Ray Tracing

This exercise investigates the reflection and refraction of light as it interacts with various objects. Sound can behave in a similar fashion to each of the following cases but it is much easier to demonstrate these effects with light. For each part of the experiment place the ray box light source and the object; lens, prism, etc., on top of a large sheet of paper and trace the arrangement onto the paper (you should be able to get all the drawings on one page). Trace the objects and the rays of light onto the paper and label the directions of the rays. The following arrangements are to be set up. Notice that the ray box can be set to produce one or more rays by changing the cardboard divider. Turn in all your answers on a separate sheet of paper (be sure to put everyone's name on the paper).

1) Hold the flat mirror perpendicular to the paper and reflect one ray off of it (pick an angle other than 90^o). Once you have traced the mirror and ray, draw a line perpendicular line to the surface with a protractor and measure the incident and reflected angles (as shown on the board). Is the law of reflection obeyed?

2) Now trace the concave mirror on the paper and trace several parallel rays along the axis (as shown on the board). Find the focal length (the distance from the center of the mirror to where the rays come together). Would the focal length be longer or shorter for a mirror which is more curved? Explain.

3) Now trace the convex mirror on the paper with several parallel rays along the axis. Remove the mirror after drawing the rays and extend the rays backward towards the source to find the focal length (distance to where the rays *would have* come from). Would the focal length be longer or shorter for a mirror which is more curved? Explain.

4) Lay the glass block (with parallel sides) down flat on the paper and trace it. Trace <u>one</u> ray entering and leaving the block at an angle other than 90^o. Draw a line perpendicular to the surface at the point that the ray enters the block. What is the angle of incidence? By removing the glass and connecting the points where the ray entered and left the glass, you can find the refracted ray that was inside the block. Notice that the refracted ray 's angle (measured from a perpendicular to the block surface on the inside of the block) is not the same as the incident ray. What is the refracted angle of the ray inside the glass (measured from a line perpendicular to the glass surface)?

5) Calculate the index of refraction of the glass block using Snell's law, shown on the board. Be sure you have measured the incident and refracted angles for Snell's law from a perpendicular drawn to the glass surface .

6) What causes refraction (you may have to consult your book or the internet for more detail)?

7) The index of refraction is the ratio of the speed of light in a vacuum to the speed of light in the material. Explain why the index of refraction is never less than one.

8) Lay the glass triangle flat on the paper and experiment with one ray. Find and draw a ray which undergoes total internal reflection in the glass triangle (the ray reflects from an inside surface instead of passing out of the side). Be sure to indicate where the ray *would* have come out had it not totally reflected.

9) Lay the glass triangle flat on the paper with one light ray (or use the entire light source with no slits) so that a spectrum of colors appears. Which color is bent more and which less? Why does this occur?

10) Lay the circular glass plate with several the maximum number of rays entering. What happens to the rays? Explain.

11) Lay the convex glass (at least one side convex) with several rays entering. What is the focal length (measured from the center of the lens to the focus)?

12) Lay the concave glass (at least one side concave). Remove the glass after drawing the rays and extend the rays backward towards the source to find the focal length.