EXPERIMENT 19 REFLECTION AND REFRACTION

EQUIPMENT

1 optics light ray kit
1 pin board
1 set of ray tracing diagrams
1 protractor
1 rectangular plastic cell
tap water
Video tape: "Geometrical Optics"

INTRODUCTION

The purpose of this experiment is to investigate the behavior of light at the boundary of two media.

If a surface is smooth, an incident (incoming) light ray will be reflected off the surface at the same angle at which it was incident. In other words, the angle of incidence equals the angle of reflection. This is the *law of reflection*. The *law of refraction* describes the path of a light ray which passes from one medium into another. A ray of light entering a transparent medium at an angle will be bent. This bending is caused by the difference in the speed of light in the two media

In this laboratory exercise you will investigate for yourself the laws of reflection and refraction. Using ray tracing diagrams, pins, mirrors, and various mediums, you will describe the behavior of incident, reflected, and refracted rays. Through these descriptions you will satisfy yourself of the correctness of these laws.

PROCEDURE

A. Reflection of Light Rays

1. Using a protractor, measure the angle between the normal line and the incident ray line on ray diagram worksheet number 1. Record this value on the diagram.

2. Place the ray diagram on the pin board and place 2 or 3 pins along the incident ray.

3. Attach a support to the plane mirror and place it in position on the diagram.

4. Position yourself so that you are looking at the mirror and can see the reflected image of the pins. Now place 2 or 3 pins, in line with this image, between your eye and the mirror. These pins describe the position of the reflected ray.

5. Remove the pins and the diagram from the pin board. Now draw a line connecting the holes left by the reflection ray pins. This is the reflected ray.

6. Use the protractor to measure the angle between the reflected ray line and the normal line. Label this angle with its value. Your diagram should now look similar to figure 1.

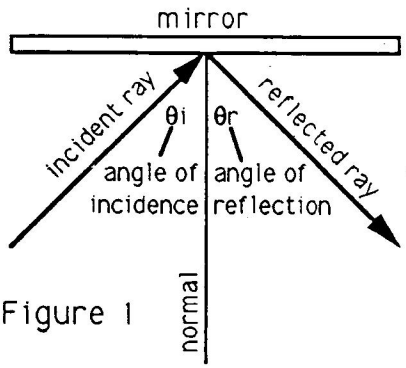


Figure 1

B. Refraction of Light Rays

1. Place ray diagram worksheet number 2 on the pin board and place several pins along the pre-drawn incident ray.

2. Place the square glass medium in the corner outline on the diagram. Be sure that a clear edge of the square is intersected by the incident ray. Complete tracing the outline of the glass medium on the worksheet.

3. Position yourself so that you are looking through the other clear edge and viewing the transmitted images of the pins.

4. Adjust your point of view until the images of

image. Now place pins between your eye and the near edge of the square, in line with this single image.

5. Remove the pins and the diagram from the pin board and draw a line connecting the holes left by the pins you positioned in step 4. Your diagram should now resemble figure 2.

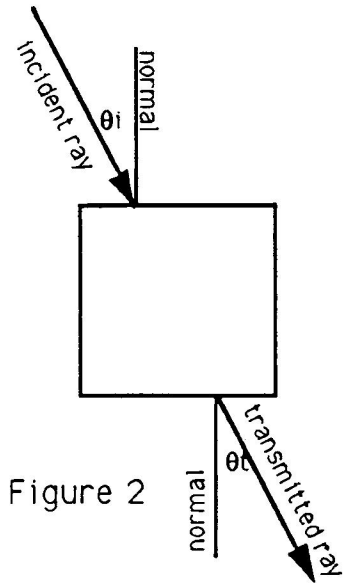


Figure 2

6. From the example of figure 3, draw a line representing the path of the light ray through the medium. Measure all angles, incident, refracted and transmitted, with the protractor and label them with their values.

7. Repeat steps 1 - 6 with the square plastic medium on the appropriate place of the worksheet.

8. Repeat steps 1 - 6 using the rectangular plastic cell partly filled with water on ray diagram worksheet number 3. Then repeat with the cell empty of water. Measure all angles and label as appropriate the diagram.

9. Use the computer program, LIGHT REFRACTION, to find the velocity of light through each medium used in the previous steps. Record the calculated values in the blanks provided on the diagrams.

