Measuring the Sun's Diameter

Overview:

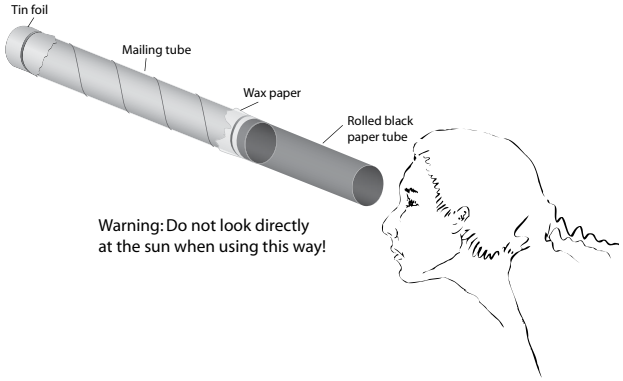
Students build a pinhole camera to produce an image of the sun. Students measure the diameter of the sun's image and the length of the pinhole camera to calculate the diameter of the sun.

Objectives:

The student will:
- build a pinhole camera;
- measure using a metric ruler; and
- calculate the diameter of the sun using the image produced by a pinhole camera.

Materials:

- Mailing tube or PVC pipe
- Aluminum foil
- Wax paper
- Rubber bands or tape
- Pin
- Metric ruler
- Calculators
- STUDENT WORKSHEET: "Measuring the Sun's Diameter"



Answers to Student Worksheet:

1. *Data Table answers will vary, but should reflect accurate conversions from millimeters to meters.*
2. *Answers will vary. Student calculations should be within 100 million meters of 1,393,000,000 meters (the actual diameter of the sun).*
3. *Answers will vary; should include inaccurate measurements of tube or image or incorrect math.*
4. *D) pinhole camera*

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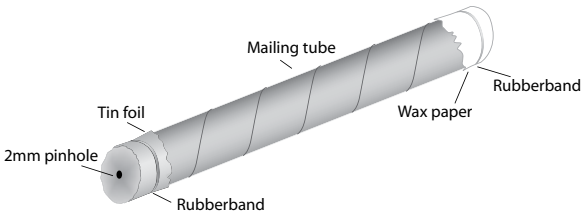
Activity Procedure:



1. Conduct this activity on a clear day. Begin by building a pinhole camera. Cover one end of a mailing tube with aluminum foil and the opposite end with wax paper. Hold the foil and wax paper in place with a rubber band or tape as shown in the diagram.
2. Using a pin, put a small hole (less than 2 millimeters) in the middle of the aluminum foil.
3. Distribute the STUDENT WORKSHEET: "Measuring the Sun's Diameter" and lead students to an area (indoors or outside) with a clear view of the sun. Point the aluminum foil end of the tube at the sun. Move the tube around until a bright spot forms on the wax paper.
4. Hold the tube steady and ask each student to measure (in millimeters) the diameter of the image of the sun formed on the wax paper. Next, ask students to write this measurement on the worksheet data table. If students performed this activity outside, return to the classroom.
5. Ask students to measure (in millimeters) the length of the mailing tube and to record this measurement on the data table.
6. Demonstrate how to convert millimeters to meters, and then ask students to complete the final column of the data table.
7. Distribute calculators and demonstrate how to find the diameter of the sun using the sample data and formula below.

   Diameter of sun = distance from sun to Earth x diameter of sun image ÷ length of camera.

   Sample Data Table:

Description	Millimeters	Meters
Diameter of sun image	8	.008
Length of pinhole camera	840	.84

   The distance between the sun and Earth is 1.5×10^{11} or 150,000,000,000 meters

   150,000,000,000 meters x .008 meters ÷ .84 meters = *1,428,571,429 meters*

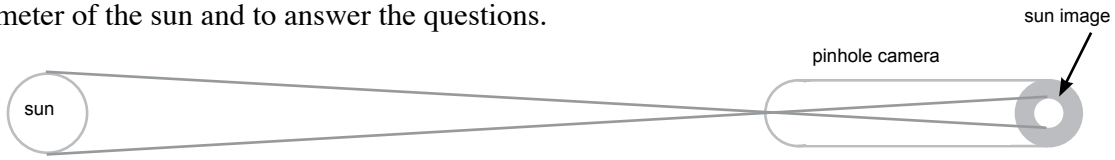
8. After all students have completed the calculation and answered the remaining worksheet questions, discuss student results. How did student calculations compare to the diameter of the sun as scientists have calculated it? Why might the two answers be different?

Extension Ideas: (1) Build several different sizes of cameras to see how results compare. Try various tubes, such as oatmeal canisters, paper towel rolls, coffee cans, etc. (2) After calculations are complete, view various images with the pinhole camera. To see images, students must darken the distance between the camera and their eyes. Ask students to wrap a piece of black construction paper around the wax paper end of the camera, then put their eye up to the construction paper and focus on the wax paper (see illustration above). The images formed on the wax paper will be inverted. Warning: Do not look at the sun when using the camera in this way!

Name: _____ **Student Worksheet**

Measuring the Sun's Diameter

Directions: Looking directly at the sun will damage vision. During this activity, a pinhole camera will be used to safely study the sun. A pinhole camera allows light to pass through a small pinhole to produce an image on wax paper. The diameter of the sun can be calculated by measuring the length of the pinhole camera and the diameter of the sun image it produces. Complete the data table, and use the data to find the diameter of the sun and to answer the questions.



1. Data Table:

Description	Millimeters	Meters
Diameter of sun image		
Length of pinhole camera		

Conversion Example:

6 millimeters = .006 meters
650 millimeters = .650 meters

2. The formula for calculating the diameter of the sun using a pinhole camera is:

diameter of the sun = distance from sun to Earth x diameter of sun image ÷ length of camera

The distance from the sun to Earth is 150,000,000,000 meters.

Use this information and the Data Table information to calculate the diameter of the sun.

150,000,000,000 m x _____m ÷ _____m = _____m
(diameter of sun; image length of camera; diameter of the sun)

3. Does this answer match the actual calculated diameter of the sun (1,393,000,000 meters)? Probably not. What are some reasons the answer may be different?

_____

_____

_____

_____

4. Identify one instrument that can be used to safely make observations of the sun.

   A) magnetometer
   B) compass
   C) Global Positioning System receiver
   D) pinhole camera

