PHY 157
Refraction and Lenses
(Experiment 9)

Names of Group Members: ____

1 Introduction

In this lab you will observe the refraction of light rays by a block and lenses and draw the paths of selected rays using ray tracing techniques.

A light box will be used to produce light rays that will be directed toward the lens. The behavior of the rays can be observed and the rays can be marked with a pencil and then drawn to show their path.

2 Apparatus

- Light box
- Ray slits
- Centimeter ruler
- White paper
- Light box power supply
- Optical shapes

- Protractor
- Night light

Note: The light ray box will get hot. Use care when touching it. To mark the path of a light ray, use the old maxim "*two points determine a straight line*". Mark a small dot at the center of a ray at two points: one point near the optical surface and the other point farther away. Use a straightedge to draw the ray.

This experiment does not have a separate analysis section. *Read through the procedure before starting so that you can plan ahead and include all the drawing, calculations, and comments on the same side of the paper.* You will submit one report for your group.

3 Procedure 1 - Refraction at the Surface of Transparent Material

Rectangular Block. Send a single ray at an angle toward one face of the rectangular block as shown in Figure 1 and adjust the angle of incidence to be greater than 45°.

1. Trace the perimeter of the block and mark the incoming and outgoing rays. Remove the block and draw the incoming and outgoing rays and draw the *refracted* ray that passes through the block. Use a protractor to measure the angle between the *incident* ray and the face of the block and the angle between the *refracted* ray (inside the block) and the face of the block. Write the angles on your diagram.

2. Use these angles to determine the angles of incidence and and refraction and write their values under your diagram. Obtain a value for the index of refraction n using Snell's Law:

   $$n_1 \sin\theta_1 = n_2 \sin\theta_2 \tag{1}$$

   Record your value for the index of refraction in the space below.

   $n =$ ____________________

4 Procedure 2 - Refraction by Lenses

1. *Converging Lens.* Place the *thin* converging (double-convex) lens on a sheet of paper and send three or four parallel rays along its axis as shown. The rays should converge to a common point. The point of convergence is called the **focal point** of the lens.

   Trace the outline of the lens, mark the incoming and outgoing rays, remove the lens, and draw the rays. Mark the focal point of the lens and draw the vertex line as shown in Figure 2. Measure and record the distance from the vertex line to the focal point. This distance is the focal length f of the lens. Record your measured focal length in the space below.

f = ____________________________

2. *Diverging Lens.* Place the diverging (double-concave) lens on a sheet of paper and send three or four parallel rays along the axis of the lens as shown in Figure 3. Notice that the refracted rays seem to diverge from a point in front of the lens. This point is the **focal point** of the diverging lens.

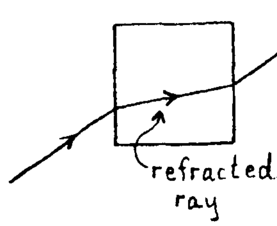

Figure 1.

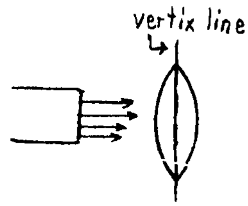

Figure 2.

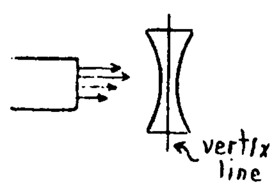

Figure 3.