Experiment 3: Reflection – Plane and Curved Mirrors

EQUIPMENT NEEDED

– Ray box (single and multiple white rays)
– Protractor (SE-8732)
– Metric rule
– Plane and curved mirrors
– Drawing compass (SE-8733)
– White paper

Purpose

To study how rays are reflected and to determine the focal length and radius of curvature of different types of mirrors.

Part I: Plane Mirror

Procedure

① Place the ray box, label side up, on a white sheet of paper on the table. Adjust the box so one white ray is showing.

② Place the mirror on the table and position the plane surface of the mirror at an angle to the ray so that the both the incident and reflected rays are clearly seen.

③ Mark the position of the surface of the plane mirror and trace the incident and reflected rays. Indicate the incoming and the outgoing rays with arrows in the appropriate directions.

④ On the paper, draw the normal to the surface. See Figure 3.1.

⑤ Measure the angle of incidence (θ_i) and the angle of reflection. Both these angles should be measured from the normal. Record the angles in Table 3.1.

⑥ Change the angle of incidence and measure the incident and reflected angles again. Repeat this procedure for a total of three different incident angles.

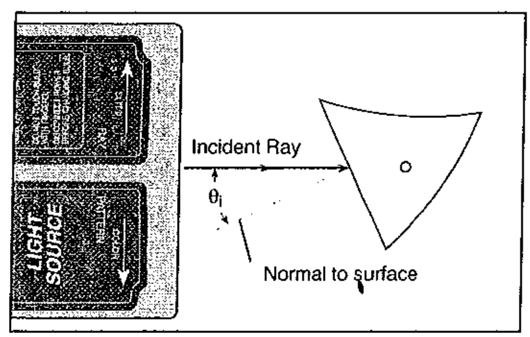

Figure 3.1

⑦ Adjust the ray box so it produces the three primary color rays. Shine the colored rays at an angle to the plane mirror. Mark the position of the surface of the plane mirror and trace the incident and reflected rays. Indicate the colors of the incoming and the outgoing rays and mark them with arrows in the appropriate directions.

Table 3.1 Plane Mirror Results

Angle of Incidence	Angle of Reflection

Questions

① What is the relationship between the angle of incidence and the angle of reflection?

② Are the three colored rays reversed left-to-right by the plane mirror?

Part II: Cylindrical Mirrors

Theory

A concave cylindrical mirror will focus parallel rays of light at the focal point. The focal length is the distance from the focal point to the center of the mirror surface. The radius of curvature of the mirror is twice the focal length. See Figure 3.2.

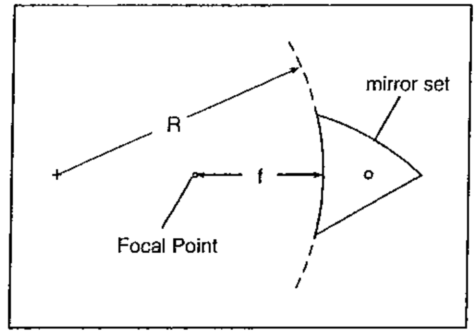

Figure 3.2

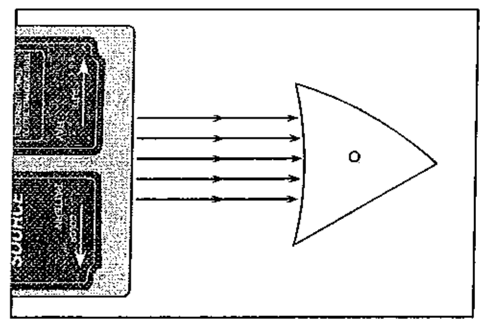

Figure 3.3

Procedure

① Using five white rays from the ray box, shine the rays straight into the concave mirror so the light is reflected back toward the ray box. See Figure 3.3. Draw the surface of the mirror and trace the incident and reflected rays. Indicate the incoming and the outgoing rays with arrows in the appropriate directions.

