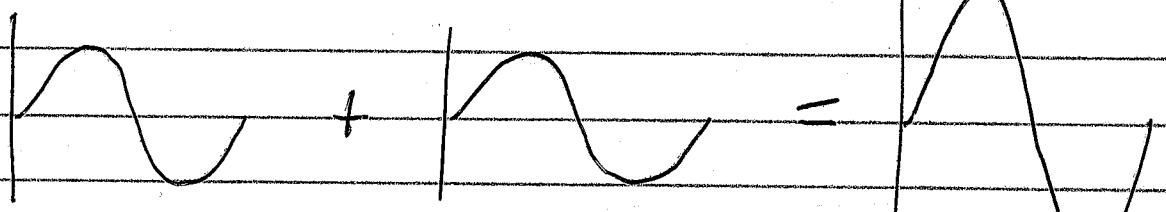
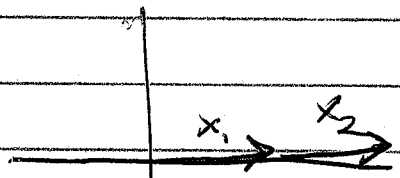
 Phys 2426 2015-11-24 Lec 26

Interference

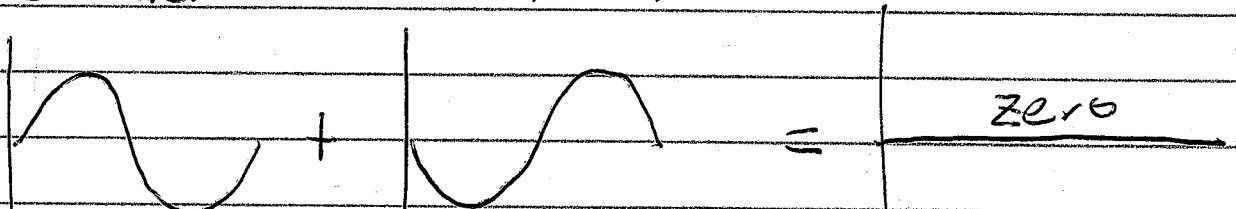
Adding sinewaves doesn't add amplitudes. The oscillations add as vectors.

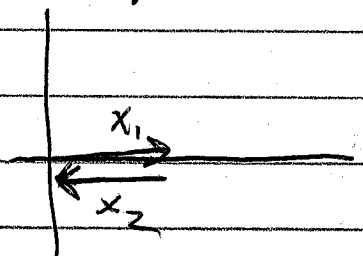
Constructive - zero phase diff





Destructive - $\Delta\phi = \pi$





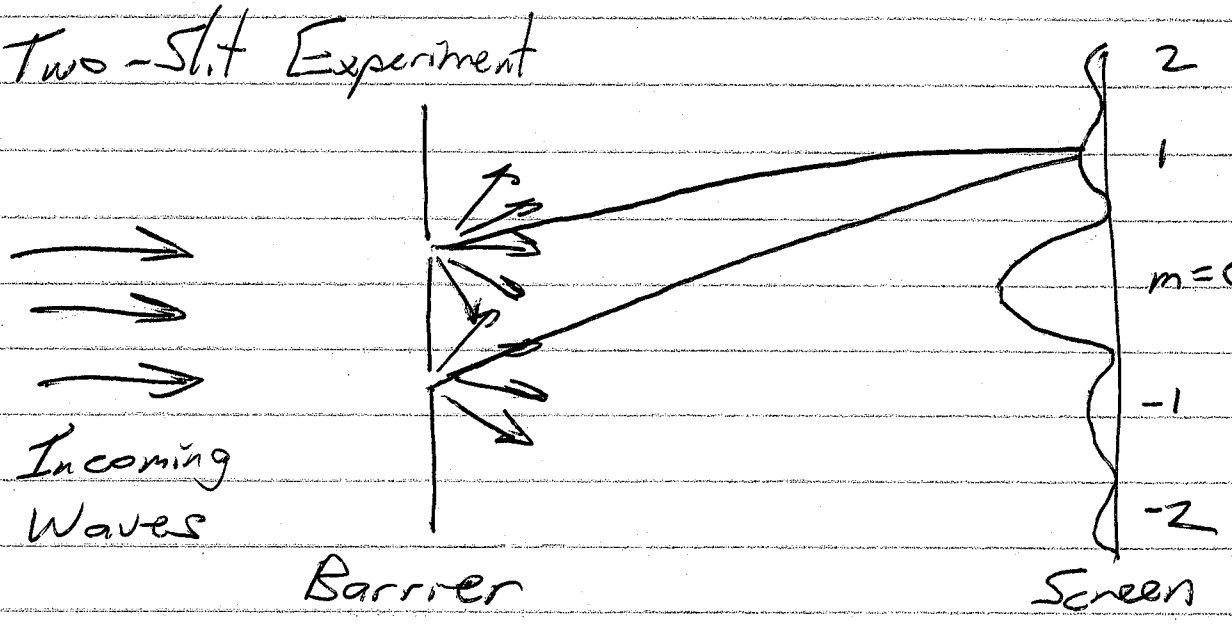
In general: $\Delta\phi = m(2\pi)$ determines interference

