WOW Lab
Science Education R&D

a WOW Lab BLUEPRINT

Light-Bending JELL-O

Inquiry Approaches

Initial Inquiry

How would you describe a wave? What are the differences between a blue light wave and a red light wave?

A wave is a disturbance that travels through a medium. Waves are characterized by amplitude, frequency and wavelength. Red and blue light waves have different frequencies and wavelengths; thus, they are reflected by different coloured surfaces.

Can you explain how light and sound waves differ in their travel through various media?

Sound waves of different frequencies travel at the same speed in various media. When listening to music through headphone speakers, the sound does not separate. In other words, you do not hear the sound waves from different instruments which have different frequencies that reach your ears at different times. Light waves differ from sound waves as light waves of different frequencies travel at different speeds in various media. This can be demonstrated when white light separates into a rainbow of colours as it is shone through a prism.

Experimental Procedure Inquiry

What happens when you make the angle of incidence greater than the critical angle?

When the angle of incidence is greater than or equal to the critical angle, total internal reflection occurs. Students can see this for themselves by finding the smallest angle at which total internal reflection occurs (the critical angle) and then increasing the angle of incidence.

What is the relationship between the index of refraction, n, of a substance and the nature of the substance?

Light will travel more slowly in substances with higher indices of refraction. Students can be given a hint by asking if the index of refraction for JELL-O is higher than that of air. Point out that the index of refraction for air is $n = 1.003$, and for a vacuum is $n = 1$.

What assumption are we making when we use the speed of light, *c*, as measured in a vacuum, for the speed of light in air? Why is this assumption acceptable for calculating the speed of light in JELL-O?

The assumption is that light waves travel at the same speed in air as they do in a vacuum, which is in fact not true; the index of refraction for air is 1.003 and that of a vacuum is 1. Ask the students to compare the difference between the indices of refraction for air and a vacuum with the difference between the measured indices of refraction for JELL-O and air. As JELL-O is very different from air, but air is not all that different from a vacuum, it is acceptable to approximate. This can be explained in the context of significant figures; the index of refraction for air is the same as the index of refraction for a vacuum up to three significant figures. All calculations made using the assumption that air is the same as a vacuum can be made up to three significant figures.

In-Depth Inquiry

What happens when the angle of incidence is 0^{o}, that is, when the laser is pointed so that the beam is perpendicular to the JELL-O interface?

The angle of refraction will be the same as the angle of reflection. The direction of the laser beam is not changed by the JELL-O. Ask students to prove this using the equation for Snell's law.

Does light travel faster in air or in JELL-O? How can you tell using Snell's law?

Light travels faster in air. Show the students that this can be demonstrated using Snell's law by plugging values of *n* and *c* into equation 1 on the equation page of *Additional Information*.