Exam 3

Wednesday!

Be there or

be square!

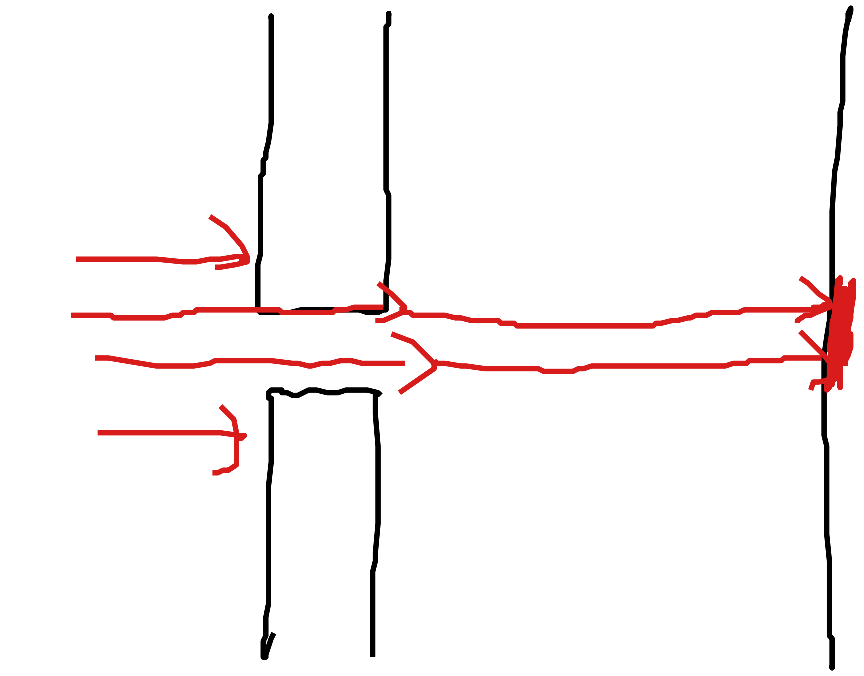
Please fill out final exam survey by Wednesday night.

Particle

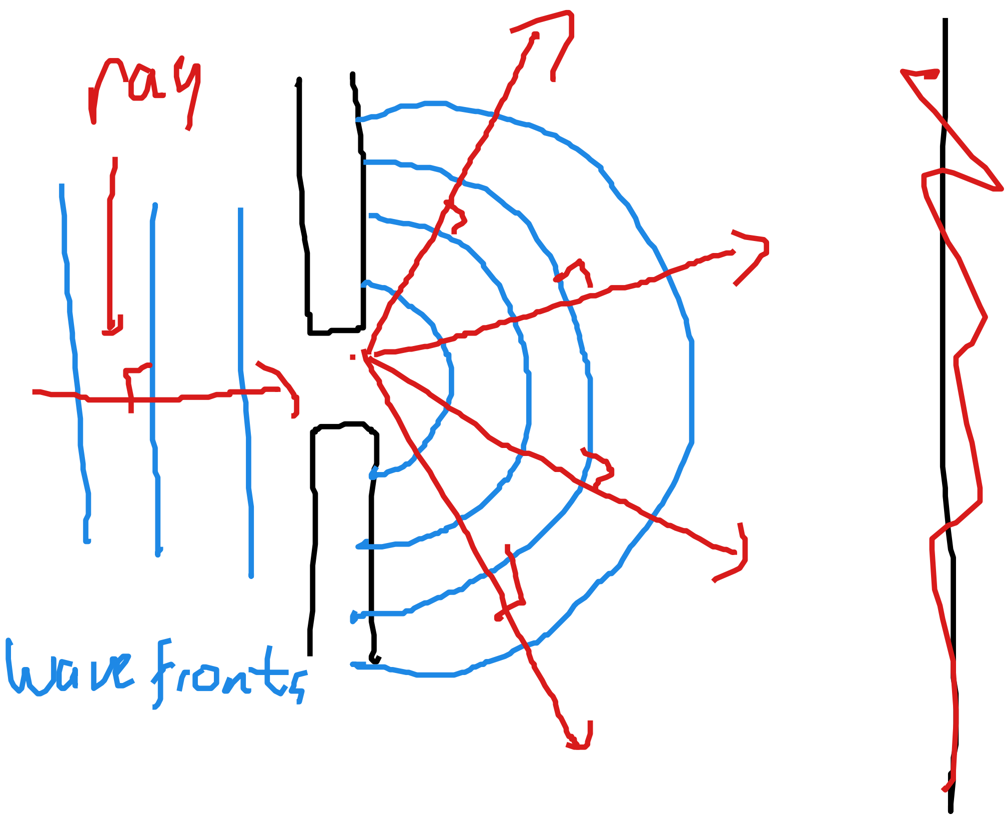
- localized phenomenon
- don't overlap
- obey Newton's 1st Law

