Ray Tracing

This lab investigates the reflection and refraction of light as it interacts with various objects. Light is a type of electromagnetic wave. As we will see in class, sound, which is a wave made of vibrations in the air, can behave the same way.

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 several drawings per 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.

1) Flat mirror with one ray at an angle other than 90°. Draw a perpendicular to the surface with a protractor and measure the incident and reflected rays (as shown in your book). Is the law of reflection obeyed?

2) Concave mirror with several parallel rays along the axis (as shown in your book). 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) Convex mirror 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. Would the focal length be longer or shorter for a mirror which is more curved? Explain.

4) Glass block (with parallel sides) with <u>one</u> ray at an angle other than 90°. Lay the block down flat on the paper. Draw a 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's angle (measured from a perpendicular to the block surface on the inside of the block). 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, $n_1 \sin \theta_1 = n_2 \sin \theta_2$. 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?

7) The index of refraction is greater than one for most materials. What does this tell you about the speed of light in these materials?

8) Lay the glass triangle flat on the paper with one ray. Find and draw a ray which undergoes total internal reflection in the glass triangle (the ray reflects from and 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) Prism with one 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) Circular glass plate with the maximum number of rays entering. Does this arrangement demonstrate spherical aberration for the rays furthest from the center? Explain.

11) 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) 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.