Class 30

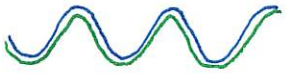
Mon: HW by 5pm

Read 9.4, 12.2

Interference of Waves

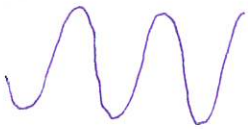
Two or more waves that propagate simultaneously through the same medium will overlap and interfere. The extreme cases are:

constructive interference



perfect match

gives →



larger wave

destructive interference

perfect mismatch

gives →

no wave

The same phenomena occur with waves that propagate in two dimensions. The geometrical situation here results in regions where there is constructive interference and others where there is destructive interference.

DEMO: PhET Wave Interference ~ Slits

- Two slits → Slit width 1cm
  Slit separation 4cm
  Slits about 1 wavelength from source
- Use meters to observe.

We can explain the pattern with a diagram that sketches the crests from each source.

Slide 1

Quiz1 60% - 80%

Quiz2 → Solution slide

The nature of this interference pattern depends on:

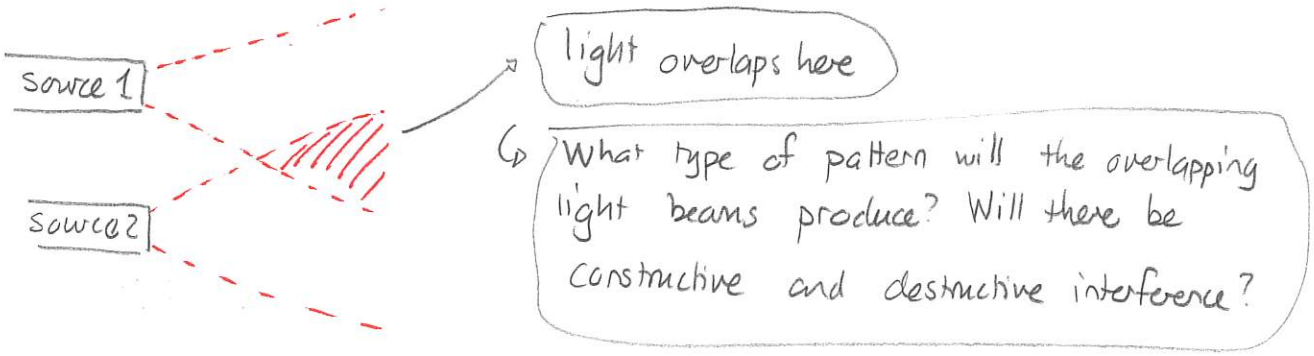
1) the wavelength of the waves
2) the separation of the sources or slits

Demo: PhET Wave Interference → as before

- vary frequency ~ observe pattern change
- vary slit separation ~ " " "

Interference of light

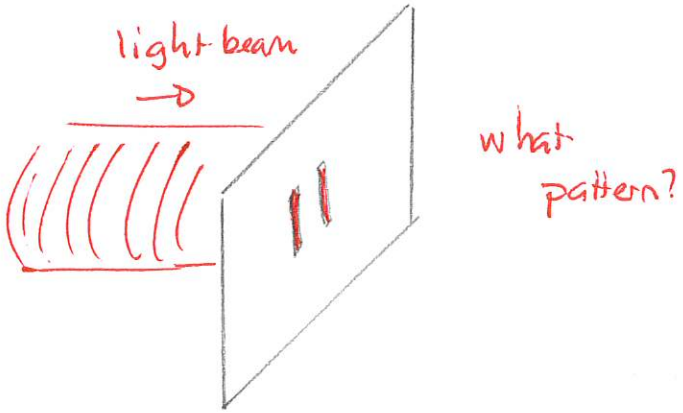
We could try an analogous experiment with overlapping beams of light.



A practical way to do this is to shine a beam of light at a barrier containing two slits. We can compare two models for light

