Lab 9. REFLECTION AND REFRACTION

10.1. Guiding Questions

- How does a ray of light change when it strikes a mirror?
- How does a ray of light change when it enters a different medium?

10.2. Equipment

Slit light source, vertical mirror, glass block, acrylic block, ruler, pencil, protractor, and three pieces of white paper.

10.3. Background

Reflection: The law of reflection describes the path of light rebounding from a plane surface. It is conventionally stated as

$$\theta_1 = \theta_2 \qquad \text{(Eq. 1)}$$

The reflected path is on the other side of a line perpendicular to the surface, but at the same angle from it.

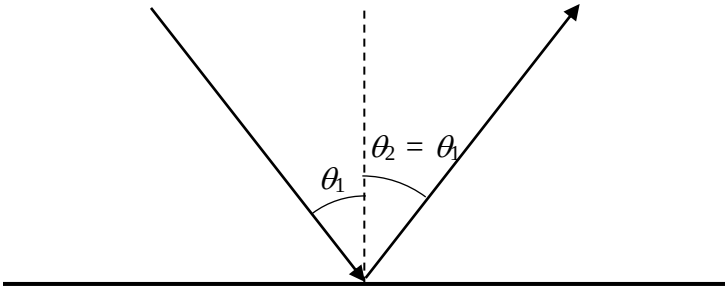


Figure 1. Reflection

Refraction: Snell's law describes the behavior of light when it travels from one medium with index of refraction n_1 into another medium with index n_2:

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \qquad \text{(Eq. 2)}$$

The index of refraction for medium 1 and medium 2 are defined as

$$n_1 = c/v_1 \quad \text{and} \quad n_2 = c/v_2 \qquad \text{(Eq. 3 and 4)}$$

where c is the vacuum speed of light, 2.9979×10^8 m/s, and v_1 and v_2 are the speeds of light in the two media. The angles referenced in Snell's law are shown in Figure 1 and represent the angle of incidence (θ_1) and the angle of refraction (θ_2).

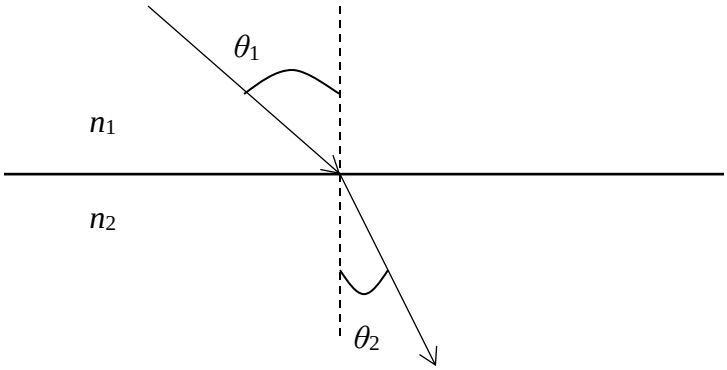
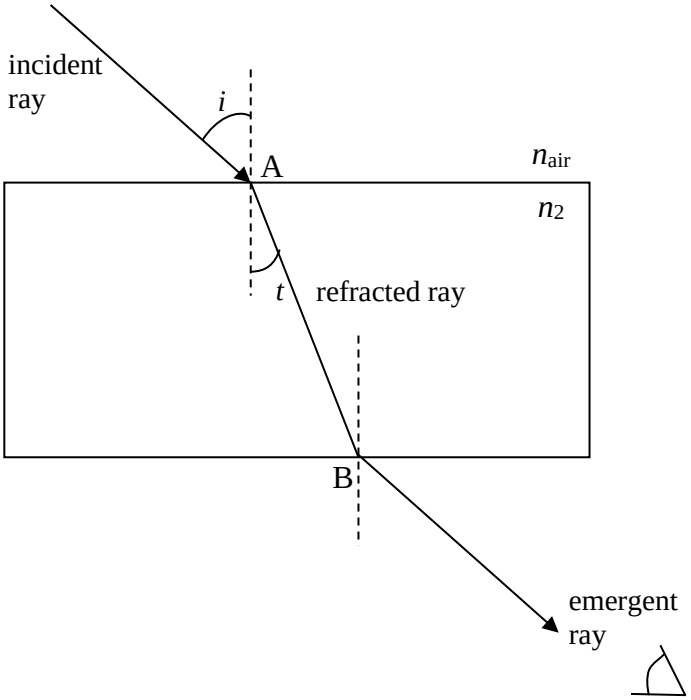


Figure 2. Snell's Law

In this experiment, you will experimentally determine the index of refraction, n_2, of a transparent block.



10.4. Procedure

Reflection

1. Lay a sheet of paper flat on the table. Lay a mirror on the paper. Draw a line along the face of the mirror. Extend the line across the paper with a straight edge.
2. Illuminate the light source so that it produces a single "blade" of light. Shine the light beam onto the face of the mirror. Orient the light source so that both the incident and reflected beam illuminate the paper.

3. Trace the incident and reflected rays on the sheet of paper. The tracings record the path of the light into and away from the mirror.
4. Measure the angle of incidence (*i*) and the angle of refraction (*t*) with a protractor and record your data in Table 1.

Table 1. Mirror

Angle of Incidence	Angle of Reflection

5. Repeat the procedure described above a total of 5 times using different incident angles. Use as wide a range of angles as possible. You may do all of the diagrams on the same paper, but shine the incident beam onto a different part of the mirror each time so that the paths have different vertices. Otherwise it will be difficult to tell which reflected ray goes with each incident ray.

Refraction

1. Lay a sheet of paper flat on the table. Lay a transparent block on the paper. Draw lines along the two long faces of the block. Extend these lines across the paper with a straight edge.
2. Define an incident ray using two vertical pins. It is easiest if one pin is flush against the back of the block.
3. Illuminate the light source so that it produces a single "blade" of light. Shine the light beam onto a face of the block. Orient the light source so that both the incident and emergent beam illuminate the paper.
4. Trace the incident and emergent rays on the sheet of paper. The tracings record the path of the light into and out of the block. Connect the rays to find the path within the block.
5. Measure the angle of incidence (θ_i) and the angle of refraction (θ_t) with a protractor and record your data in Table 2.
6. Repeat the procedure described above a total of 5 times using different incident angles. Use as wide a range of angles as possible. You may do all of the diagrams on the same paper. Also enter the sines of the angles in the table.
7. The index of refraction of the plate is given by $n_{\text{glass}} = n_{\text{air}} \sin\theta_i / \sin\theta_t$. Calculate the index of refraction n_{glass} from the angles θ_i and θ_t of each ray in Table 2, and enter these values in the last column of the table. Also calculate the average index of refraction. (Tip: make sure your calculator is in degrees.)

Table 2. First block

Angle of Incidence	Angle of Refraction	sin *i*	sin *t*	*n*
			Average	

7. Repeat with a block made of a different transparent material. Enter those measurements and calculations into Table 3.

Table 3. Second block

Angle of Incidence	Angle of Refraction	sin *i*	sin *t*	*n*
			Average	

10.5. Questions

1. Does the law of reflection match your observations with the mirror?

2. Does Snell's law match your observations with the transparent blocks? If so, what are the indices of refraction of the two blocks?