

Electromagnetic Waves: Mediums

Essential Question: How are the characteristics of electromagnetic waves affected by medium?

Let's Review

Electromagnetic Waves

Waves that DO NOT NEED matter (medium) to transfer energy

Examples: radiation, TV & radio waves, X-rays, microwaves, lasers, energy from the sun, visible light

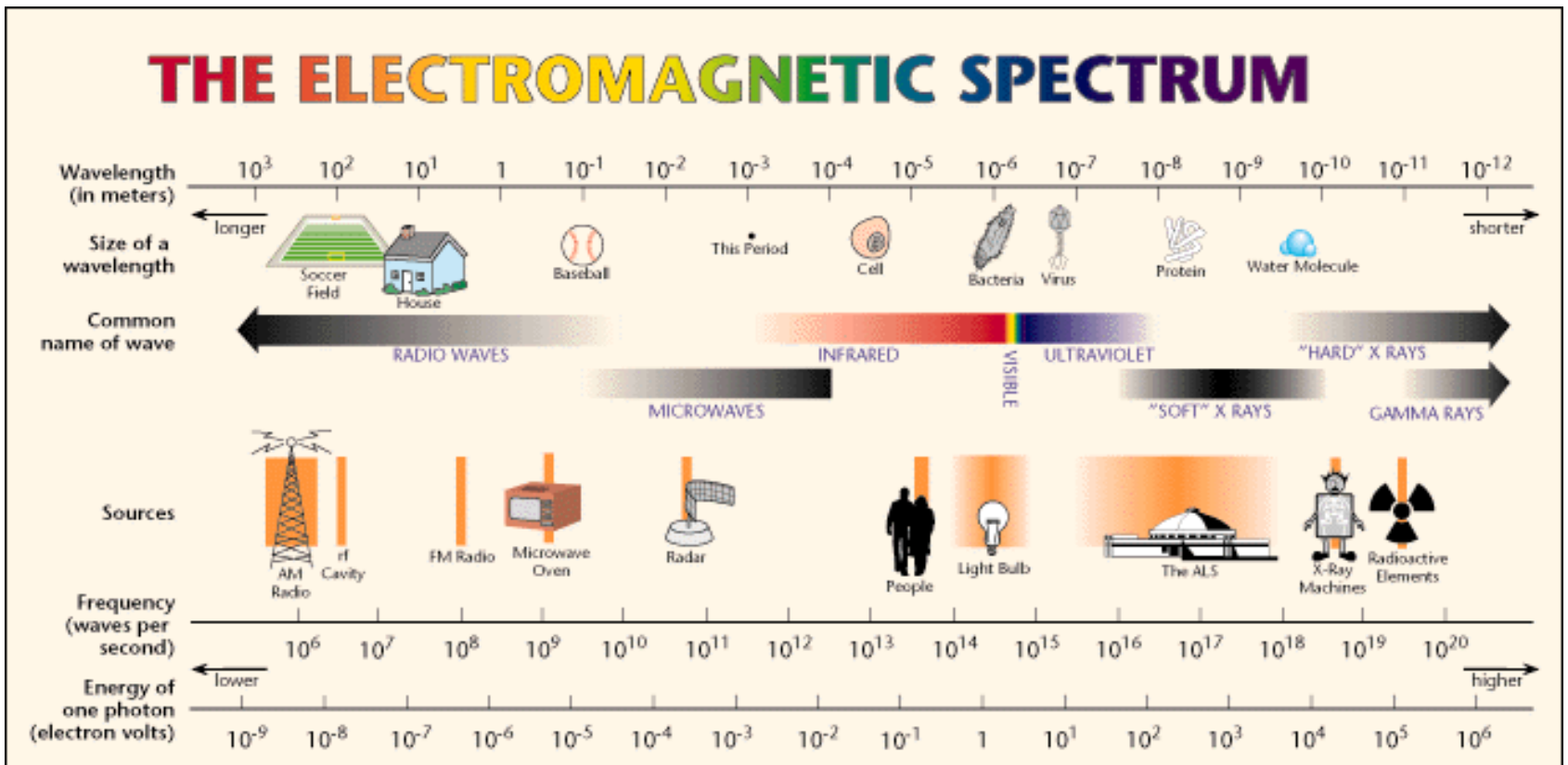
Electromagnetic waves are considered transverse waves because they have similar characteristics. They have a crest, trough, wavelength, and amplitude

How are Electromagnetic Waves made?

- An electrically charged particle vibrates.
- When the particle vibrates, the electric field vibrates.
- The vibrating electric field creates a vibrating magnetic field.
- The vibration of an electric field and a magnetic field together produces an Electromagnetic (EM) Wave that carries energy

The Electromagnetic Spectrum

illustrates the range of wavelengths and frequencies of electromagnetic waves.



Notice that some kinds of waves have overlapping ranges

Radio

Microwave

Infrared

Ultraviolet

Gamma



Frequency (Hz)

10^6 10^7 10^8 10^9 10^{10} 10^{11} 10^{12} 10^{13} 10^{14} 10^{15} 10^{16} 10^{17} 10^{18} 10^{19}



Mobile

Radar

Visible

X-ray

The Electromagnetic Spectrum

Notice the changes in the frequency of the wavelengths in the spectrum

Distributed Summarizing

With a partner, discuss the following questions:

How is an electromagnetic wave different from a mechanical wave (sound)?

