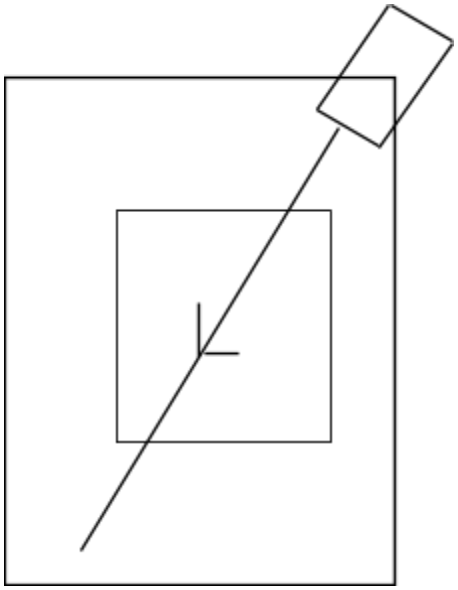
Refraction



Obtain a laser pointer with clay stand, a liter box and a note card screen.

1. Place the liter box in the center of a piece of paper. Put the laser pointer at a corner of the paper and point it so that the beam travels through opposite sides of the box. Place the screen on the opposite side of the box in the path of the beam. Trace the outline of the box. Trace a ray from the laser pointer to the screen. Label this path A.

2. If you filled the box with water, predict what would happen to the beam.

3. Fill the box with water to the 500 mL mark.
   a. Mark the points where the beam enters the box, exits the box and hits the screen.
   b. Trace the path of a ray of light from the laser pointer to the screen. Label this B.
   c. Compare your diagram to your prediction and explain any differences.

4. What happens to light as it passes from one medium to another?

5. Predict where the light would appear on the screen if you change the angle of incidence of the beam with the liter box. Explain your reasoning.

6. Keep the laser pointer in the same orientation as before. Turn the box so there is a different angle of incidence (not 90 degrees) for the light beam. Make sure that the position which the beam contacts the surface of the box does not change. Mark the new position of the box. Trace the path of a ray of light from the laser pointer to the screen. Label this path C.
   a. How does the angle of incidence for path B compare to the angle of incidence for path C?
   b. How does the first angle inside the box for path B compare to the first angle inside the box for path C?
   c. How does the second angle inside the box for path B compare to the second angle inside the box for path C?
   d. How does the first angle outside of the box for path B compare to the first angle outside of the box for path C?

7. You have seen that light bends when it travels from one medium to another. What factors determine how much the light is bent?

This bending is called **refraction** and occurs because light travels at different speeds in different media. There is a coefficient that is used to describe the amount of bending that will occur when light enters a medium called the **Index of Refraction**. This index is a number that is determined by comparing the behavior of light in a medium to the behavior in air. The relationship between the incident angle and the refracted angle is described by Snell's Law:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

where n_1 and n_2 are the indices of refraction for medium 1 and medium 2, θ_1 is the incoming angle and θ_2 is the outgoing angle. Note that both of the angles are with respect to a line perpendicular to the surface (also called a normal line).

8. Assume the index of refraction for air is 1. Use your diagram to determine the index of refraction for the water. Repeat this for at least two of the lines to determine a range of acceptable values.

9. What happens to light that travels from a medium with a low index of refraction to a medium with a high index of refraction (is the light bent toward the normal or away from the normal)? Draw a diagram and include an example calculation.

10. What happens to light that travels from a medium with a high index of refraction to a medium with a low index of refraction (is the light bent toward the normal or away from the normal)? Draw a diagram and include an example calculation.

11. What would the path of the light beam be if the beam were incident at 90 degrees with respect to the surface of the box? Draw a diagram and show your calculations.

12. Obtain a piece of plexi-glass. Look at your finger through the plexi-glass. Use a ray diagram to explain what happens to your finger as you rotate the plexi-glass.

13. Imagine you are looking at a fish in a pond. As compared to the fish's actual position, should the fish appear to be closer to the surface or closer to the bottom of the pond? Explain your reasoning with a ray diagram.