Main Topic	Light & Color
Subtopic	Refraction
Learning Level	High
Technology Level	Low
Activity Type	Student

Description: Experiment with rays refracting in a semicircular block. Measure angles and find the block's index of refraction.

Required Equipment	Light Box and Optical Set, Protractor
Optional Equipment	Refraction Cup

This lab is excerpted from *Light and Color Teacher's Guide* (Arbor Scientific P2-9560). The diagrams allow students to use the Light Box and Optical Set (Arbor Scientific P2-9561) directly on their lab pages.

Refraction—B1—How Does Light Refract?

Teacher's Notes

Educational Objectives

- Students will be able to explain that light entering a transparent material at a slanting angle will change direction (refract) when crossing the boundary between two different transparent materials (e.g. air/ plastic interface).
- Students will be able to state and demonstrate that light crossing the boundary between two transparent materials along the normal will not change direction.
- Students will recognize that refraction occurs at the boundary (interface) between two transparent materials.
- Students will be able to discover that the angle of refraction when light passes from air to plastic is always smaller than the angle of incidence.
- Students will be able to use their measurements to calculate the index of refraction for the plastic semicircular optical element.
- ***Extension:*** Students will be able to calculate the index of refraction of a number of different liquids.

Key Questions

- Is light bent when it travels from one transparent material to another transparent material?
- If it is bent, where does the bending take place?
- If it is bent, which angle is smaller, angle if incidence or angle of refraction?
- If light is refracted is there a mathematical relationship between the angles of incidence and the angle of refraction?

Concept Overview

Refraction is a common phenomenon that we see each day in many different places. Each time we look out a window or into water we are seeing light refract. This

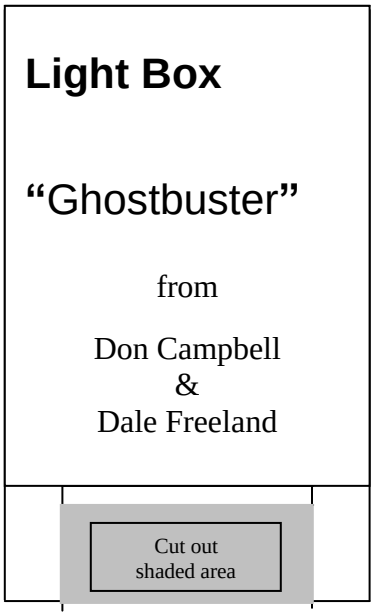
activity will have your students discover some of the basic concepts related to refraction. Students will be able to observe that refraction (bending) always takes place at the interface between two different transparent materials and that the angle of refraction in plastic is smaller than the angle of incidence in air. The light is directed at the center of the semicircular optical element where it is bent along a radius and exits the element without bending a second time. (It exits along a normal to the surface.) Careful measurement of the incident angle and the refracted angle will produce data which may be used to compute a constant (within experimental error) ratio of the sines of the angles.

The Extension. By using a half round petrie dish in place of the plastic semicircular optical element and filling the dish with transparent liquids, the index of refraction of different liquids may be computed from measured angles. (The liquids should selected so that they do not interact with the petrie dish.)

Techniques

All Refraction experiments use the light box and optical set. For all experiments, a darkened room is desirable.

Students may observe extraneous rays of light that may interfere with their observations. One solution to eliminate these stray "ghost rays" is to make a "ghost buster" for the light box. The template master "Light Box GHOSTBUSTER" when copied on card stock will yield a classroom set of Ghostbusters. When the "Ghostbusters" is placed over the masks that come with the box ghost rays were not observed.



How Does Light Refract?

Goal

- To learn how light is bent when it passes from air to Plexiglas.

Materials

Light box **mask with single slit**

Procedure

Set up equipment as in sketch on the following page.

Place the mask with single slit opening on the light box. This will produce a narrow beam of light.

Position the light box so that the light is directed along a line toward Point O.

Mark the lines exiting the Plexiglas semicircular optical element.

Use a single slit mask and aim the ray at the center point on the semi-circular slab of plastic. Start at the normal. The light should pass through the semi-circular slab of plastic with no change in its direction. Move the light box so the ray is along line AO. Use your sharpened pencil to mark the ray path of light that comes out of the slab. Adjust the light box so that the light ray enters the slab along each indicated line. Mark the path each ray takes as it leaves the slab.

Where does the bending of the light ray take place?

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Remove the plastic slab. Draw a best-fit line for each refracted ray starting at point 0. Measure each angle of incidence and the corresponding angle of refraction for each ray. Record your measurements in the data table below.

Ray	Angle of Incidence θ_i	Angle of Refraction θ_r	Sine of the angle of Incidence	Sine of the angle of Refraction	Ratio of Sin θ_i/Sin θ_r
AO					
BO					
CO					
DO					
EO					

Use the data above to make a general statement about refraction of light as it moves from air into plastic.

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_____

Please make a general statement about the ratio of **Sin θ_i/Sin θ_r.**

_____

_____

How Does Light Refract?

Name: _____

Class: _____