Thin Lenses

Saddleback College Physics Department

Purpose

- To experimentally determine the index of refraction of a given medium using Snell's Law and compare it to the handbook value.
- To experimentally determine the critical angle for a provided medium and compare it to the calculated critical angle for that medium (use the handbook value for "n" in this calculation).

Equipment

PASCO Ray Box (single white ray and colored ray)/Light Source OS-8470
PASCO Optics Table OS-8465
PASCO D-shaped Lens OS-8492

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 to the right.)

θ_c = critical angle (For all incident angles $\geq \theta_c$ light rays undergo total internal reflection.)

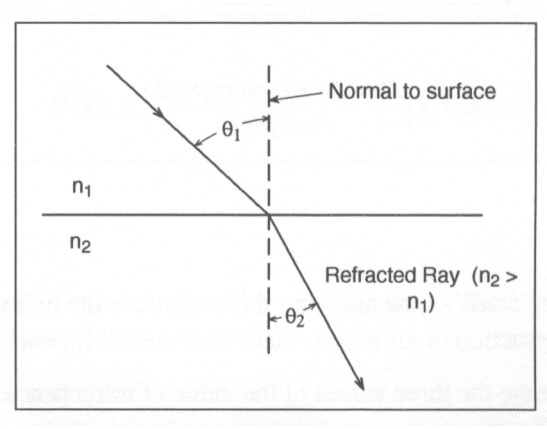

Figure 1.

Procedure

1. Place the ray box, on the table and slide the ray mask until only one white ray (or a single colored ray) is showing.
2. Place the optics table close to the ray box and place the D-shaped lens in the position shown in Figure 2 & 3.

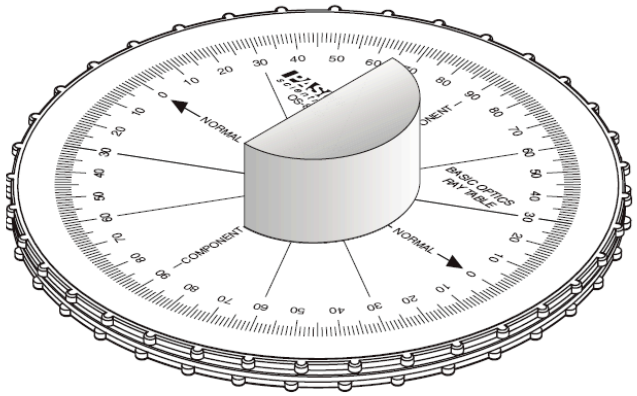

Figure 2.

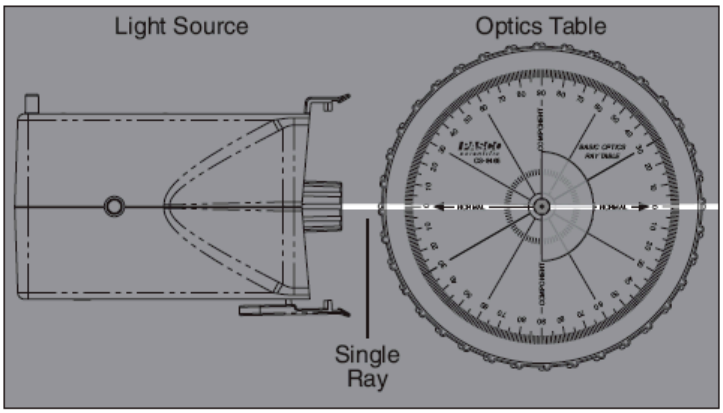

Figure 3.

3. Notice that you can change the angles of incidence by rotating the upper half of the optics table while the non-skid feet keep the base firmly in place. You may write in PENCIL on the table's white surface during the experiment but you MUST erase them when you are all done. This should allow you to mark angles and trace rays directly on the optics table.
4. Position the light source such that the ray crosses the center of the optics table; rotate the optics table to place one of the 0° marks on the incident ray.
5. Place the D-shaped lens over the lens outline on the optics table. Note that the flat surface of the lens is aligned with the "Component" line on the table and that the lens's curved surface is concentric with the table.
6. With the light source on, measure the angle of incidence (θ_1) and angle of refraction (θ_r). Record the angles in the table below.
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. Record your results.
8. Experimentally determine θ_c and record it.

DATA AND RESULTS

Angle of Incidence	Angle of Refraction	n experimental
Average index of refraction (experimental)		

Experimental θ_c	Theoretical θ_c
	n (acrylic) = 1.492

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 the table above.

2. Average the three values of the index of refraction and compare it to the handbook value for that medium.
3. Use Snell's Law to calculate the theoretical θ_c for the D-shaped lens using the handbook value for n_{medium}. Compare the experimental value for θ_c with the theoretical one.