② The place where the five reflected rays cross each other is the focal point of the mirror. Measure the focal length from the center of the concave mirror surface to the focal point. Record the result in Table 3.2.

③ Use the compass to draw a circle that matches the curvature of the mirror. Measure the radius of curvature using a rule and record it in Table 3.2.

④ Repeat Steps 1 through 3 for the convex mirror. Note that in Step 2, the reflected rays are diverging for a convex mirror and they will not cross. Use a rule to extend the reflected rays back behind the mirror's surface. The focal point is where these extended rays cross.

Table 3.2 Cylindrical Mirror Results

	Concave Mirror	Convex Mirror
Focal Length		
Radius of Curvature using compass		

Questions

① What is the relationship between the focal length of a cylindrical mirror and its radius of curvature? Do your results confirm your answer?

② What is the radius of curvature of a plane mirror?

Experiment 4: Snell's Law

EQUIPMENT NEEDED

- Ray box (single white ray and colored rays)
- Rhombus
- Protractor (SE-8732)
- White paper

Purpose

To use Snell's Law to determine the index of refraction of the acrylic rhombus.

Theory

Snell's Law states

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

where θ_1 is the angle of incidence, θ_2 is the angle of refraction, and n_1 and n_2 are the respective indices of refraction of the materials. See Figure 4.1.

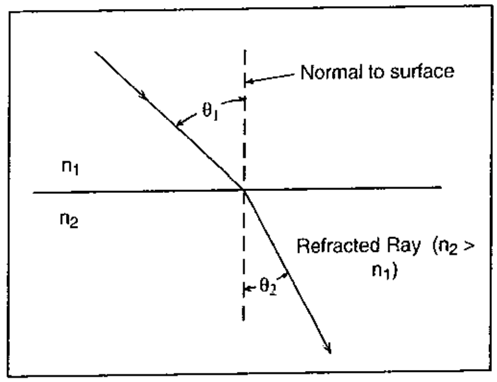

Figure 4.1

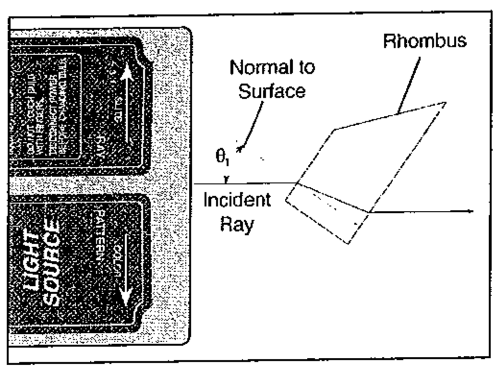

Figure 4.2

Procedure

① Place the ray box, label side up, on a white sheet of paper on the table. Slide the ray mask until only one white ray is showing.

② Place the rhombus on the table and position it so the ray passes through the parallel sides as shown in Figure 4.2.

③ Mark the position of the parallel surfaces of the rhombus and trace the incident and transmitted rays. Indicate the incoming and the outgoing rays with arrows in the appropriate directions. Mark carefully where the ray enters and leaves the rhombus.

④ Remove the rhombus and on the paper draw a line connecting the points where the ray entered and left the rhombus.

⑤ Choose either the point where the ray enters the rhombus or the point where the ray leaves the rhombus. At this point, draw the normal to the surface.

⑥ Measure the angle of incidence (θ_i) and the angle of refraction with a protractor. Both these angles should be measured from the normal. Record the angles in Table 4.1.

⑦ Change the angle of incidence and measure the incident and refracted angles again. Repeat this procedure for a total of three different incident angles.

Table 4.1 Data and Results

Angle of Incidence	Angle of Refraction	n rhombus
Average index of refraction		

Analysis

① Using Snell's Law and your data, calculate the index of refraction for the Acrylic rhombus, assuming the index of refraction of air is one. Record the result for each of the three data sets in Table 4.1.

② Average the three values of the index of refraction and compare to the accepted value (n = 1.5) using a percent difference.

Question

What is the angle of the ray that leaves the rhombus relative to the ray that enters the rhombus?