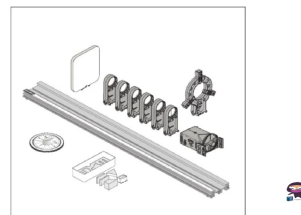


PASCO 012-09900B Basic Optics System



## PASCO 012-09900B Basic Optics System Installation Guide

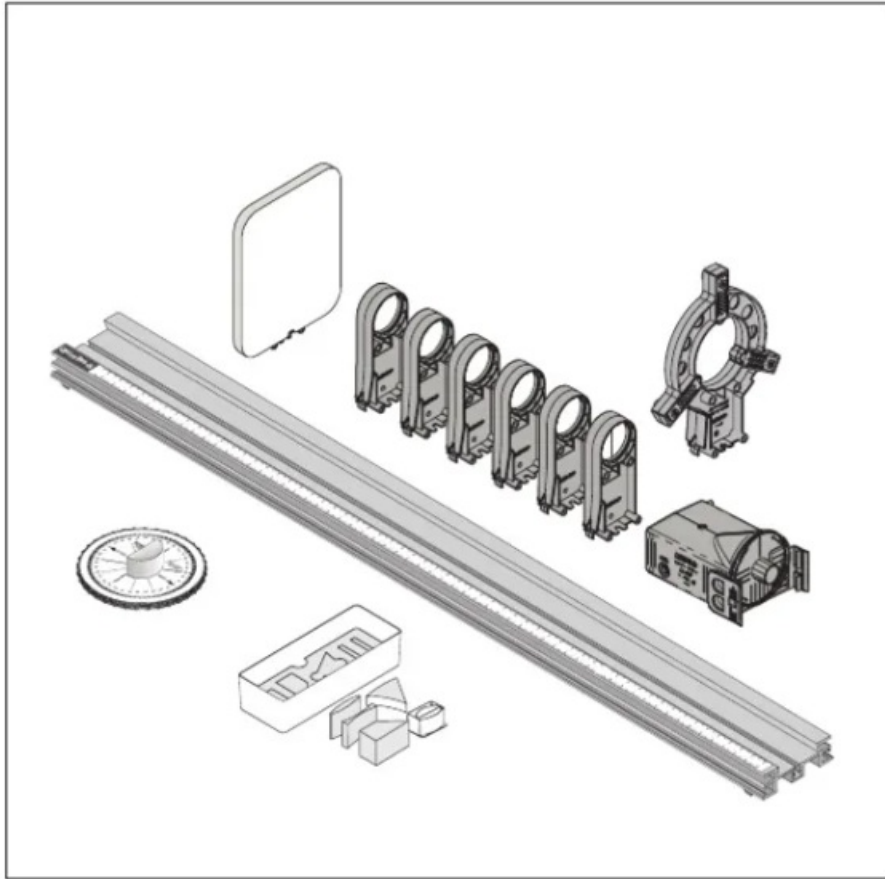
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PASCO 012-09900B Basic Optics System



