The Sun—Ruler of the Solar System

Teacher Information

This activity has been adapted form Activity 6.3 *Building and Using a Pinhole Tube* found in *Project STAR: The Universe in Your Hands.* Kendall/Hunt Publishing Company. 1993. ISBN 0-8403-7715-0. Copyright 1993 by the President and Fellows of Harvard College.

Objectives

Students will measure the distance to the Sun from their own schoolyard, using a pinhole projection tube they will make.

Key Concepts

- We can create a model of the Sun and use the model and the real Sun as rulers.
- We use models to study things that are big, like the Sun.
- Geometry is powerful because it lets us estimate sizes and distances easily.
- Similar triangles have angles that are the same and sides that are proportional.
- We can explore the Solar System from Earth.

Answer Key

Part III: Measuring the Distance to the Sun

1. Answer will vary depending on the length of the tube. Most tubes are 28 cm (280 mm), yielding an image size of 2.8 millimeters.
2. Answers will vary depending on the length of the tube. Most tubes are 28 cm (280 mm).
3. tube length/image width = 280mm/2.6 mm = 107*
   *The number of Suns that could fit between the Earth and the Sun actually varies from 106 to 109, due to the fact that the Earth's orbit is not a perfect circle.
4. NA

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5.

Questions	Little Triangle	Big Triangle
Where is the point of the triangle?	At the pinhole.	At the pinhole.
What forms the base of the triangle?	The diameter of the model Sun.	The diameter of the real Sun.
What is the length of the triangle?	The length of the tube.	The distance between the real Earth and the real Sun.
How many bases fit along the length of the triangle?	approximately 107	approximately 107
What did you figure out?	The number of model Suns that fit along the length of the tube.	The number of real Suns that fit between the real Earth and the real Sun.
What did you use as a ruler?	The model Sun.	The real Sun.

6. Approximately 107

Activity Preparation

- Be sure to try this activity ahead of time. It takes some practice. Do not wait for the night before—you will not have a Sun.
- You can only do this activity on a sunny day.
- Gather enough materials ahead of time. Cut aluminum foil and graph paper into 10 cm by 10 cm squares. Cut enough for each team with extras. (Aluminum foil tears easily.)

Procedures

1. Discuss triangles as models and the rules of similar triangles: angles are the same, sides are proportional.
2. Direct students to work in pairs to assemble pinhole tube. (See Part 1 of Student Worksheet.)
3. On a sunny day, direct teams to go outside and use the pinhole tube to find the image of the Sun. (See Part II of the Student Worksheet.) Warn students not to use the pinhole tube as a telescope to look directly at the Sun.

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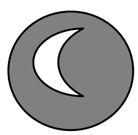
4. Return to the classroom and tell students to complete Part III of the Student Worksheet to calculate the Sun's distance and to answer the discussion questions.

Discussion Questions

1. Is the image of the Sun a good model of the real Sun?
   The image is not a very detailed model of the Sun, so it limits what we can learn about the Sun. Nevertheless, it is all we need to find the distance of the Sun.

2. Imagine the Moon was blocking part of the Sun's light (a partial solar eclipse.) What would the image on the graph paper look like?
   Answer:



3. If you did the experiment at different times of the year, the answers would vary. Why?
   The Earth does not orbit the Sun in a perfect circle, so the Sun-Earth distance changes.

4. How is the pinhole tube a camera?
   Just like a camera, the pinhole tube focuses an image on a screen. If the graph paper were replaced with photographic film, you would have a picture of the Sun.

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Extensions

1. The Moon and the Sun have almost the same apparent size in the sky (this is why total eclipses work!) Figure out how many Moons fit between the Earth and the Moon. (Hint: You already know the answer!)
   The answer is still approximately 107. The Moon is much smaller, but it is much closer so the triangles proportions stay the same.

2. Imagine you are standing next to a flagpole on a sunny day. Both you and the flagpole have shadows. Using similar triangles, figure out the height of the flagpole.
   You and your shadow are the legs of one triangle. The flagpole and its shadow are the legs of a similar, bigger triangle. Since you can measure your height and the length of both the shadows, you find the flagpole height using similar triangles.

   (Your height x flagpole shadow length) / Your shadow length = Flagpole height

3. The Sun is 1,400,000 kilometers in diameter. Based on your answer from Part III, number 6 on the Student Worksheet, how far away is the Sun from the Earth in kilometers?
   (1,400,000 kilometers) x (approximately 107) = 150,000,000 kilometers