Wave

- non-localized phenomenon
- can overlap
- interference / superposition
  - destructive interference
- diffraction
  (can go around corners)



particle



wave

waves spread out,
go around corners

wavefronts are perpendicular
to rays

Waves interact with objects about the same size as their wavelength

Sound $\lambda \sim 1m$

a doorway is about the same size, so sound diffracts through a doorway (spreads out)

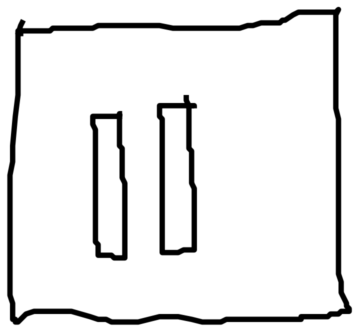
Visible light $\lambda \sim 0.5 \mu m = 500nm$

doorway is huge → no diffraction

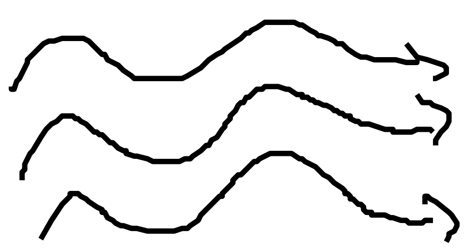
Starburst patterns occur when light enters your pupil and diffracts.