## Total Internal Reflection

### Required Equipment from Basic Optics System

- Light Source
- Trapezoid from Ray Optics Kit

### Other Required Equipment

- Protractor
- White paper

### Purpose

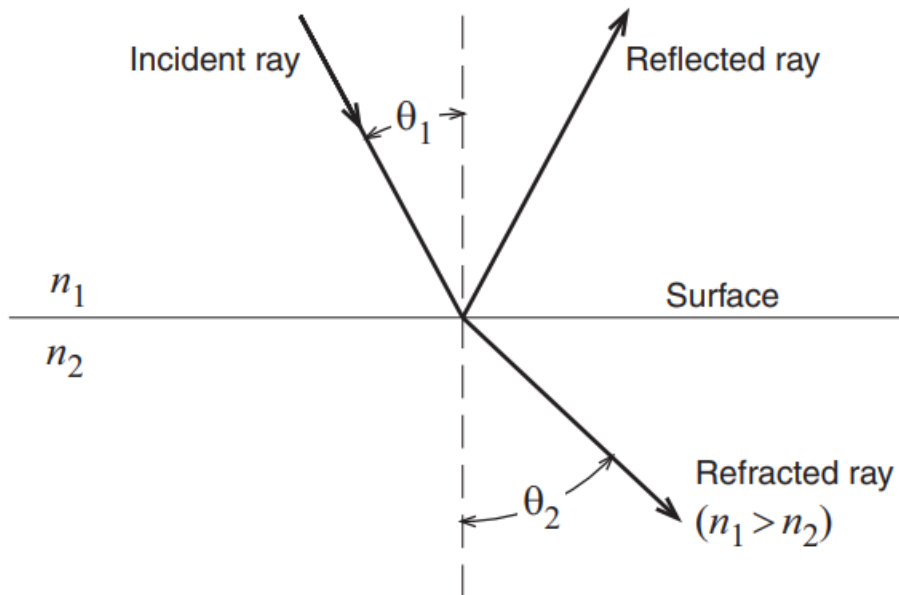
In this experiment, you will determine the critical angle at which total internal reflection occurs in the acrylic trapezoid and confirm your result using Snell's Law.

### Theory

For light crossing the boundary between two transparent materials, Snell's Law states

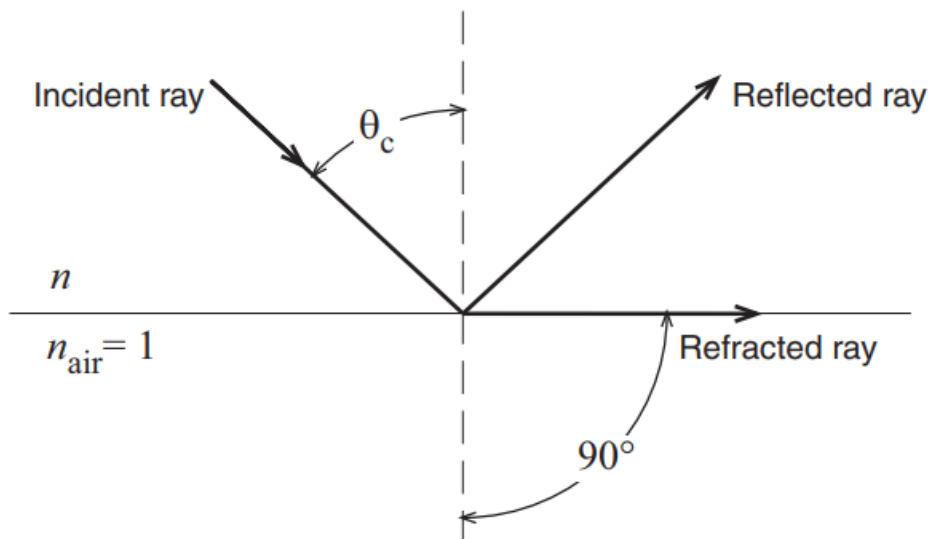
$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

where  $\theta_1$  is the angle of incidence,  $\theta_2$  is the angle of refraction, and  $n_1$  and  $n_2$  are the respective indices of refraction of the materials (see Figure 1).



**Figure 1**

In this experiment, you will study a ray as it passes out of the trapezoid, from acrylic ( $n = 1.5$ ) to air ( $n_{\text{air}} = 1$ ). If the incident angle ( $\theta_1$ ) is greater than the critical angle ( $\theta_c$ ), there is no refracted ray and total internal reflection occurs. If  $\theta_1 = \theta_c$ , the angle of the refracted ray ( $\theta_2$ ) is  $90^\circ$ , as in Figure 2.



