Brewster's Angle

Required Equipment from Basic Optics System (OS-8515D)

Ray Table
D-shaped Lens
Light Source
Polarizer
Screen

Purpose

The purpose of this experiment is to determine the index of refraction of acrylic by finding Brewster's Angle.

Theory

When unpolarized light reflects off a nonconducting surface like the acrylic D-shaped lens, it is partially polarized parallel to the plane of the reflective surface depending on the incident angle of the incoming light. As you have also seen, there is a specific incident angle at which the reflected light is 100% polarized. This angle is called Brewster's angle, and it occurs when the reflected ray and the refracted ray are 90° apart.

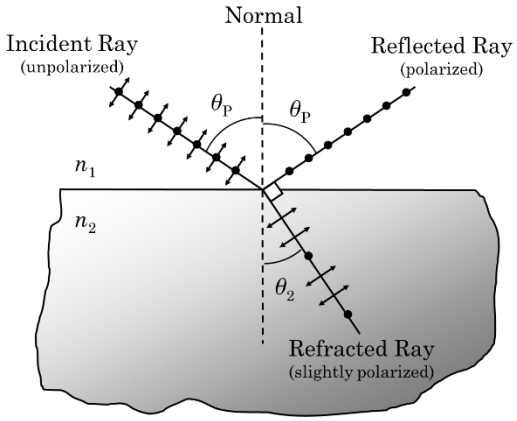

Figure 1: Reflected Ray Is Polarized

To determine the mathematical relationship that describes Brewster's angle we can start by using Snell's Law:

$$n_1 sin\theta_p = n_2 sin\theta_2 \qquad (1)$$

Because $\theta_1 + \theta_2 = 90^o$ or $\theta_2 = 90^o - \theta_p$, an important substitution can be made into Equation 1:

$$n_1 sin\theta_p = n_2 sin(90^o - \theta_2) \qquad (2)$$

Substituting $sin\,(90^o - \theta_p) = cos\,\theta_p$ back into Equation 2 gives:

$$n_1 sin\theta_p = n_2 cos\theta_2$$

Therefore,

$$tan\theta_p = \frac{n_2}{n_1} \qquad (3)$$

Setup

1. Set the Ray table on the lab bench and place the clear acrylic D-shaped lens within the outline on the top of the ray table. Rotate the table to zero degrees.

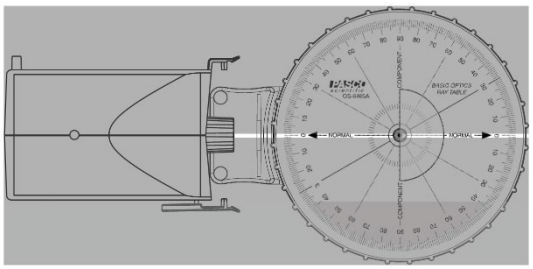

Figure 2: Aligning Ray Box with Ray Table

2. Connect the light source to power, and then adjust the dial on the front of it so that only one ray of light is emitted.

3. Turn off all the lights in the classroom.

4. Place the light source on the lab bench so that the front of it is against the square tab of the ray table, and the ray of light is incident on the center of the flat side of the D-shaped lens (see Figure 2). The ray should pass through the center of the lens without bending.

5. Place the Basic Optics Screen on its side on the table next to the ray table at the 90-degree mark to act as a screen (see Figures 3a and 3b).

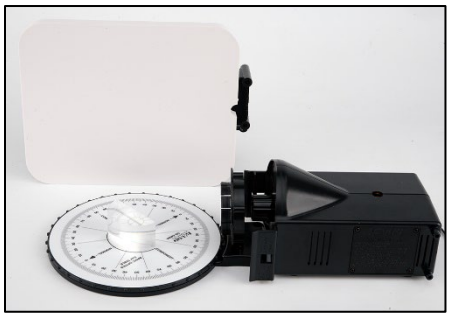

Figure 3a: Setup with Screen

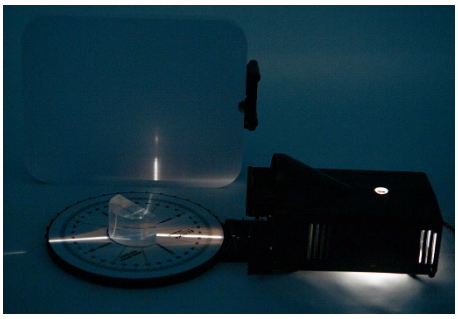

Figure 3b: Reflected Ray Shows on Screen

Procedure

1. Install the polarizer, oriented with zero degrees at the top (see Figure 4). The light passing through the polarizer will be vertically polarized (parallel with the surface of the D-lens).

2. Rotate the ray table and observe the reflected ray on the side screen. How does the intensity of the reflected light change as the incident angle increases?

3. Return the ray table to zero degrees and change the polarizer angle to 90 degrees. The light passing through the polarizer

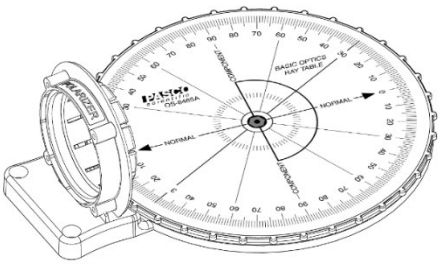

Figure 4: Install Polarizer

will be horizontally polarized (perpendicular to the surface of the D-lens).

4. Rotate the ray table and observe the reflected ray on the side screen. How does the intensity of the reflected light change as the incident angle increases?

5. Rotate the ray table to the angle that makes the reflected ray as dim as possible. You may have to remove the polarizer to get a good reading of the angle. Record this angle.

Analysis

1. Use the angle to calculate the index of refraction of the plastic D-lens.