Experiment 4: The Law of Refraction

EQUIPMENT NEEDED:

-Optics Bench
-Ray Table and Base
-Slit Plate
-Cylindrical Lens.
-Light Source
-Component Holder
-Slit Mask

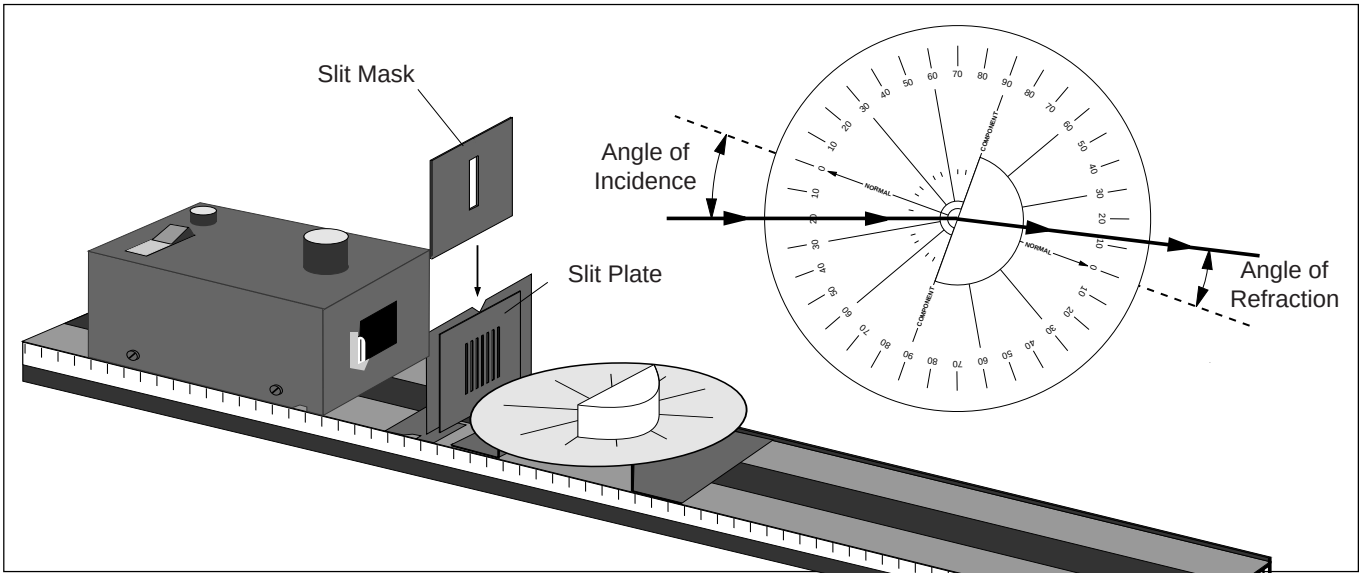

Figure 4.1 Equipment Setup

Introduction

As you have seen, the direction of light propagation changes abruptly when light encounters a reflective surface. The direction also changes abruptly when light passes across a boundary between two different media of propagation, such as between air and acrylic, or between glass and water. In this case, the change of direction is called Refraction.

As for reflection, a simple law characterizes the behavior of a refracted ray of light. According to the Law of Refraction, also known as Snell's Law:

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

The quantities n_1 and n_2 are constants, called indices of refraction, that depend on the two media through which the light is passing. The angles θ_1 and θ_2 are the angles that the ray of light makes with the normal to the boundary between the two media (see the inset in Figure 4.1). In this experiment you will test the validity of this law, and also measure the index of refraction for acrylic.

Procedure

Set up the equipment as shown in Figure 4.1. Adjust the components so a single ray of light passes directly through the center of the Ray Table Degree Scale. Align the flat surface of the Cylindrical Lens with the line labeled "Component". With the lens properly aligned, the radial lines extending from the center of the Degree Scale will all be perpendicular to the circular surface of the lens.

Without disturbing the alignment of the Lens, rotate the Ray Table and observe the refracted ray for various angles of incidence.

① Is the ray bent when it passes into the lens perpendicular to the flat surface of the lens?

_____

_____.

② Is the ray bent when it passes out of the lens perpendicular to the curved surface of the lens?

_____

_____.

By rotating the Ray Table, set the angle of incidence to each of the settings shown in Table 4.1 on the following page. For each angle of incidence, measure the angle of refraction (Refraction$_1$). Repeat the measurement with the incident ray striking from the opposite side of the normal (Refraction$_2$).

③ Are your results for the two sets of measurements the same? If not, to what do you attribute the differences? _____

_____

_____.

Angle of:	**Incidence**	**Refraction$_1$**	**Refraction$_2$**
	0°		
	10°		
	20°		
	30°		
	40°		
	50°		
	60°		
	70°		
	80°		
	90°		

Table 4.1 Data

On a separate sheet of paper, construct a graph with sin(angle of refraction) on the x-axis and sin(angle of incidence) on the y-axis. Draw the best fit straight line for each of your two sets of data.

④ Is your graph consistent with the Law of Refraction? Explain. _____

_____.

⑤ Measure the slope of your best fit lines. Take the average of your results to determine the index of refraction for acrylic (assume that the index of refraction for air is equal to 1.0).

n = _____.

Additional Questions

① In performing the experiment, what difficulties did you encounter in measuring the angle of refraction for large angles of incidence?

② Was all the light of the ray refracted? Was some reflected? How might you have used the Law of Reflection to test the alignment of the Cylindrical Lens?

③ How does averaging the results of measurements taken with the incident ray striking from either side of the normal improve the accuracy of the results?