Name some examples of electromagnetic waves. Compare the wavelength and frequency of your examples (you may need to use electromagnetic spectrum diagram)

Changes in Mediums

- Waves do not just stop when they reach the end of a medium or when they meet an obstacle in the path.
- These behaviors were first introduced in the lesson on sound. They include: absorption, reflection, diffraction, and refraction.
- We will be examining these behaviors in regards to light waves

Changes in Mediums: Light Waves

- When light waves strike an object, some of the waves are **absorbed** by the object, some are **reflected** by it, and some might pass through it (transmitted).
- What happens to light when it strikes the object depends on the material of the object.

Changes in Mediums

Absorption of Light Waves

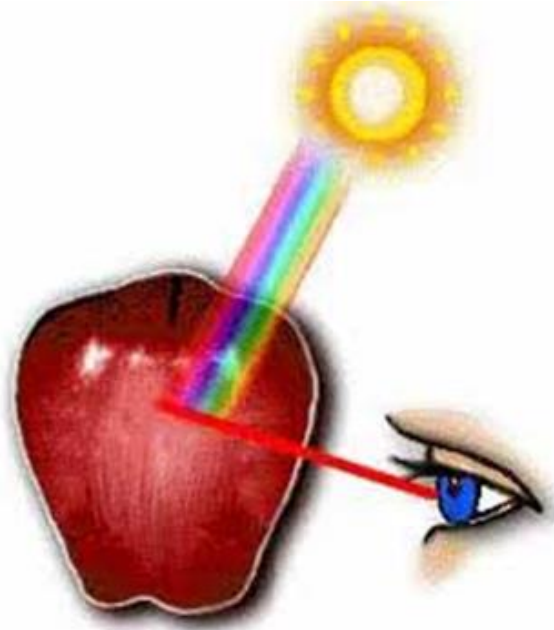
- **Absorption** is the transfer of light energy to matter
- Absorbed light can make things feel warmer
- Think of examples of light absorption that you have experienced

When a beam of light shines through the air, particles in the air **absorb** some of the energy from the light. As a result, the beam of light becomes dim. The farther the light travels from its source, the more it is **absorbed** by particles, and the dimmer it becomes.



Changes in Mediums: Absorption of Light Waves

Absorption will be discussed more in the next essential question on how light is detected by the human eye.



Changes in Mediums

Reflection of Light Waves

- **Reflection** occurs when a wave strikes an object or surface and bounces off.
- Light waves **reflecting** off an object allow you to see that object.
- Light **reflected** from any surface always follows a simple rule: the angle with which the ray of light hits the surface is the same with which the ray of light will be **reflected** (Law of Reflection)

If the surface is smooth and even, the **reflection** will be clear.



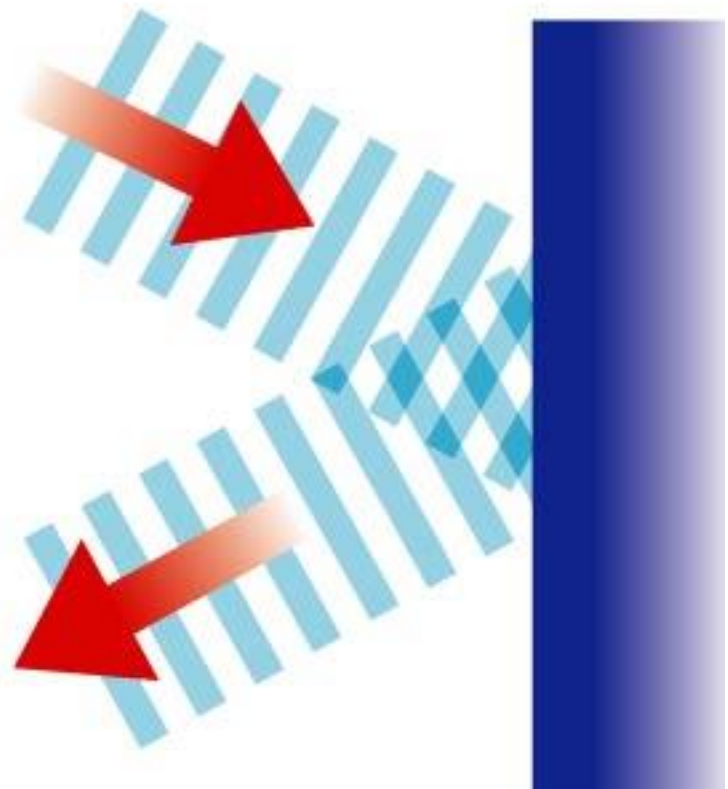
If the surface is uneven, like ripples in a pond, the light is **reflected** in many directions and the image is not clear.