10. Using ray diagram sheet number 4 and the triangular plastic medium, find the transmitted ray for the incident ray shown. Carefully examine all sides of the triangle for transmitted rays. Note that

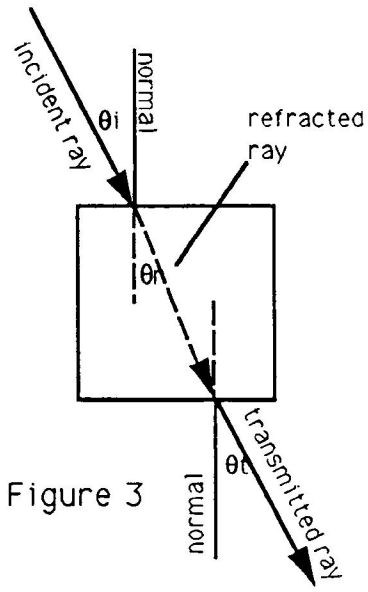


Figure 3

the incident and transmitted ray enter and leave the same side of the triangle. This is a case of *total internal reflection.*

CONCLUSIONS

(Answer on the back of your worksheets)

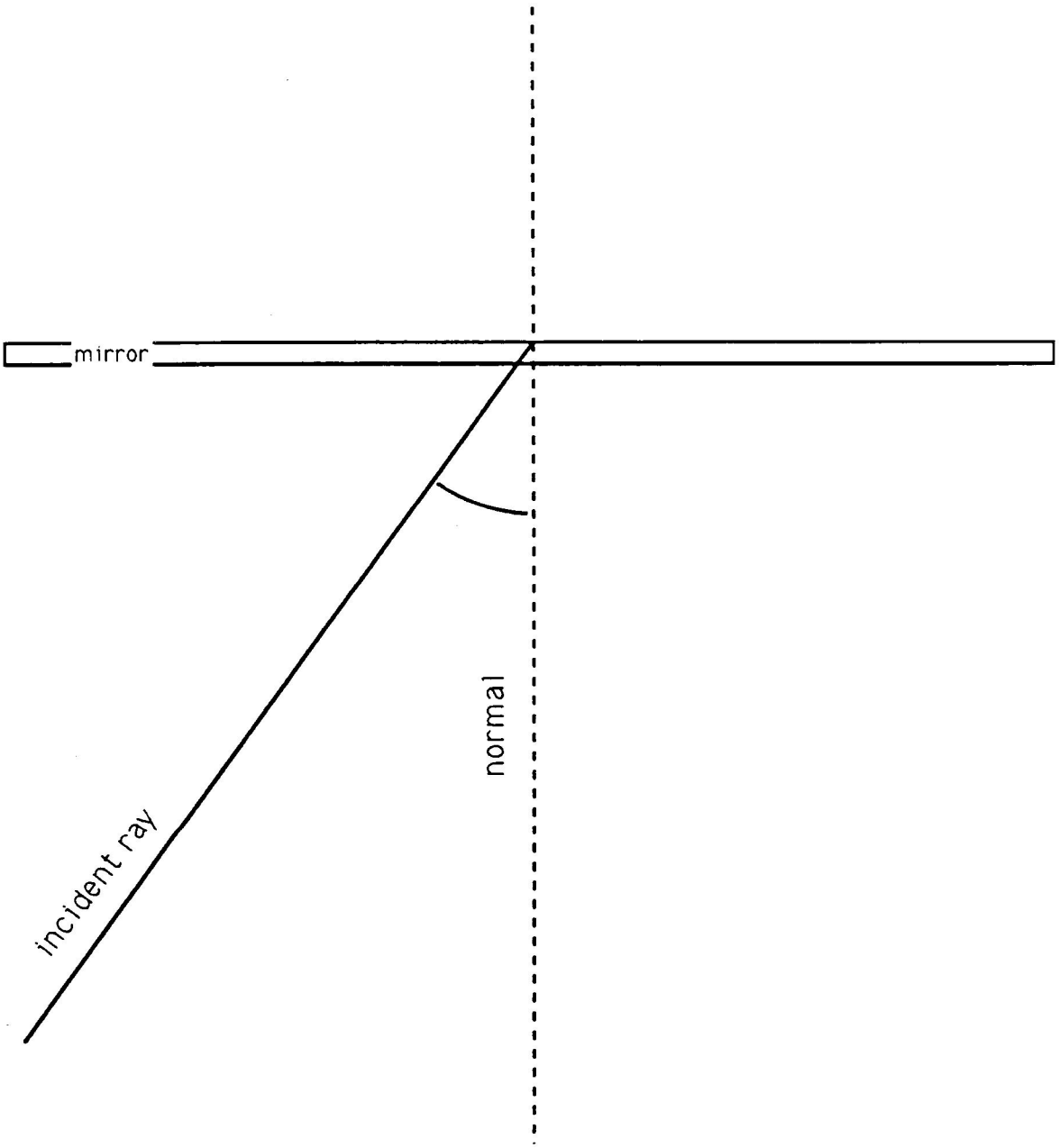
1. Do your results for part A support the Law of Reflection as defined in your text book? Fermat's Principle is closely related to the laws of reflection and refraction. What is Fermats Principle and how does it apply to these laws.

