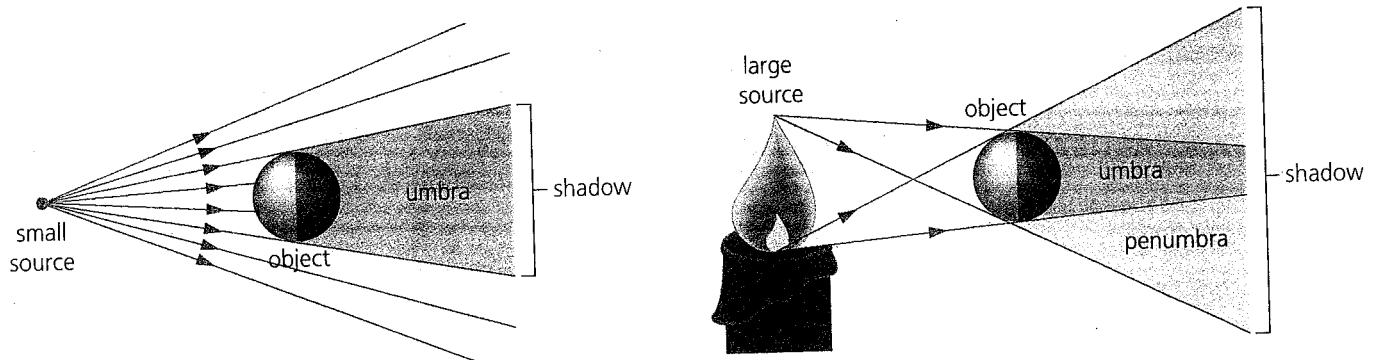



**INQUIRY SKILLS**

- |  |  |
|--|--|
| <input type="radio"/> Questioning              | <input checked="" type="radio"/> Hypothesizing |
| <input type="radio"/> Predicting               | <input type="radio"/> Planning                 |
| <input checked="" type="radio"/> Conducting    | <input checked="" type="radio"/> Recording     |
| <input checked="" type="radio"/> Analyzing     | <input type="radio"/> Evaluating               |
| <input checked="" type="radio"/> Communicating |  |

## Watching Light Travel

Have you ever tried to escape from the heat of direct sunlight on a summer day? One way is to find shade under a tree or to step into the shadow of a building. A **shadow** is an area where light has been blocked by a solid object (**Figure 1**). The dark part of a shadow is called the **umbra**; no light from the source reaches there. The lighter part of a shadow is called the **penumbra**; some light from the source reaches there. In this Investigation, you will use the umbra and the penumbra to reveal an important property of light.



(a) Light from a small source spreads out in all directions. The object blocks some of the light to produce a shadow.

(b) If the light source is larger, or there is more than one light source, the shadow will have both an umbra and a penumbra.

Figure 1

### Question

What property of light allows shadows to form?

### Hypothesis

(a) Create a hypothesis that answers the question.

### Experimental Design

Using light and a solid object, you will explore shadow formation. You will create diagrams that include rays. A ray is how we represent the path taken by light energy. A ray is a line with an arrow at one end to show the direction that light is travelling. Light does not really travel in rays, but rays help us understand some of the properties of light.

### Materials

- rubber stopper
- pencil
- paper
- ruler
- 2 ray boxes

### LEARNING TIP

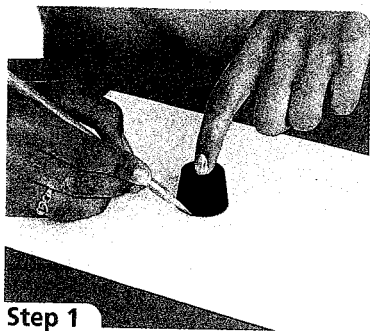
For help with writing a hypothesis, see "Hypothesizing" in the Skills Handbook section **Conducting an Investigation**.



Do not touch the light bulb in a ray box or look directly into the light.

## Procedure

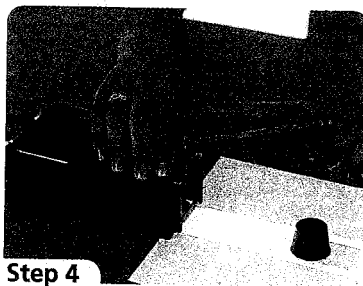
1. Put a rubber stopper on a piece of paper. Draw a line around the stopper on the paper. Place the ray box 5 cm away from the stopper, and aim a wide light ray toward the stopper. The ray must travel on both sides of the stopper.



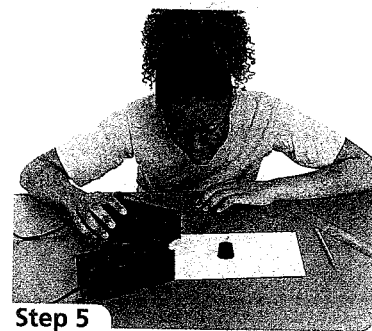
2. Use a pencil and a ruler to draw the outside edges of the shadow behind the stopper, and the source of the light. Remove the stopper, and turn off the ray box.



3. Shade the area of your diagram where the shadow was. Label the light source, stopper, and umbra on your diagram.
4. Repeat steps 1 to 3 using a new piece of paper and moving the ray box to 10 cm from the stopper. How is this diagram different from your first diagram?



5. Using another piece of paper, set up the stopper again as in step 4. Aim light rays from two ray boxes toward the stopper. Make sure that each light ray travels on both sides of the stopper.



6. Use a ruler and a pencil to outline the umbra and the penumbra. Use darker shading for the umbra than for the penumbra. Label the light sources, stopper, umbra, and penumbra on your diagram.

## Analysis

- (b) Add arrows to the pencil lines in your diagrams to show the direction in which the light was travelling.
- (c) What can you conclude about the property of light that causes shadows to form?
- (d) Explain how the property of light illustrated in this Investigation also prevents us from seeing around corners.
- (e) Compare **Figure 1** with your ray diagrams. Does a wide light ray from a single ray box act like light from a small source or from a large source?

### PERFORMANCE TASK

How are shadows important in the optical device you chose for the Performance Task? Are shadows desirable or undesirable?