m = int = constructive

m = int.5 = destructive

How do we cause a $\Delta\phi$?
Two waves arriving at the same spot add.
To interfere they must be synchronized.
Solution: Break a wave into parts.

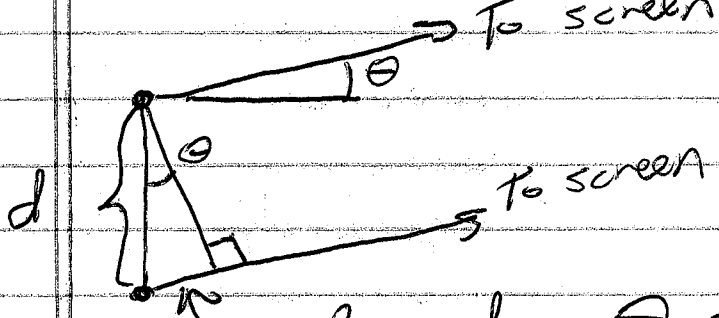
Two-Slit Experiment



The bright & dark areas are due to interference.

$$m = \frac{\Delta\phi}{2\pi} = \frac{\Delta\ell}{\lambda}$$

$\Delta\ell$ = path length difference



$$\Delta\ell = d\sin\theta = m\lambda$$

Why does diffraction happen?

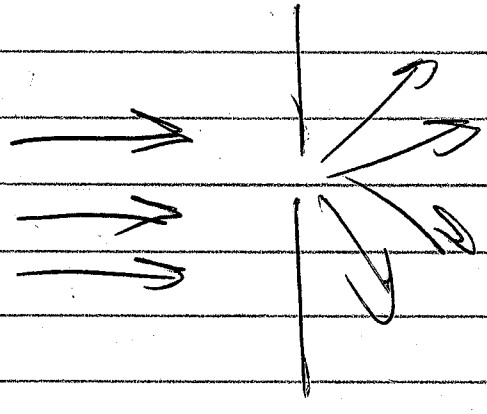
Waves are formed from coupled oscillators.

Common Solutions

- Plane Waves - uniform amplitude, velocity is uniform.
- Spherical Waves - radiate from point, amplitude decreases w/ dist.

Huygens Principle - All waves are formed from an infinite number of spherical waves. The "forward" progress of a macroscopic wave is the only direction w/ constructive interference. All other dirs have destructive interference.

A partial barrier blocks the destruction. This is diffraction.



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Circular Diffraction - Airy rings

Limits resolution of eye, camera, telescope.

Angular Size limit

$$\theta = 1.22 \frac{\lambda}{D}$$

Ex: $\lambda = 500$ nm

$D = 3$ mm

$\theta = 0.0002$ radians

At 40 cm, $\tan\theta = \frac{y}{L} \approx \theta$

$y = (0.0002)(0.4) = 0.00008$ m

$= \sim 0.1$ mm