**Laboratory Investigation** Name _____

Physics@Frisch: Form L9.2A Date _____ Period _____

# Reflection and Refraction

## Problem

How do we describe the reflection and refraction of light?

## Introduction

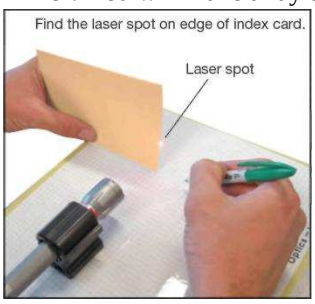
We observe the law of reflection every day. Looking in a mirror, we see ourselves reversed left-to-right. Our sense of sight depends on light reflected from objects around us. Light rays can also bend when they cross an interface between two different materials. The bending of light rays by a boundary between materials is called refraction. Prisms and lenses use refraction to manipulate light in telescopes, binoculars, cameras, and even your eyes. In this investigation, you will: take a closer look at reflection; apply geometry to predict exactly where reflected light goes; and determine the rules for how and to what degree light is refracted by glass and water.

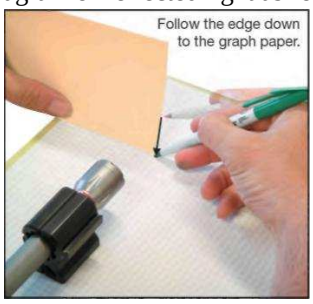
## Materials (*per group*)

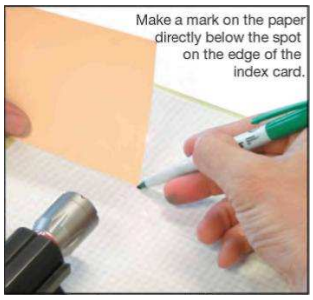
Graph paper and pencil; Index card; Laminated graph sheet; Laser flashlight and holder; Mirror; Prism; Protractor; Starch solution; Water soluble marker.

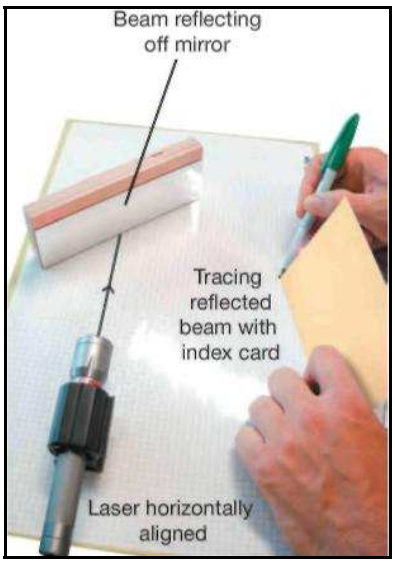
## Procedure

**1.** A diagram showing how light rays travel is called a *ray diagram*. Lines and arrows on a ray diagram represent rays of light. The *incident ray* travels to the mirror, the *reflected ray* travels away from the mirror. You will make a ray diagram of reflected light as follows:




Place your laminated graph sheet on a flat surface and align the laser so the beam follows one horizontal line across the paper.

**2.** Set the mirror on the laminated sheet so the light beam from the laser hits its shiny surface at an angle. Draw a line on the graph paper, marking the position of the front face of the mirror.

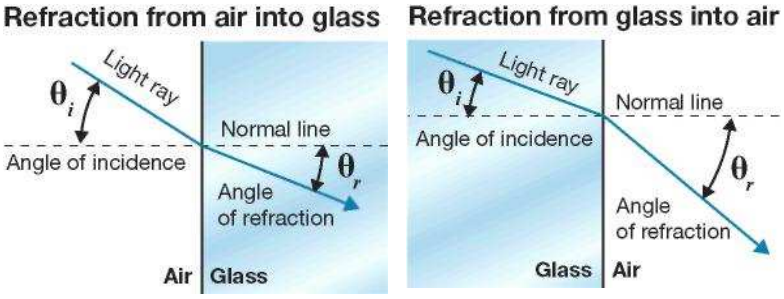
**3.** Use a fine point water soluble marker and an index card to trace the incident and reflected light rays from the laser. See the photos above and at right for clarification.

**4.** Repeat steps 1–3 with the mirror set at a different angle. Do the experiment for at least four different angles. Use different colored markers or label your incident and reflected rays so you don't get them confused.

**5.** A diagram showing how light rays travel is called a *ray diagram*. Lines and arrows on a ray diagram represent rays of light. The *incident ray* travels to the mirror, the *reflected ray* travels away from the mirror. For each ray diagram, draw a line perpendicular to the mirror surface at the point where the rays hit. This line is called the *normal line*.

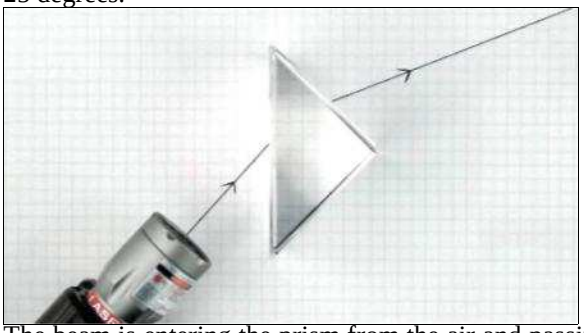
**6.** Use a protractor to measure the angle between the normal and the incident and reflected rays. Record your measurements in the table on page 3.