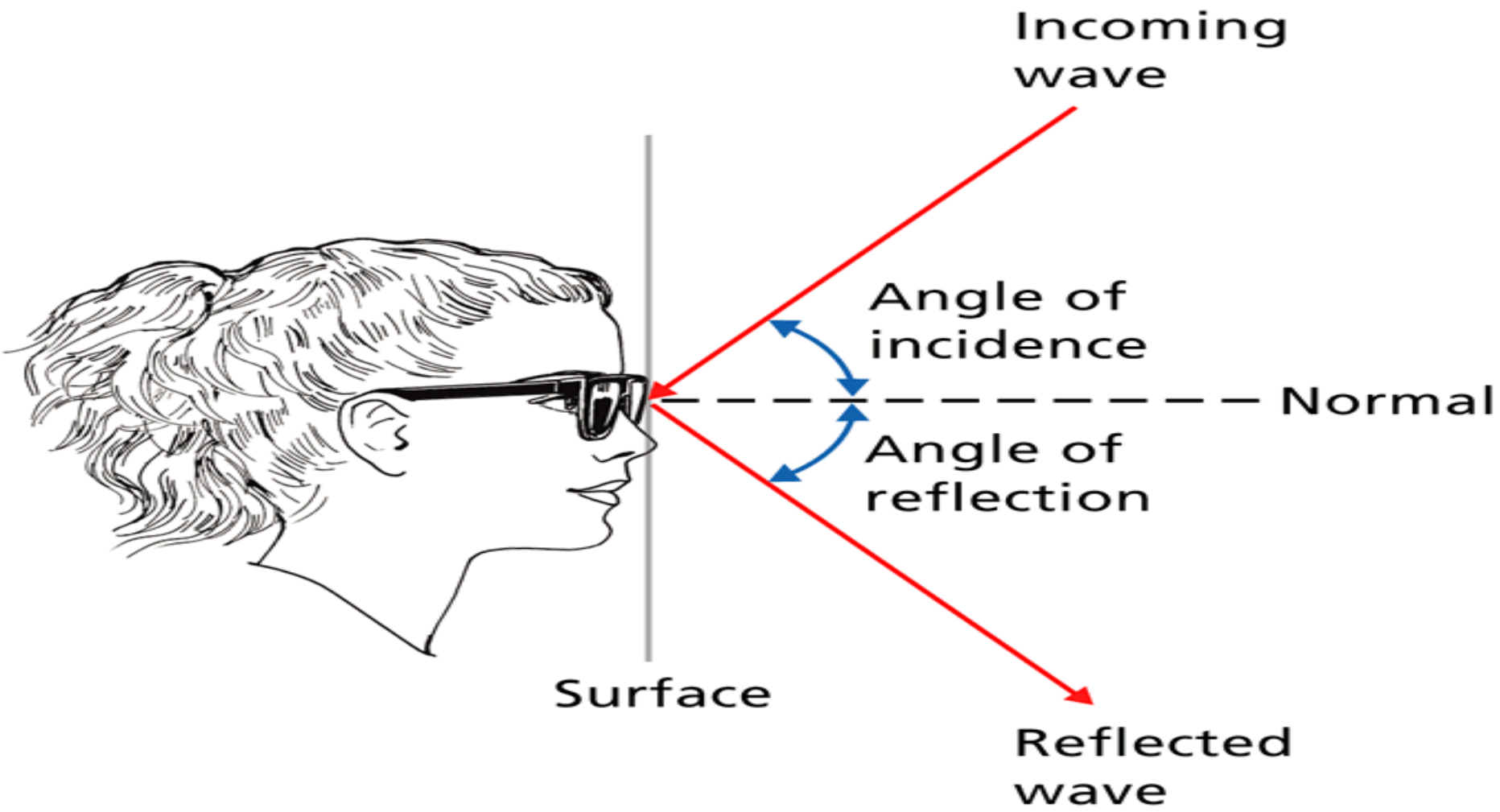


Wave Interactions

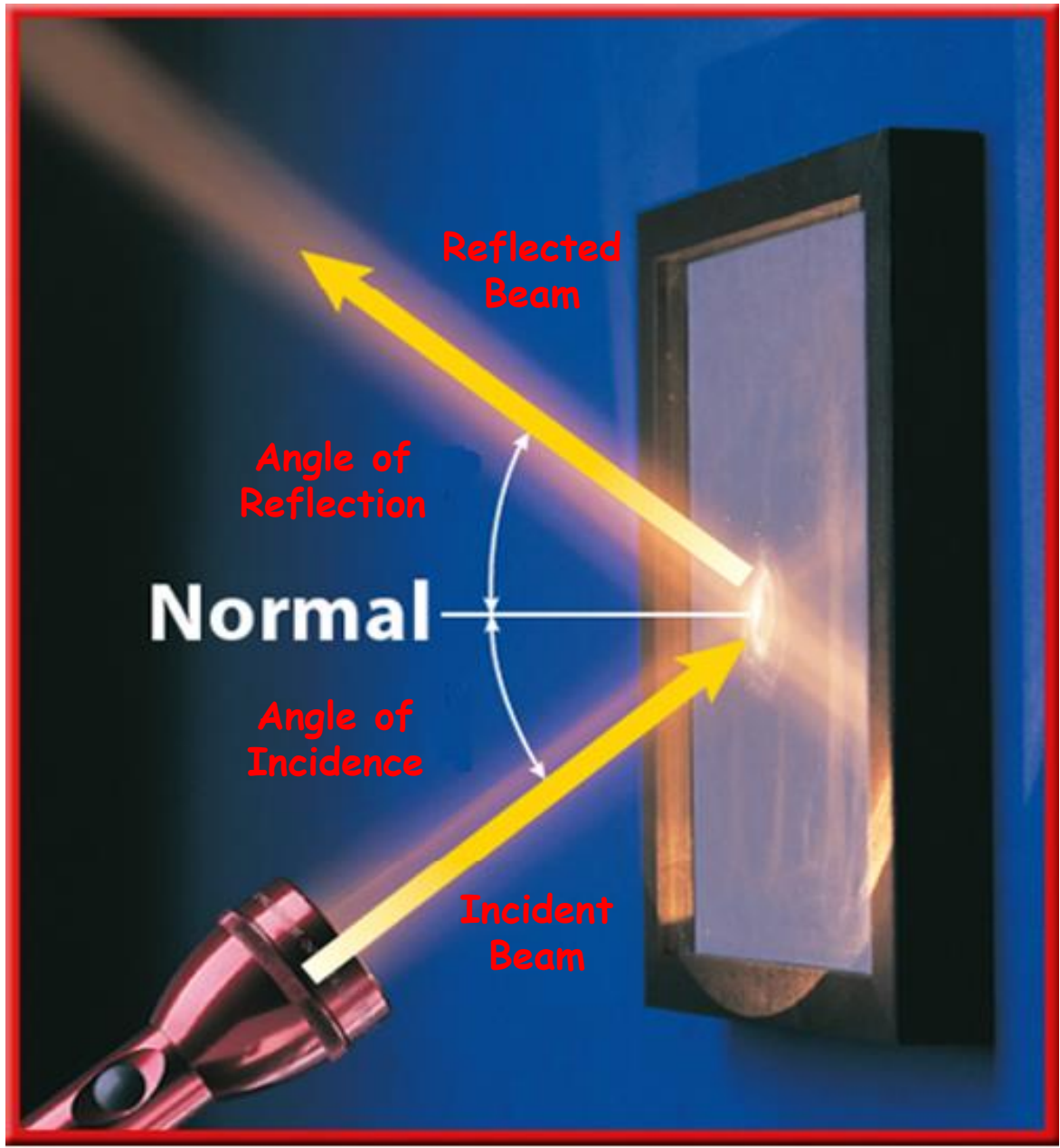
Reflection

Wave bounces off a material and goes in a new direction.





