The Atoms of Democritus
And Newton's Particles of Light
Are sands upon the Red Sea shore,
Where Israel's tents do shine so bright.

-- Blake

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Last Time

- Double Slit Experiment for
  - Particles (e.g. bullets): $N_{both} = N_1 + N_2$
  - Waves (e.g. water wave): $I_{both} \neq I_1 + I_2$
- Light:
  - Some sort of ray from the object to our eyes
  - The ray is some sort of wave
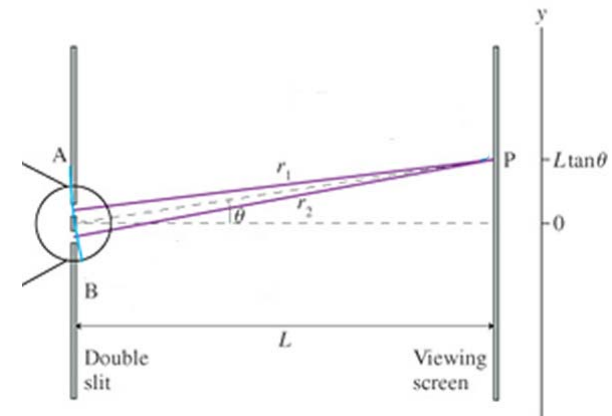- Sketched in Analysis of the Double Slit for Light

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Today

- §22.2 – *The Interference of Light* continued
  - Review Analysis of the Double Slit for Light
  - A small text correction
- §22.3 – *The Diffraction Grating*
- Supplementary Course Note: some qualitative aspects of diffraction
- §22.6 – *Interferometers*
- Begin Chapter 23 – *Ray Optics* **?**

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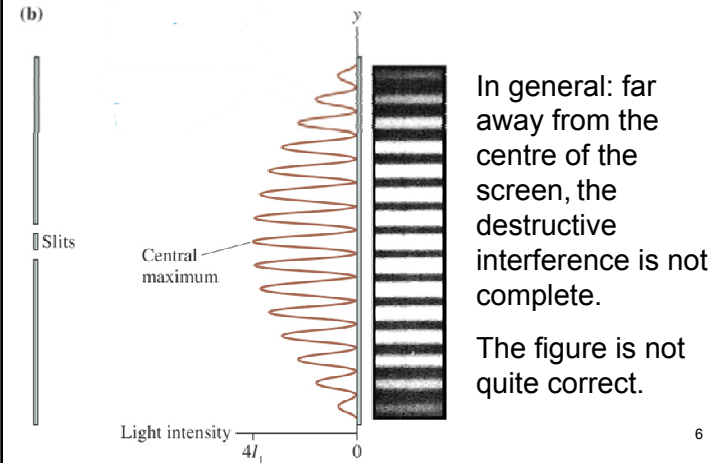---

Figure 22.4 (right part, slightly modified)

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1

Constructive Interference

$L \gg d$:　$d \sin(\theta_m) = m\lambda, \ m = 0,1,2,3,...$

θ small:　$\theta_m = \dfrac{m\lambda}{d}, \ m = 0,1,2,3,...$

$$y_m = \dfrac{m\lambda L}{d}, \ m = 0,1,2,3,...$$

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Figure 22.5 (b)

(b)

Slits

Central maximum

Light intensity

$4I_1$

0

In general: far away from the centre of the screen, the destructive interference is not complete.

The figure is not quite correct.

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Constructive Interference

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$$y_m = \dfrac{m\lambda L}{d}, \ m = 0,1,2,3,...$$

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Reflection Grating – Fig. 22.9

(a) Incident light

Different wavelengths diffracted at different angles

Mirror surface

Few μm
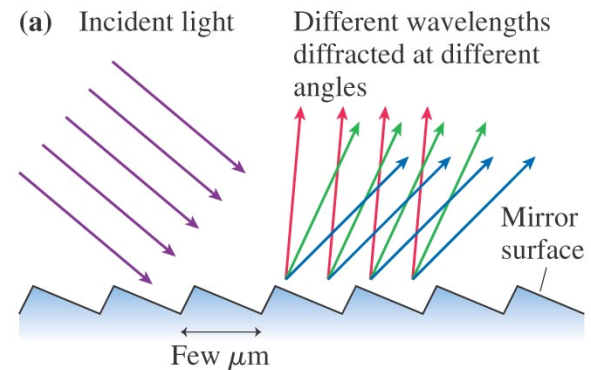
A reflection grating can be made by cutting parallel grooves in a mirror surface. These can be very precise, for scientific use, or mass produced in plastic.
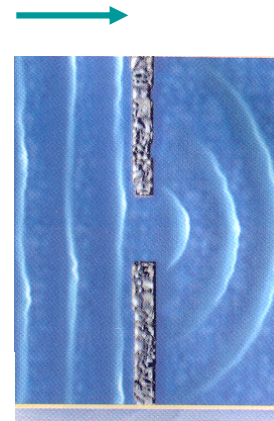
8

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A Reflection Diffraction Grating

