Kit Activity A-3

The Diameter of the Sun

When you have completed this activity, you should be able to do the following:

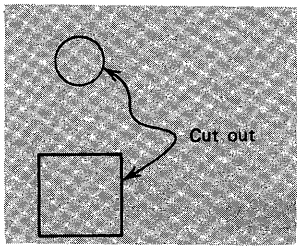
- Measure the diameter of the Sun using the pinhole activity and explain how it works.
- Assess the effects that the pinhole shape and size have on the accuracy of the activity.

A pinhole camera is a box having a small hole through which light passes to form an image. By using such a camera, one could easily measure the diameter of the Sun. The bigger the camera is, the more accurate the measurement is. This section shows that the same thing can be accomplished in a very simple way--using just a piece of paper with a hole in it, a small mirror, and a cardboard box.

Kit Figure A-3-1 is a pattern that shows the outlines of two "pinholes" that may be used to carry out the observations of this activity. They are in fact considerably larger than real pinholes, since one is a half-inch square and the other is a quarter-inch circle. We are going to construct a large pinhole camera by throwing our image over a large distance, so that the holes will still be small compared to the size of the camera.

Trace Kit Figure A-3-1 onto a sheet of paper. Use a sharp razor blade or a modeling knife (a pair of scissors will probably be too awkward here, unless you have some very tiny scissors) and *cleanly* cut out the two holes. Cut the paper containing the holes to the shape of your small mirror and tape it over the mirror to create two small mirrors of different shapes.

As a screen for viewing the image formed by the holes, use an ordinary sheet of white paper. Tape this viewing screen to the back of an ordinary cardboard carton (with the front end removed), as shown in **Kit Figure A-3-2**, and put the box on the ground so that the open face of the box points away from the Sun. The reason for placing the viewing screen inside a box is that the shading provided by the walls of the box increases the contrast of the image and makes it much easier to see.



Kit Figure A-3-1 Pattern for the "pinholes" used in front of a mirror to project the Sun's image onto a wall.

Have a friend stand 3 or 4 meters away from the screen and hold the mirror so that the light from the Sun passes through the pinholes, is reflected off the mirror, and projected onto the screen (**Kit Figure A-3-3).** Cover first one hole, then the other. You should clearly see the image of the Sun projected by each of the "pinholes."

- **Inquiry A-3a** Does the square hole cast a square image and the round hole a round image, or does the shape of the hole seem to have no major effect on the shape of the image?

- **Inquiry A-3b** Which hole casts the *larger* image, the small one or the large one? How does the increase in the size of the image compare with the increase in the size of the hole?

- **Inquiry A-3c** Which image is brighter? To what do you attribute this?

- **Inquiry A-3d** Which image do you think would be easiest to measure an *accurate* diameter? Explain your reasoning.

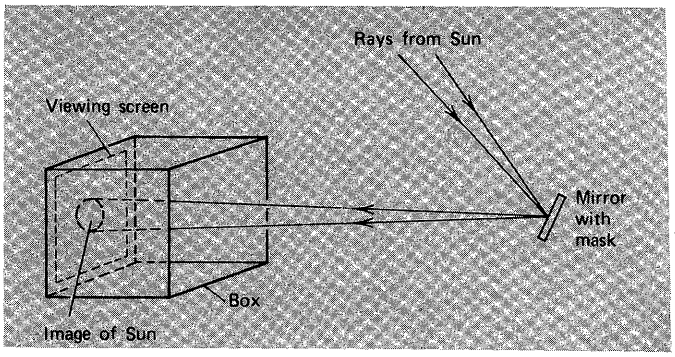
Now measure the diameter of the sharper of the two images. Then measure the distance from the *pinhole* to the *screen.* Your friend can help you do this. Be sure both distances are expressed in the same units.

Kit Figure A-3-3 shows the geometry of the situation. The laws of similar triangles tell us that

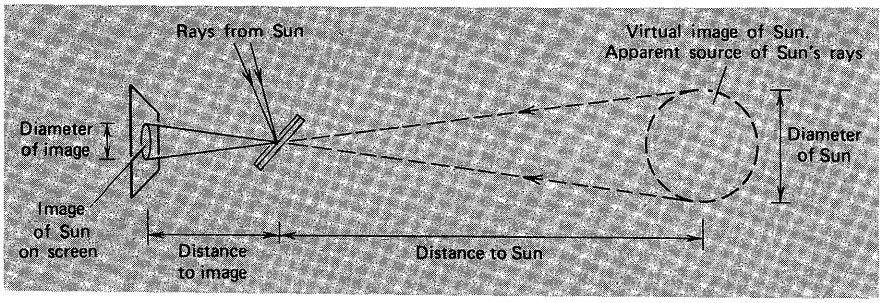
$$\frac{\text{Diameter of Sun}}{\text{distance of Sun}} = \frac{\text{diameter of Sun's image}}{\text{distance of screen from pinhole}}.$$

If the Sun is 150 million km from the Earth, you can use the above ratio to compute the diameter of the Sun.

- **Inquiry A-3e** What do you compute for the diameter of the Sun? What is the percentage difference between your observed value and the value in your textbook?



Kit Figure A-3-2 How to set up the solar diameter activity.



Kit Figure A-3-3 The geometry of the experiment. It is as if the Sun were behind the pinholes at the position of its virtual image. (Not to scale.)