Notice: the angle with which the ray of light hits the surface is the same with which the ray of light is **reflected**



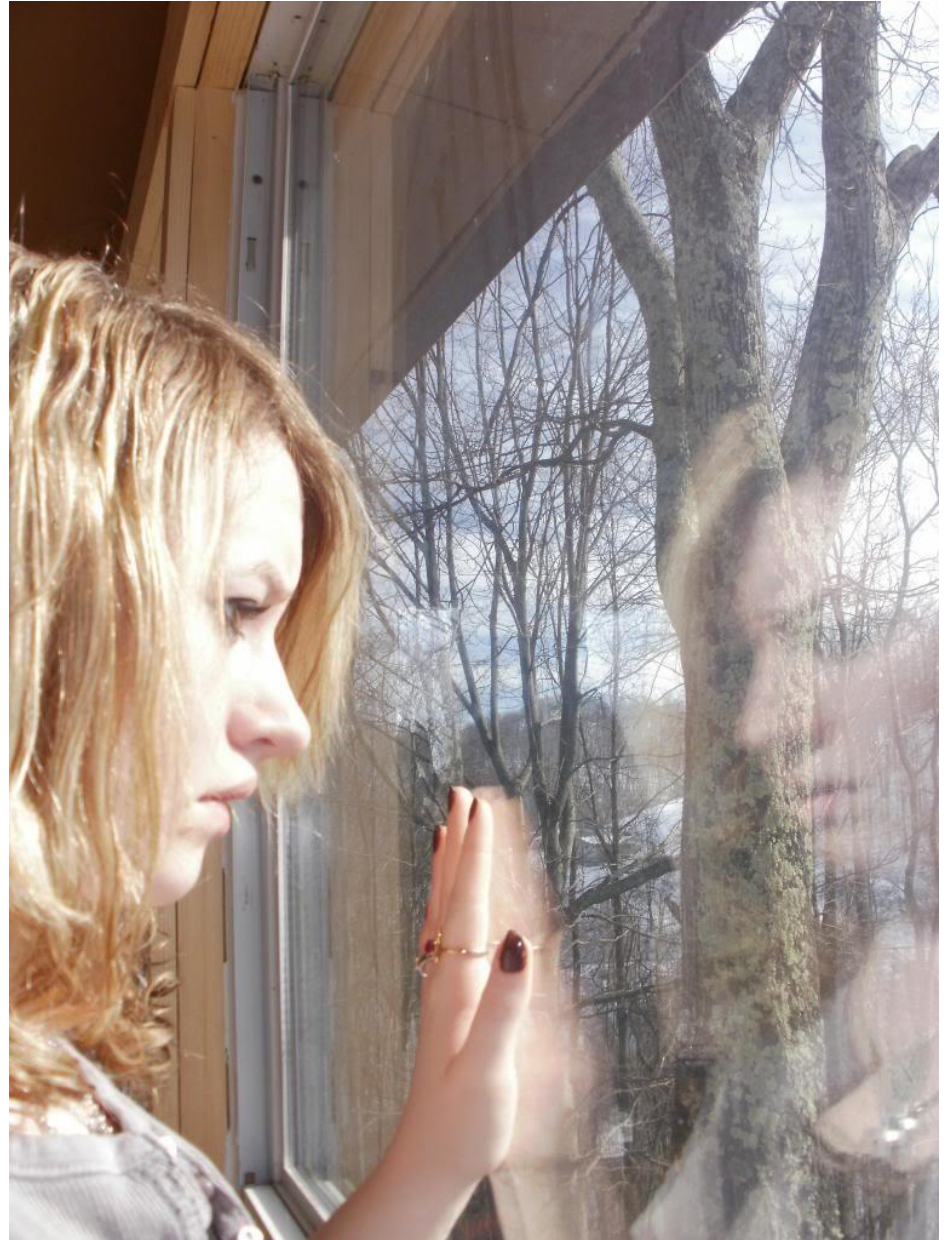
Distributed Summarizing:

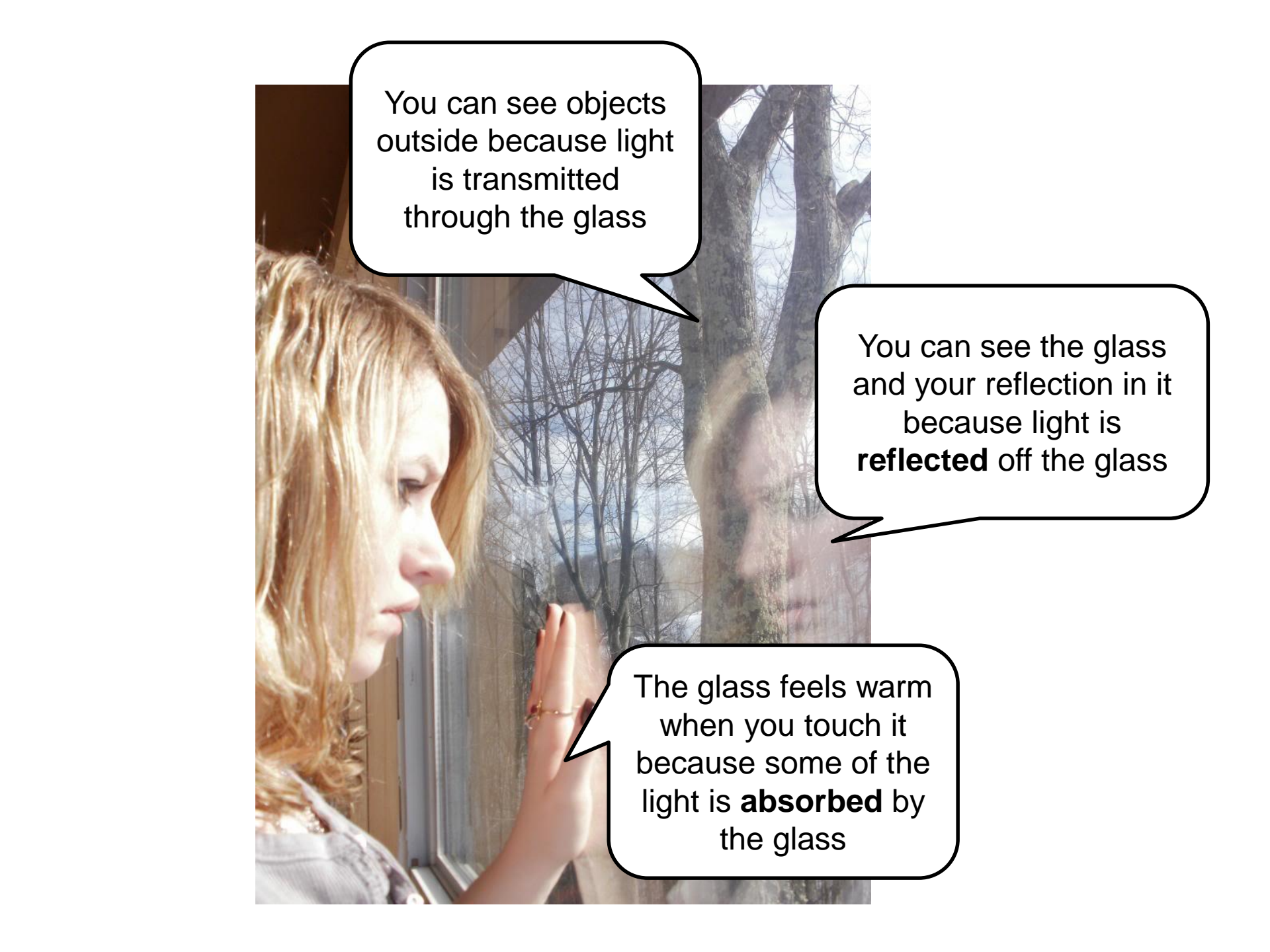
Look at the picture to the right. Discuss the following questions with a partner.

How is the girl able to see the trees outside the window?

How is the girl able to see herself on the glass? What is this called?

What does the girl feel when she touches the glass? Why?



A photograph of a woman with long, wavy blonde hair looking out a window. The window shows a view of trees and a building. Three callout boxes are overlaid on the image, each pointing to a different part of the scene. The first callout points to the view outside the window. The second callout points to the reflection of the woman's face on the glass. The third callout points to the woman's hand touching the window frame.