2. What do your results tell about the velocity of light through glass as compared to the velocity of light through acrylic plastic; through water? How do each of these compare to the velocity of light through air?

3. If you stick a pencil into a glass of water, it appears bent or broken depending on the angle from which it is viewed. Why is this so?

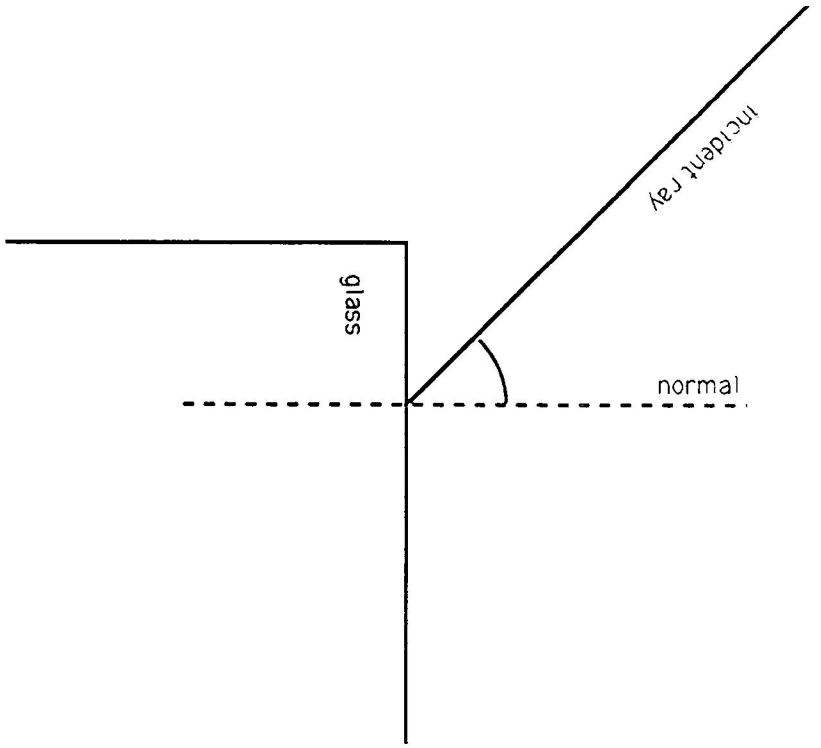
4. Fiber optics is an emerging technology, especially in the area of communications. How is it that light can be transmitted through this fiber with all its bends and twists? Doesn't light travel in a straight line?