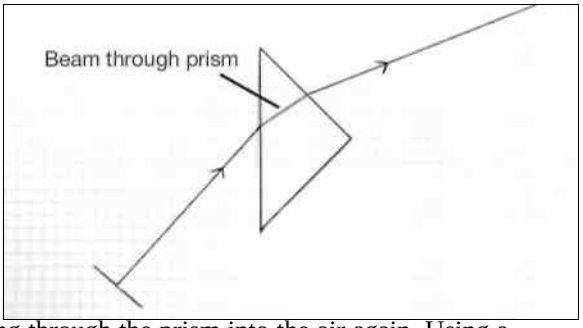
**7.** The normal line is also used to describe how refraction works. Remember, the normal is a line perpendicular to the surface. A light ray falling on a surface is called the incident ray. The light ray passing through the surface is called the refracted ray. You may assume these light rays move in straight lines except at the point where they cross the surface.




Measure and record the angles of the incident and refracted rays on the diagrams above.

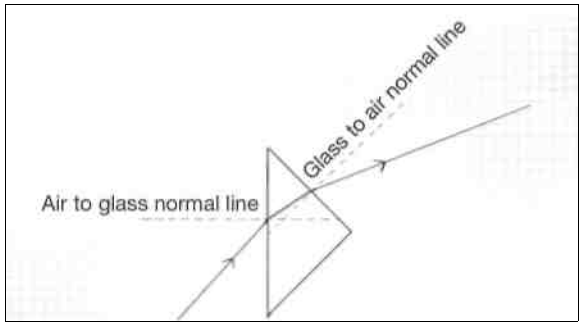
**8.** A prism is a solid piece of glass with polished surfaces. Prisms are useful for investigating how light bends when it crosses from one material into another. Place a prism on a piece of graph paper as shown below. Shine the laser so the beam comes out the opposite short side. The angle of incidence should be at least 25 degrees.





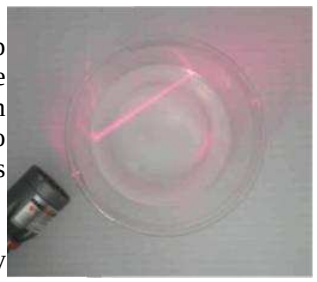

**9.** The beam is entering the prism from the air and passing through the prism into the air again. Using a sharp pencil and an index card, carefully trace the path of the laser beam as it enters and exits the prism. Then remove the laser and prism from the paper and draw the lines connecting the beam through the glass as shown above. Now, label the incident/refracted pair of rays involved when the beam passes from the air to the glass. Next, label the incident/refracted pair of rays involved when the beam passes from the glass to air.

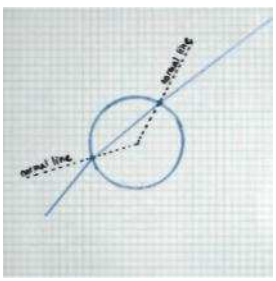
**10.** Draw the normals to the two faces of the prism the beam passed through as shown at right. Note whether light bends toward the normal or away from the normal when it goes from a low-index of refraction (air) to a higher-index of refraction (glass) material and from a high-index of refraction (glass) to a low-index of refraction (air) material.




**11.** Use the two normals and a protractor to determine the angles of incidence and refraction for both surfaces crossed by the light beam. Record the angles in the table on the next page.

**12.** If you shine a laser through a cup of water, the beam will show up if you put a drop of starch solution in the water. Fill a clear plastic cup about halfway with water. Add a drop of starch solution to the water. Set the cup on a piece of graph paper and trace around the base of the cup. Shine the laser through the cup so it passes off-center, as shown in the photo. Use an index card and water soluble marker to find and mark the beam going into and out of the cup. Remove the cup and laser. Connect the beam that passes through the cup.





**13.** Draw the normals to the surface of the cup at the points where the light ray enters and exits the cup. Note whether light bends toward the normal or away from the normal when it goes from a low-index of refraction (air) to a higher-index of refraction (water) material and from a high-index of refraction (water) to a low-index of refraction (air) material.

**14.** Use the two normals and a protractor to determine the angles of incidence and refraction for both surfaces crossed by the light beam. Record the angles in the table below.

## OBSERVATIONS

| Angles of Incidence and Reflection | | | | |
|---|---|---|---|---|
| **Angle of:** | **Diagram #1** | **Diagram #2** | **Diagram #3** | **Diagram #4** |
| **Incidence** | | | | |
| **Reflection** | | | | |

**Attach Drawings**

| Angles of Incidence and Refraction | | | |
|---|---|---|---|
| **Medium** | **Angle of incidence** | **Angle of refraction going from:** | |
| | | **low index to high index** | **high index to low index** |
| **Glass** | | | |
| **Water** | | | |

## CONCLUSIONS

**1.** Write down your own statement of the law of reflection, describing the relationship between the angles you measured. _____

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**2.** A laser shines at a mirror at an angle of incidence of 75 degrees. What is its angle of reflection? _____

**3.** The *index of refraction* is a property of a material that describes its ability to bend light rays. The higher the index of refraction, the more the material bends light. Which has a higher index of refraction, glass or water? _____

**4.** When light moves from a substance with a higher index of refraction to a substance with a lower index of refraction, does it bend toward or away from the normal? Support your answer with your data. _____

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