You can see objects outside because light is transmitted through the glass

You can see the glass and your reflection in it because light is **reflected** off the glass

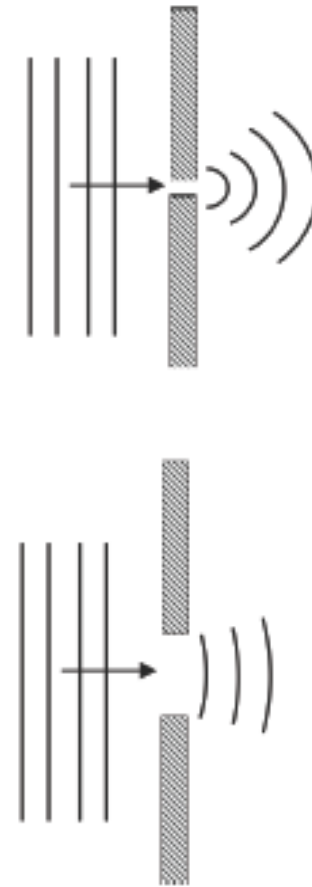
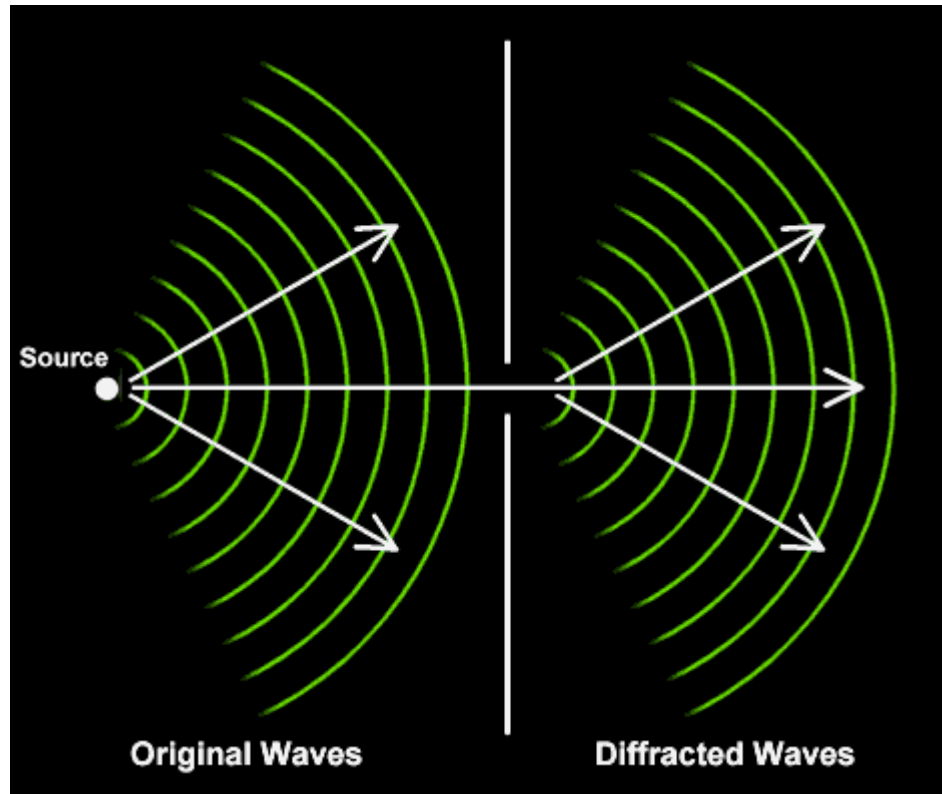
The glass feels warm when you touch it because some of the light is **absorbed** by the glass

Changes in Mediums

Diffraction of Light Waves

- Diffraction is the bending of waves around a barrier.
- The amount a wave diffracts depends on its wavelength and the size of the barrier or the opening.
- The greatest amount of diffraction occurs when the barrier or opening is the same size or smaller than the wavelength

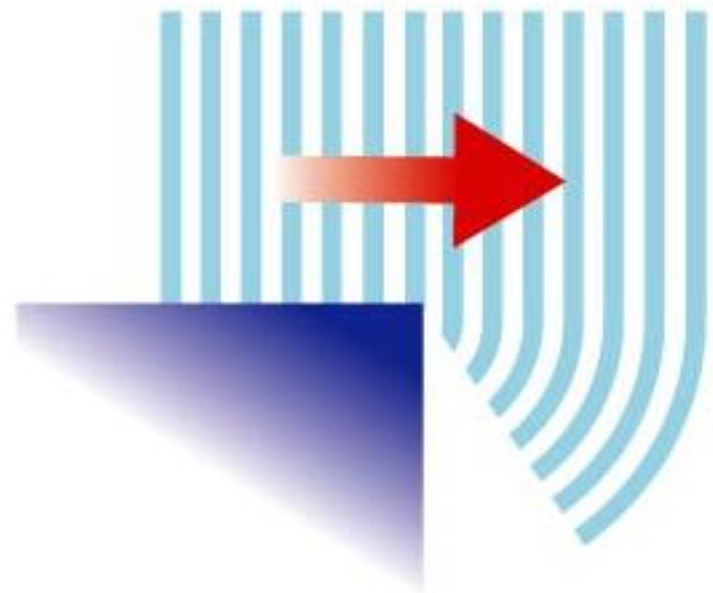
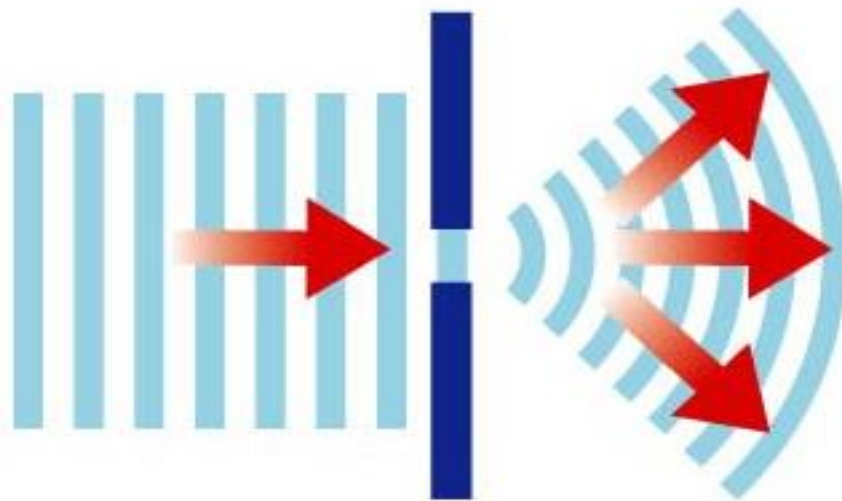
Diffraction