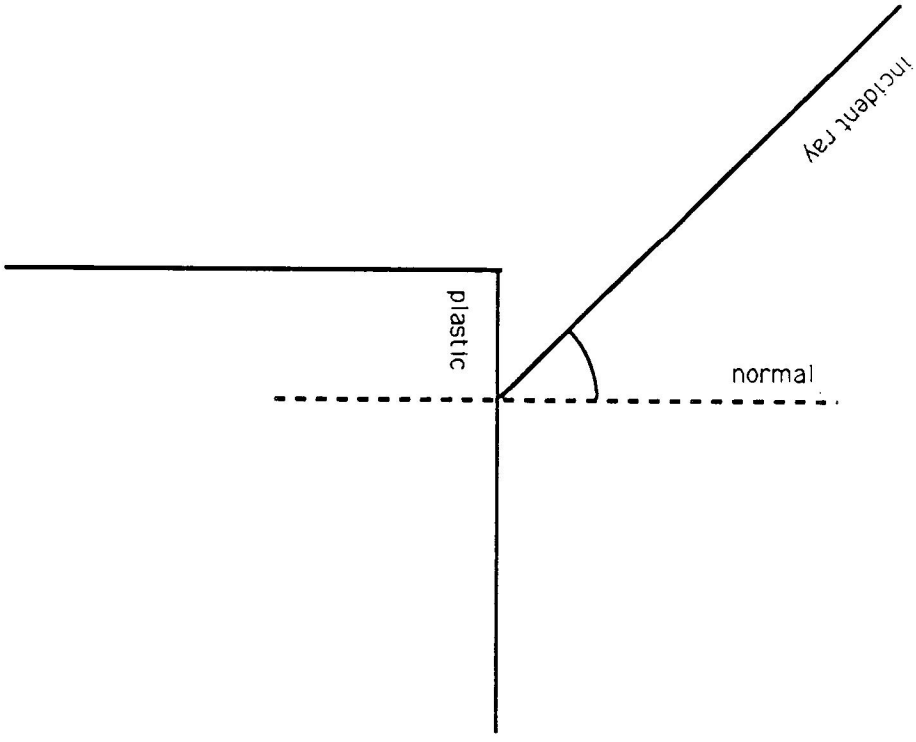
Experiment 19
Ray Tracing Diagram #1



State the Law of Reflection:

Experiment 19
Ray Tracing Diagram #2

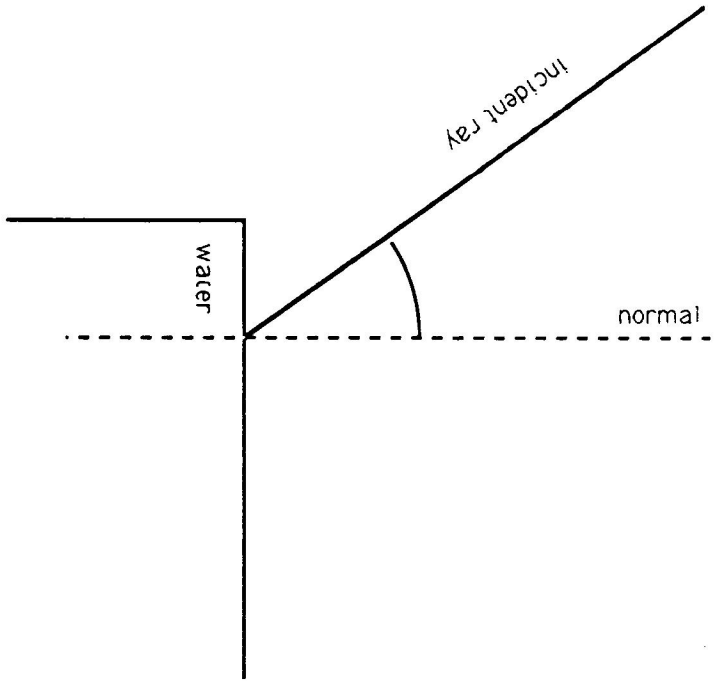


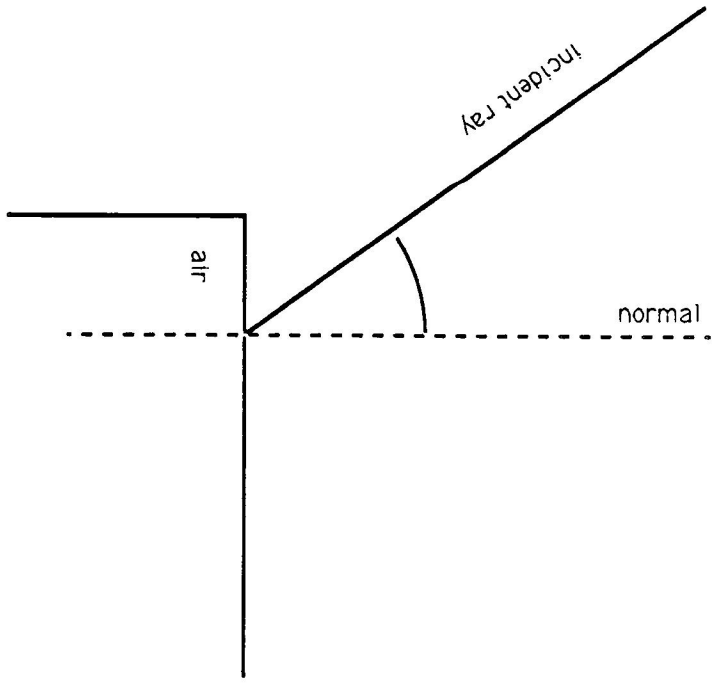


Velocity of light through glass_____.

Velocity of light through plastic_____.

Experiment 19
Ray Tracing Diagram #3





Velocity of light through water_____.

Velocity of light through air _____.

Experiment 19
Ray Tracing Diagram #4