Laser Pointer   Ruler

The angle between the light ray and the ruler must be very very small

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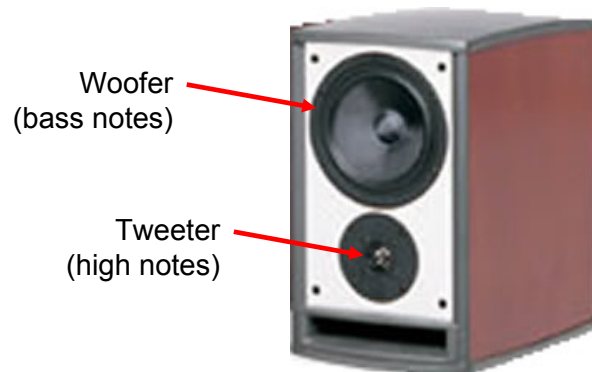## Diffraction of Water Waves From a Slit

To the right of the slit, the waves spread out

As the angle with the horizontal increases, the amplitude of the diffracted wave becomes less
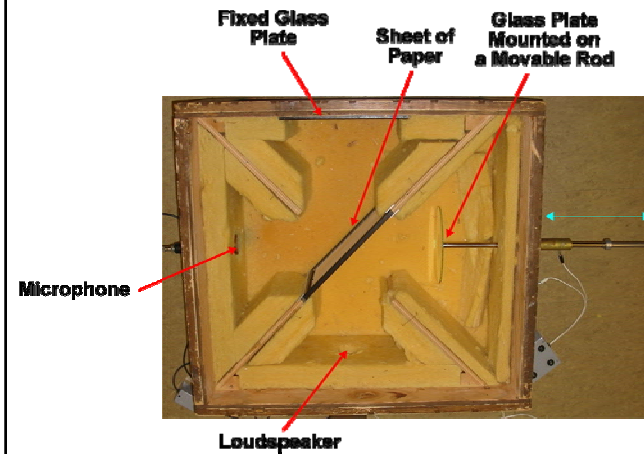
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A "Two Way" Loudspeaker

Woofer (bass notes)

Tweeter (high notes)

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Acoustic Michelson Interferometer

Fixed Glass Plate   Sheet of Paper   Glass Plate Mounted on a Movable Rod

Microphone

Loudspeaker

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Acoustic Michelson Interferometer

If I slowly move the movable glass plate to the right, the sound level measured by the microphone will:

A. Remain constant
B. Decrease to and remain zero
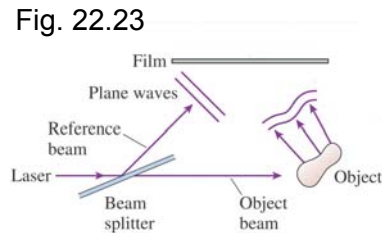C. Alternate between some maximum and zero

Acoustic Michelson Interferometer

I position the movable glass plate to a maximum. If I then move it out until the sound again reaches a maximum, I will have moved the plate a distance:
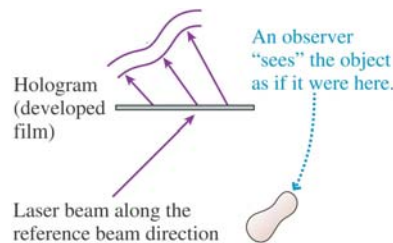
A. 0
B. $\lambda/4$
C. $\lambda/2$
D. λ
E. 2λ

Fig. 22.23

Making a Hologram

**Reconstructing The Image**

In the Ray Model, rays can cross each other without interacting with each other in any way

What property of the Wave Model corresponds to this property of the Ray Model?

A. Waves reflected from a fixed end are inverted
B. The phase difference between the waves determines where constructive interference will occur
C. Superposition
D. Beats
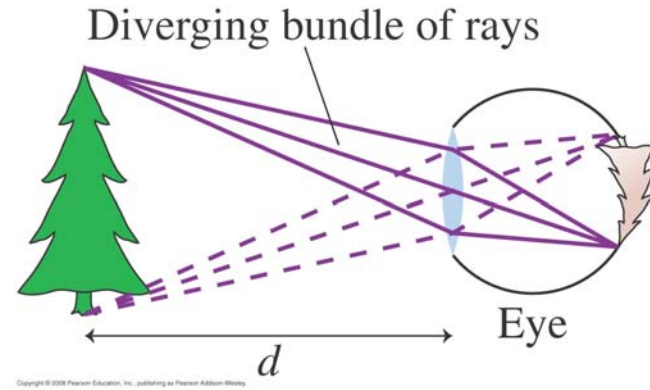E. There is no corresponding property in the Wave Model
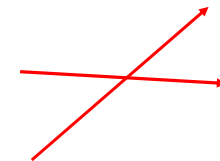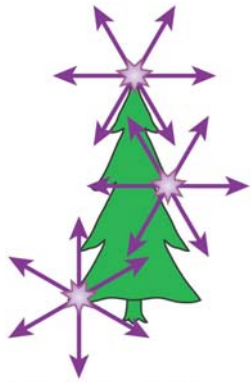
An *object* is a source of light rays

Rays originate from *every* point on the object and each point sends rays in *all* directions

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Diverging bundle of rays

Eye

d

The eye sees by focusing a diverging bundle of light rays. Note: the image is inverted!

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