Wave Interactions

Diffraction

Wave bends around or goes through a hole in a material.



When plane waves go through a small hole, they become circular waves.

Narrow Opening

Wave direction



Changes in Mediums

Diffraction of Light Waves

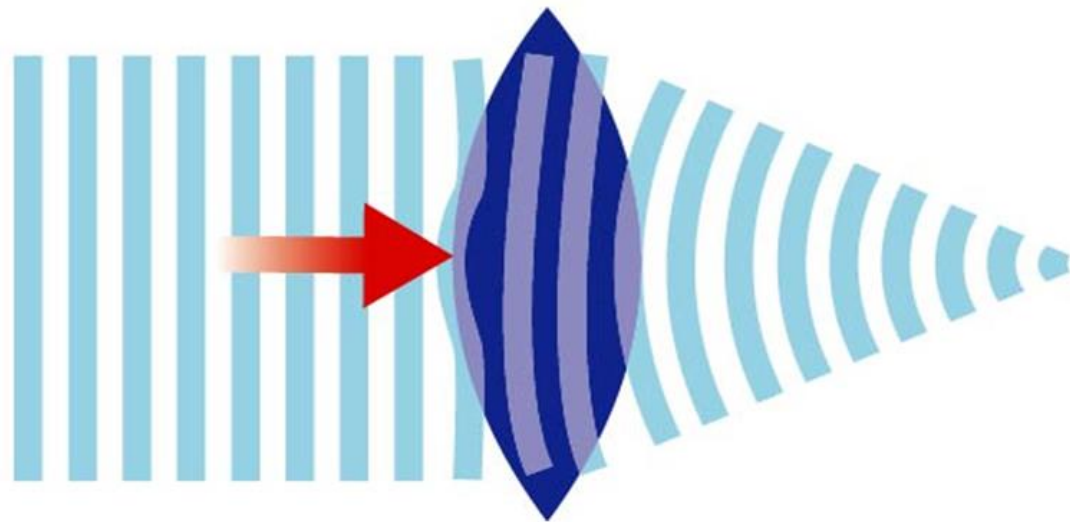
Light waves have very small wavelengths; therefore, light waves cannot diffract very much around large obstacles, such as buildings. Thus, you cannot see around corners (but you can hear sound around corners)

