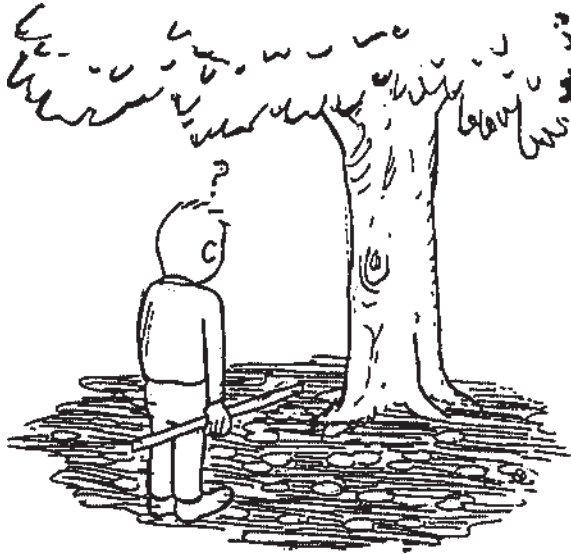**Concept-Development
Practice Page** | **30-1**

Pinhole Image Formation

Look carefully at the round spots of light on the shady ground beneath trees. These are sunballs, and are actually images of the sun. They are cast by openings between leaves in the trees that act as pinholes. Large sunballs, several centimeters in diameter or so, are cast by openings that are relatively high above the ground, while small ones are produced by closer "pinholes." The interesting point is that the ratio of the diameter of the sunball to its distance from the pinhole is the same as the ratio of the sun's diameter to its distance from the pinhole. We know the sun is approximately 150,000,000 km from the pinhole, so careful measurement of this ratio tells us the diameter of the sun. That's what this page is about. Instead of finding sunballs under the shade of trees, make your own easier-to-measure sunballs.
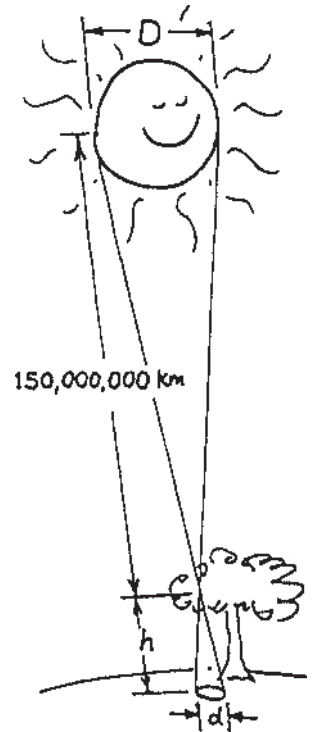
1. Poke a small hole in a piece of cardboard (like with a sharp pencil). Hold the cardboard in the sunlight and note the circular image that is cast. This is an image of the sun. Note that its size does not depend on the size of the hole in the cardboard, but only on its distance. The image will be a circle when cast on a surface that is perpendicular to the rays — otherwise it will be "stretched out" as an ellipse.

2. If you were doing this when the sun is partially eclipsed, what image shape would you expect to see? ————————————————————————————

3. Try holes of different shapes — say a square hole, or a triangular hole. What is the shape of the image when its distance from the cardboard is large compared to the size of the hole? ————————————— Does the shape of the "pinhole" make a difference?

————————————————————

4. Measure the diameter of a small coin. Then place the coin on a viewing area that is perpendicular to the sun's rays. Position the cardboard so the image exactly covers the coin. Carefully measure the distance between the coin and the the small hole in the cardboard.
Complete the following:

$$\frac{\text{Diameter of sunball}}{\text{Distance to pinhole}} = \underline{\hspace{1cm}}$$

WHAT SHAPE Do SUNBALLS HAVE DURING A PARTIAL ECLIPSE OF THE SUN?

With this ratio, estimate the diameter of the sun. Show your work on the back.

CONCEPTUAL PHYSICS