**Figure 2**

In this case, Snell's Law states:

$$n \sin \theta_c = 1 \sin 90^\circ$$

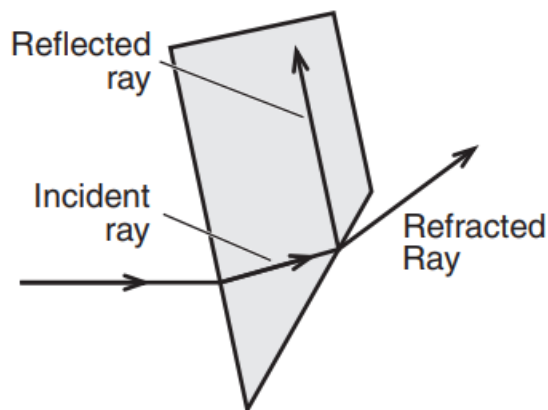
Solving for the sine of critical angle gives:

$$\sin \theta_c = \frac{1}{n}$$

## Procedure

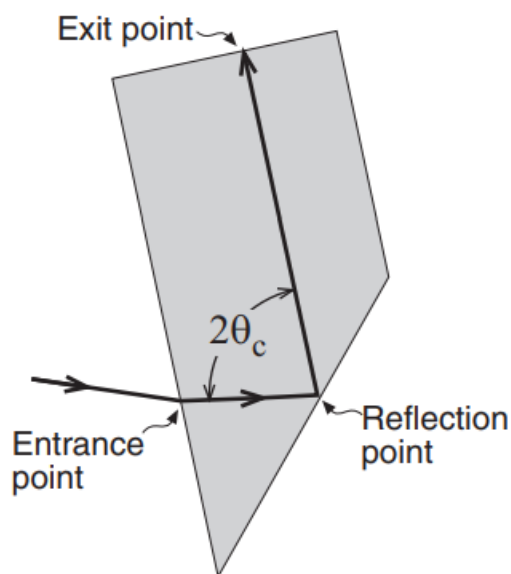
1. Place the light source in ray-box mode on a sheet of white paper. Turn the wheel to select a single ray.

2. Position the trapezoid as shown in Figure 3, with the ray entering the trapezoid at least 2 cm from the tip.



**Figure 3**

3. Rotate the trapezoid until the emerging ray just barely disappears. Just as it disappears, the ray separates into colors. The trapezoid is correctly positioned if the red has just disappeared.
4. Mark the surfaces of the trapezoid. Mark exactly the point on the surface where the ray is internally reflected. Also mark the entrance point of the incident ray and the exit point of the reflected ray.
5. Remove the trapezoid and draw the rays that are incident upon and reflected from the inside surface of the trapezoid. See Figure 4.



**Figure 4**

Measure the angle between these rays using a protractor. (Extend these rays to make the protractor easier to use.) Note that this angle is twice the critical angle because the angle of incidence equals the angle of reflection. Record the critical angle here:

- $\theta_c = \underline{\hspace{2cm}}$  (experimental)

6. Calculate the critical angle using Snell's Law and the given index of refraction for Acrylic ( $n = 1.5$ ). Record the theoretical value here:

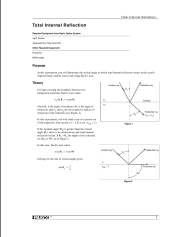
- $\theta_c = \underline{\hspace{2cm}}$  (theoretical)

7. Calculate the percent difference between the measured and theoretical values: % difference =  $\underline{\hspace{2cm}}$

## Questions

1. How does the brightness of the internally reflected ray change when the incident angle changes from less than  $\theta_c$  to greater than  $\theta_c$ ?
2. Is the critical angle greater for red light or violet light? What does this tell you about the index of refraction?

## Documents / Resources

	<p><a href="#">PASCO 012-09900B Basic Optics System</a> [pdf] Installation Guide</p> <p>012-09900B Basic Optics System, 012-09900B, Basic Optics System, Optics System, System</p>
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## References

- [User Manual](#)

### [Manuals+](#), [Privacy Policy](#)

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