<http://www.acoustics.salford.ac.uk/feschools/waves/diffract.htm>

Changes in Mediums

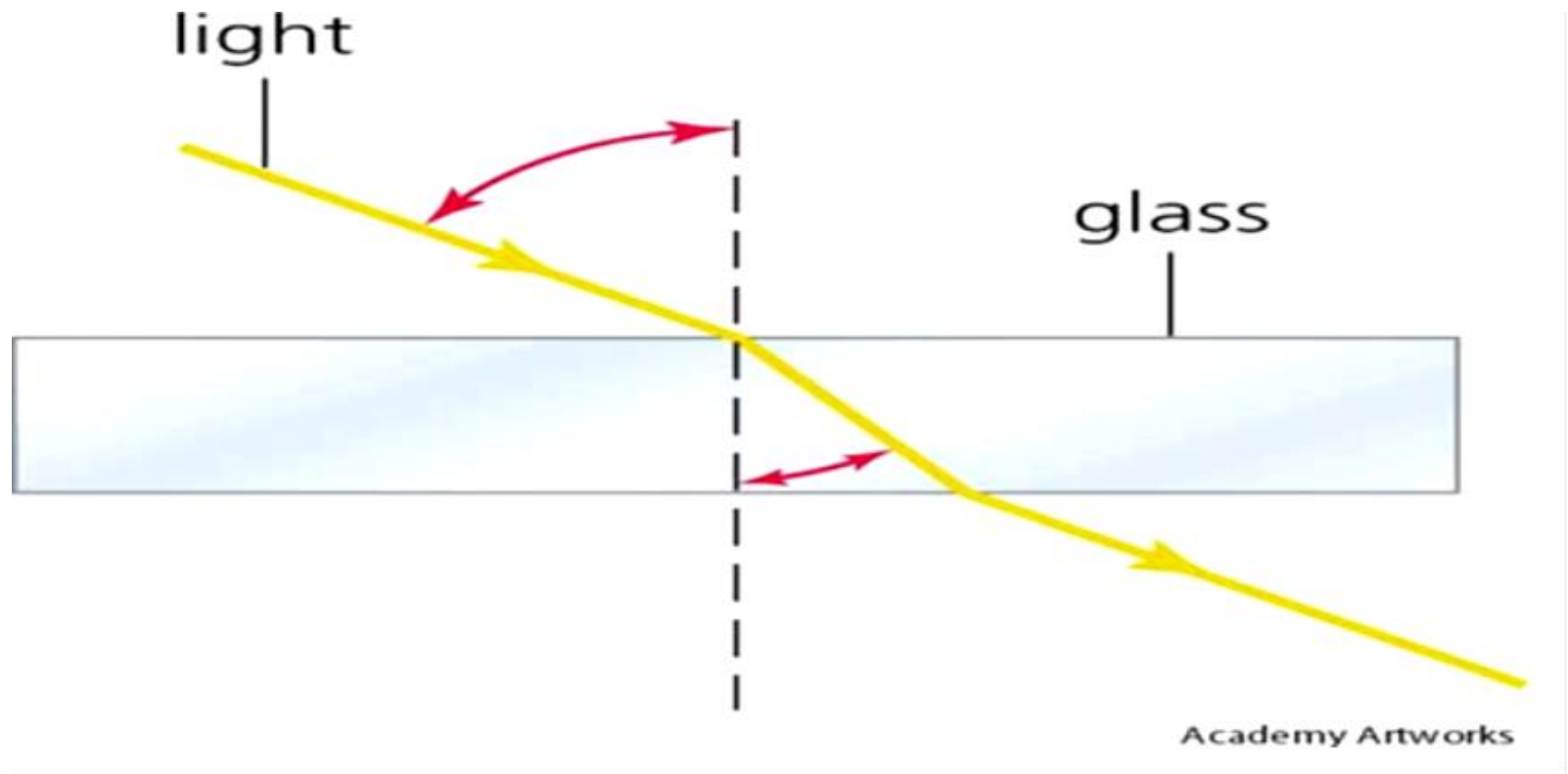
Refraction of Light Waves

- Refraction is the bending of a wave as it moves from one medium into another
- The speed and wavelength of a wave changes during refraction (velocity changes)



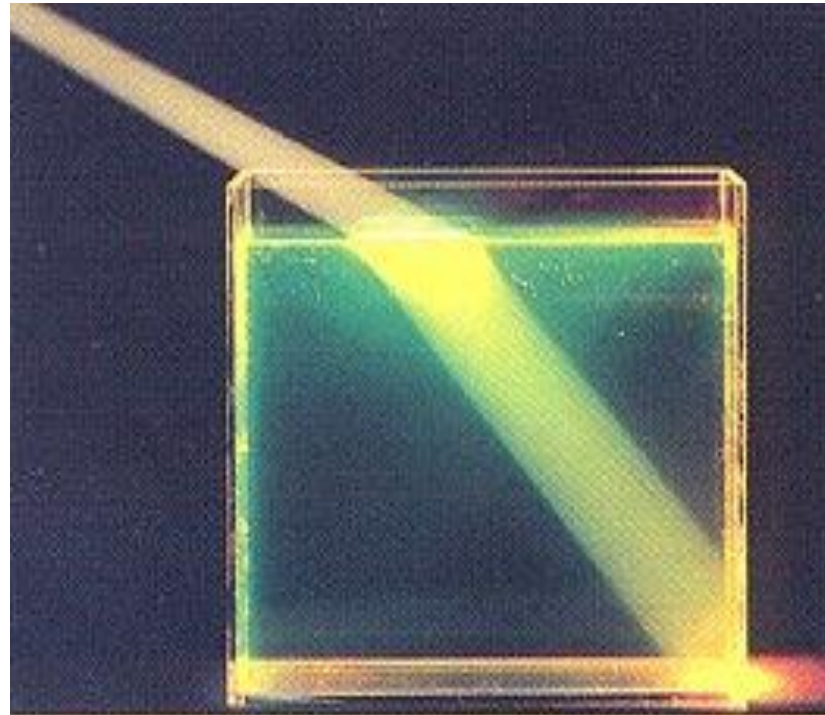
The speed of light varies depending on the material through which the waves are traveling.

When a wave enters a new material at an angle, the part of the wave that enters first begins traveling at a different speed from that of the rest of the wave.



Refraction is what gives the illusion of a bent straw or spoon in a clear glass of water.

Light waves travel faster in air than in water, so as it passes through the water, it slows down and appears to bend.



Refraction at the water surface gives the "broken pencil" effect.

Submerged objects always appear to be shallower than they are because the light from them changes angle at the surface, bending downward toward the water.



As light passes through a prism, such as a crystal or a drop of water, refraction causes light to bend and separate into many colors and produces a rainbow.



Distributed Summarizing

Explain the difference between
Diffraction and Refraction.

Give examples of both.

How is refraction an optical illusion?