Division Of Geological Survey
HANDS ON
EARTH SCIENCE
No. 14

JUST HOW BIG IS THE SUN?

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In *Life on the Mississippi*, Mark Twain remarks, “There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of facts.” Such an example would be the old schoolboy method of measuring the diameter of the Sun. In that method, a pinhole is pricked in a card at one end of a closed cardboard box, and the image of the Sun is projected onto a small screen at the opposite end of the box (see diagram A). This same principle is involved in making a pinhole camera. By measuring, using a centimeter ruler, the diameter of the Sun’s image and the distance from the pinhole to the screen (the length of the box), and by knowing the distance from the Earth to the Sun, you can calculate the actual diameter of the Sun.

This experiment describes an improved variation on that theme. We substitute a masked mirror for the pinhole and a darkened room for the box. The advantage of this technique is that the Sun’s image is cast over a greater distance, thus enlarging the image. Also, because the experiment is done in a darkened room, the image appears brighter and an entire class can sit in comfort and participate in the measurements.

Procure a small, flat mirror and cover the front with masking tape, leaving a small opening about 0.5 cm x 0.5 cm near the center of the mirror. Using a piece of modeling clay, prop the edge of the mirror on the windowsill of a Sun-facing window. Close all the blinds except for the one where the mirror is, and adjust that one so that a minimum of light enters the room and strikes the mirror. Orient the mirror so that the image of the Sun is projected across the room to the opposite wall. A large piece of white paper can be taped to that wall to serve as a screen.

The image of the Sun is inverted because the two rays from the Sun (and any other rays you might wish to draw) criss-cross as they pass through the pinhole or reflect from the small aperture in the mirror (see diagrams). The geometry is the same whether one uses a pinhole or a mirror. The mirror simply folds back the image and projects it onto the wall.

The geometry of similar triangles informs us that the diameter of the Sun is to the distance from the Earth to the Sun as the diameter of the image is to the distance from the mirror to the wall.

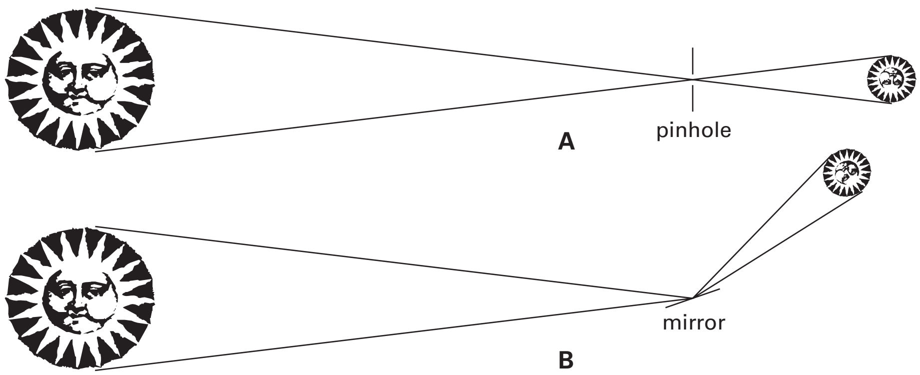
$$\frac{\text{diameter of Sun}}{\text{distance to Sun}} = \frac{\text{diameter of image}}{\text{distance from mirror to image}}$$

or,

$$\text{diameter of Sun} = \frac{\text{diameter of image x distance to Sun}}{\text{distance from mirror to image}}$$

You can easily measure the diameter of the image and the distance from the mirror to the image. Knowing that the distance from the Earth to the Sun is 1.5×10^8 km, you can calculate our unknown, the diameter of the Sun. If your measurements are in centimeters, remember to convert them into kilometers.

This method of viewing the Sun also provides an excellent way of observing the next solar eclipse. Students can sit at their seats, eat popcorn, and watch the entire progress of the eclipse. Teachers should take advantage of this perfectly safe technique and allow their students to see these spectacular displays of nature. As you use this method, see if you can observe sunspots. If you can, they can be used to measure the rotational rate of the Sun, which is exactly what Galileo did 400 years ago.



*Diagrams showing image formation by a pinhole (**A**) and a masked mirror (**B**). Diagrams not to scale.*

One last question. The diameter of the Earth is 12,800 km. What is the diameter of the Sun in units of Earth diameters? That is, how many Earths could be placed side by side across the face of the Sun? [Answer: about 100, a remarkable number that will impress your students and one that is easy to remember.]

Mark Twain was right. So many returns for such little investment!