The Wave Nature of Light
Lesson Notes

Learning Outcomes
- How do the particle model and wave model compare to one another?
- What behaviors of light support the wave model?

The Age-Old Debate
What is light? Is it a wave? Or is it a particle?

Duality

Situation in which two opposite ideas exist at the same time.

Particle Model of Light
- consists of tiny packets of energy known as photons
- photons have no mass and a finite energy
- energy depends on frequency and the intensity depends on the number of photons

Wave Model of Light
- light propagates through space as a fluctuating electric and magnetic field
- can have varying wavelengths and frequencies
- exhibits classic wave behaviors (diffraction, interference)

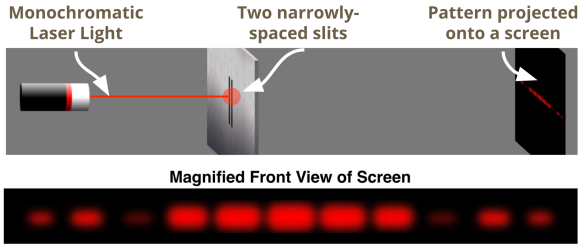
Wave-Particle Duality
Sometimes light behaves in a manner that is particle-like; and at other times it behaves in a manner than is wave-like.

The dual nature of light extends to all objects; even electrons demonstrate duality.

Classic Particle Behaviors	Classic Wave Behaviors
Photoelectric Effect	Diffraction
	Interference
	Polarization

Interference of Light
Physics Demonstration

Get a laser beam - a source of monochromatic light. Pass it through a *double slit*, to create two sources. The two waves land on a screen and interfere … producing a pattern of alternating dark and bright spots.



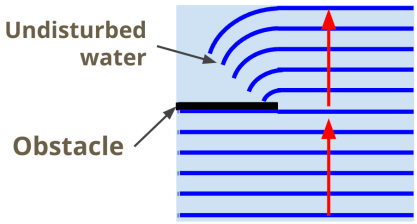
This experiment (or one like it) was first performed and explained by Thomas Young in 1801, providing evidence that light exhibits wave-like behaviors.

Diffraction of Light

Waves diffract as they pass through openings or around barriers, bending into the space behind the barrier.

The amount of diffraction is dependent on the wavelength of the wave relative to the size of the obstacle. Longer waves have greater diffractive ability.

Water waves in a ripple tank approaching an obstacle.



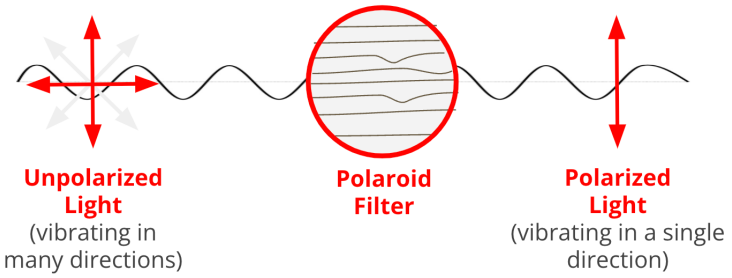
Laser light can be observed diffracting through a circular aperture.

Polarization of Light

A Polaroid filter has its molecules aligned in one direction.

When light is incident on a Polaroid filter, vibrations aligned with the molecules are absorbed; vibrations perpendicular to the molecules pass through.

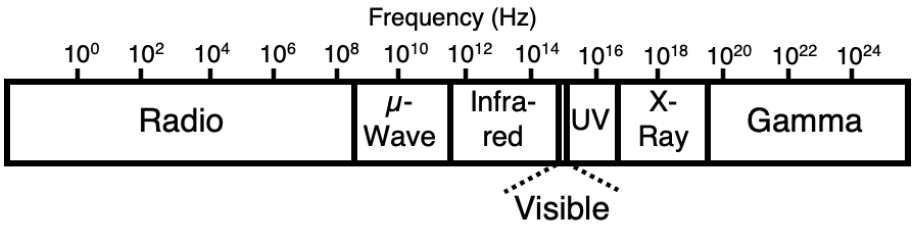
The light emerging from the filter is polarized (vibrating in a single direction) and has one-half the original intensity.



Electromagnetic Spectrum

Light has measurable wavelengths and frequencies … wave properties that are not typically associated with particles.

The range of frequencies are organized into an EM spectrum.



More Evidence for Wave-Like Behaviors

Other light phenomenon - reflection at surfaces, refraction at boundaries, and Doppler shifting of frequencies - follow the patterns observed of any wave.

This Tutorial Series will focus on the **Wave Model** of light.