** particle model
→ light is a stream of particles

** wave model
→ light is a wave



We can ask what each model predicts

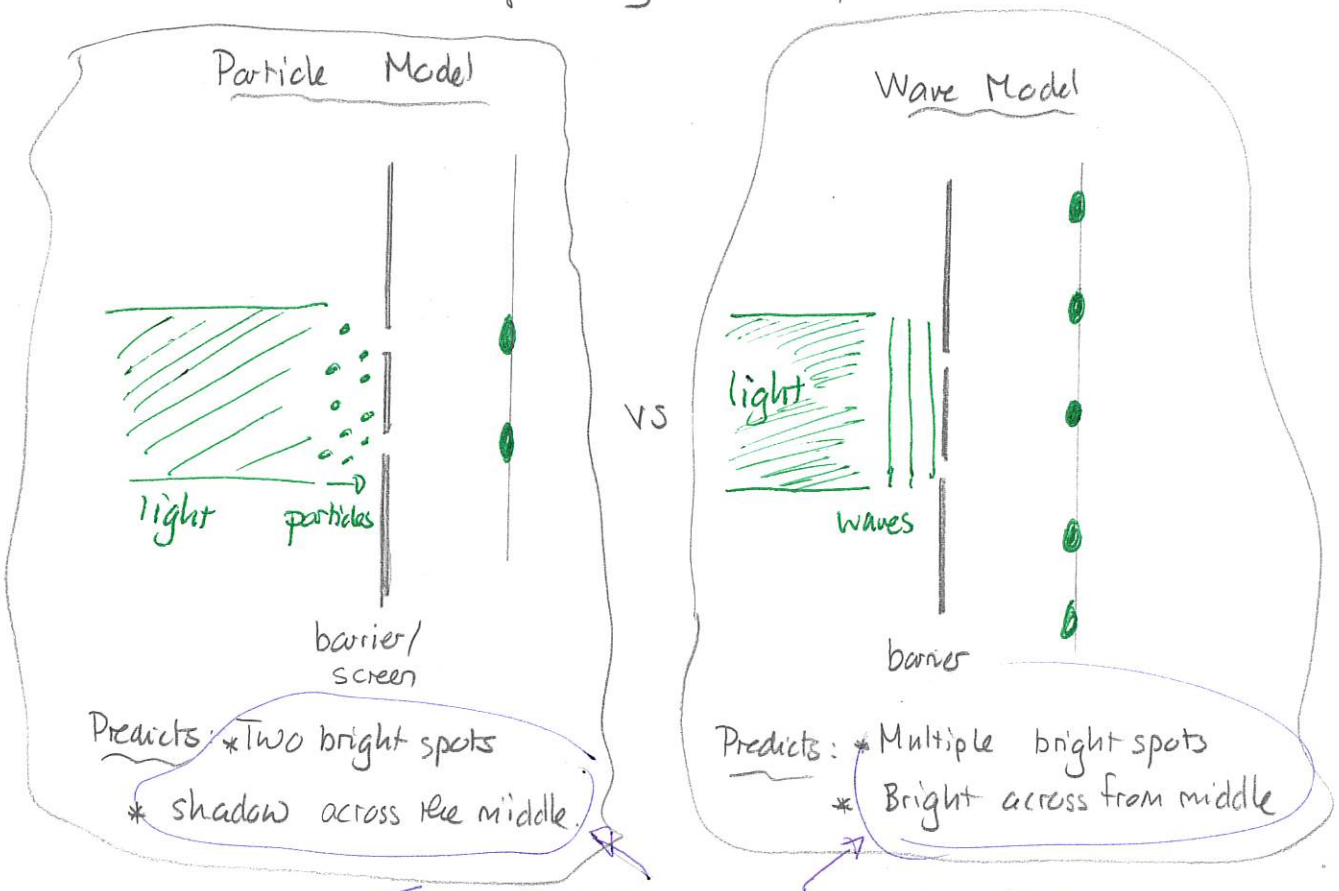
Quiz 3 60%

The particle model predicts two bright regions surrounded by shadow. If light were a wave, there would be two waves radiating outward from the slits. The wave model would predict the same type of interference as observed for water or sound waves.

DEMO: Wave Interference
- Slits tab
- Two slits – default setting
- Screen.

Slide Overlapping Waves from a Double Slit

Then the two models give very different predictions.



THE PREDICTIONS ARE DIFFERENT

What actually occurs

DEMO: Laser / Double Slit

This experiment and others reveal:

> Interference experiments with slits and barriers support the wave model of light

1 Interference of Light

The PhET animation "Waves Interference" allows you to visualize interference of light. Find the animation at

https://phet.colorado.edu/sims/html/wave-interference/latest/wave-interference_en.html

and open it. Adjust the settings as follows:

- Select the "Slits" option.
- In the middle control panel on the right, select light (rightmost).
- In the middle control panel on the right, check Screen and Check Intensity.
- In the bottom control panel on the right, select "Two Slits."
- Adjust the slit separation to 1000 nm.
- Hit the green button to produce light.

a) How many bright bands do you observe on the screen?

b) Increase the slit separation to 2000 nm. Describe how the pattern on the screen changed. Did the distance between bright bands increase or decrease?

You will now consider how the pattern depends on the frequency and wavelength of the light. The animation will allow one to adjust the color of the light. The color is related to the frequency. Red light has a lower frequency than green. All frequencies travel at the same speed.

c) Explain whether the wavelength of the light increases, decreases or stays the same as the frequency decreases.

d) Reset the slit separation to 1000 nm. After the pattern has settled, adjust the frequency of the light to the red end of the spectrum. Did the distance between bright bands increase or decrease as a result of the frequency adjustment?

e) Use this to describe whether the distance between bright bands increases or decreases when the wavelength increases.

Answer: a) There are 3

b) The number of bright bands increase, The distance between adjacent bright bands decreased.

c) speed = wavelength × frequency

constant = increases × decreases ⇒ wavelength increases.

d) Distance observed increased.

⇒ As wavelength increases → distance between adjacent fringes increases