Young's Two-Slit Interference

- start with two narrow slits



- shine laser light through both
    - single wavelength
    - all in sync

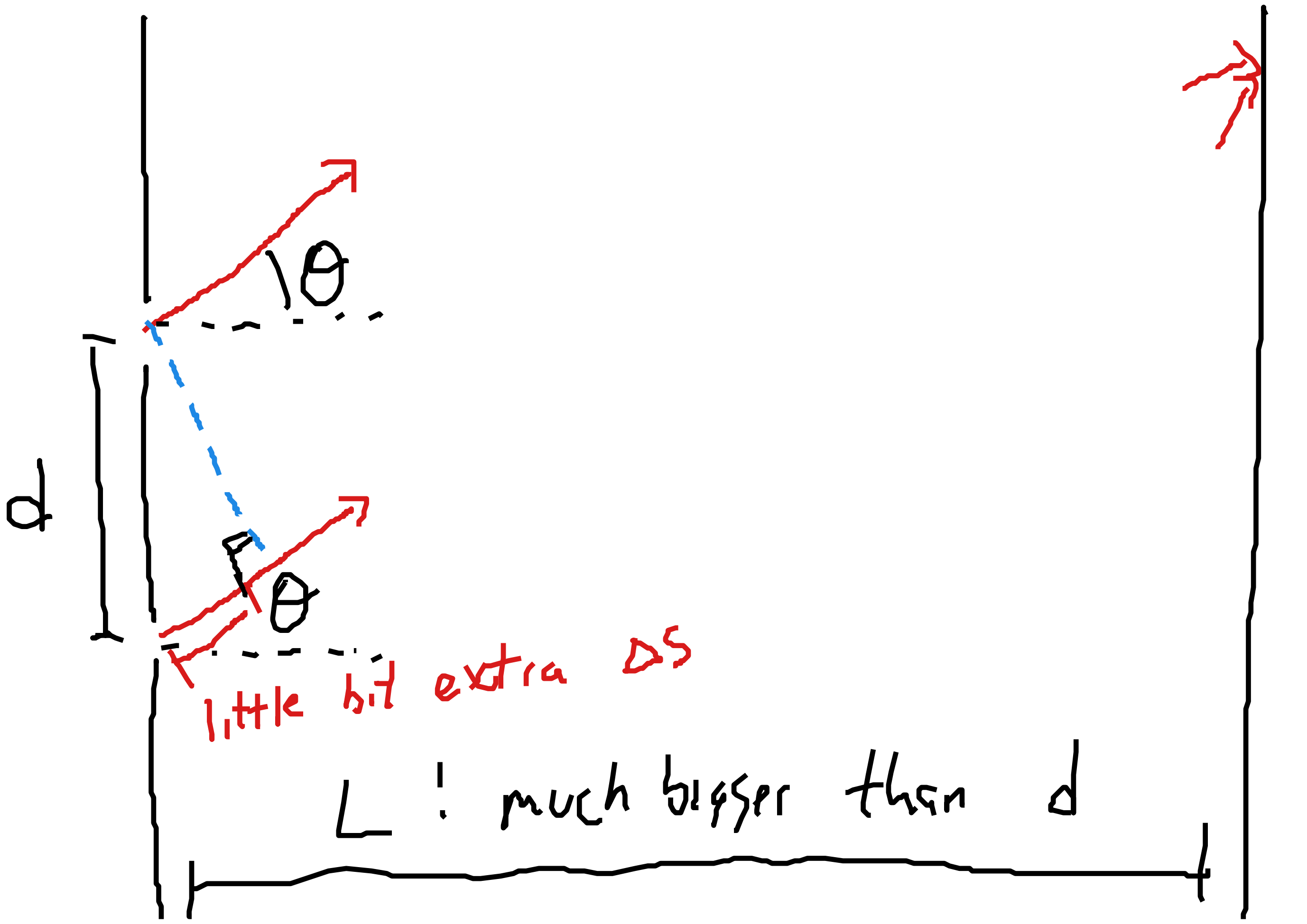


What he saw

destructive interference
-dark spots
where light from
both slits hit

Young saw
evenly spaced dots

First strong evidence of
wave-like behavior

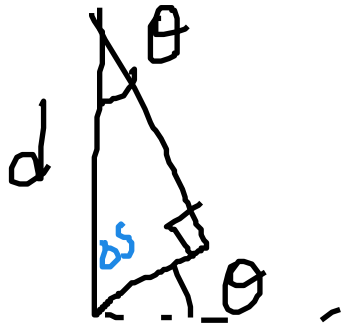


Not parallel rays but they are pretty close to parallel

Bottom ray travels extra distance ΔS

If $\Delta S = \lambda \times$ integer, constructive interference

If $\Delta S = \lambda \times (\text{integer} + \frac{1}{2})$ destructive interference



$$\frac{\Delta s}{d} = \sin\theta$$

$$\Delta s = d \sin\theta$$

integer

If $d\sin\theta = n\lambda$ bright spot

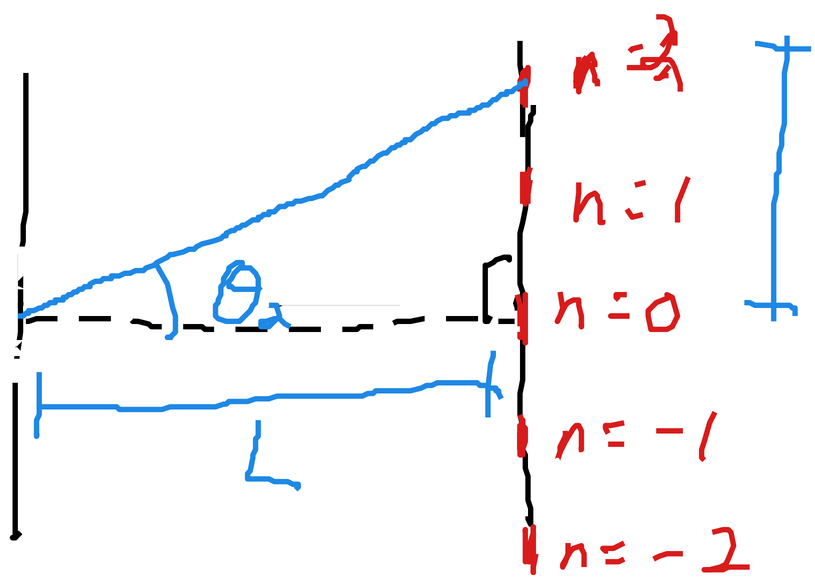
$d\sin\theta = (n+\frac{1}{2})\lambda$ dark spot

$$d \sin\theta_n = n\lambda$$

θ_n : locations of the bright spots in the pattern

$n = 0, \pm 1, \pm 2, \pm 3$

"order" of bright spot (fringe)



y_n : distance from center to nth bright spot

$$\tan\theta_n = \frac{y_n}{L}$$

if $|\theta_n| < 0.4$ radians

$$\sin\theta_n \approx \tan\theta_n$$

$$\approx \theta_n \text{ in radians}$$

$$\sin\theta_n = \frac{n\lambda}{d} \approx \tan\theta_n = \frac{y_n}{L}$$

$$\frac{n\lambda}{d} \approx \frac{y_n}{L}$$

$$\boxed{y_n = \frac{n\lambda L}{d}}$$

for small angles

$$\Delta y = y_n - y_{n-1}$$ gap between bright spots

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

- big L, big Δy (projector)
- big d, small gap
  (close-together slits, wider pattern)
- longer λ, bigger gap
  (more red)