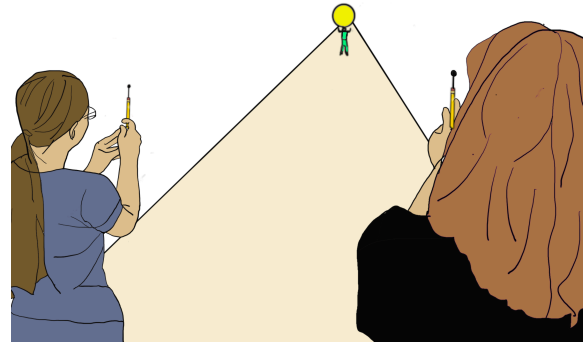


Scaling a Solar Eclipse

Introduction

Eclipses are a common phenomenon and throughout history have often been associated with ominous predictions.

The number of solar eclipses on Earth (total, annular or partial) is about 5 per year. There are at least 2 solar eclipses per year somewhere on Earth. A total eclipse can only happen during a new moon.



Do you know?

- How many Earth moons would fit across the face of the Earth?
- How many Earths would fit across the Sun?
- How many times further away is our Sun from the Earth than the Earth is from the moon?
- How the Earth, Sun and moon are arranged in a solar eclipse?

This activity will help you to build an understanding of the relative sizes of the Earth, moon and Sun, and the spatial relationships among them during a solar eclipse. Have plenty of space, you'll need it!

Measuring a Standard Step

During your experiment, you will need to accurately measure long distances by walking and counting your steps. We'll start by determining the number of steps needed to walk a measured distance and calculating your distance per step.

Materials per group

- Painters' tape
- Long measuring tape, 50 feet (or 10 m) or equivalent)
- Calculator

Procedure

1. In an open flat space of at least 30 feet (10 m) lay down a piece of masking tape to mark a starting point (0 feet). Measure and record your given distance and mark that spot with another piece of tape.
2. With an even and **consistent**, normal stride, count the number of steps you take, between the two pieces of tape. Record this number in the table below, and repeat two more times. Calculate the average for your number of steps for this distance.

Trial	# Steps for between tapes
1	_____
2	_____
3	_____
Average	_____

Write the distance, and average number of steps you walked, as a ratio. For example,

$$\frac{30 \text{ feet (distance)}}{19.5 \text{ average steps}}$$

What is **your ratio** of distance and average steps? _____

Scaling Earth, Sun and Moon

In the next part of your investigation, you will create a Sun-Earth-moon system outside and discover your own solar eclipse model. Measure the distances between the bodies and check the accuracy of your model. We will use a 7/8 inch marble (your eyeball) as the scale model Earth.

Materials per group

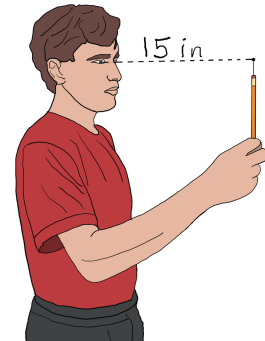
- Big latex balloon approximately 60 inches (1.5 m) in diameter (the Sun)*
- Air pump (to blow up the balloon)
- Power extension cord
- Clamp (to close the balloon)
- Standard wood pencil with eraser
- Pearl head pin (the moon)
- Glass marble (about 5/8- 3/4 in, or 18 mm)
- Scientific calculator

*You will of course need to take the pump, power cord and clamp outside to blow up the balloon because you will never get it through a standard doorway!

Procedure

1. Find a straight path outside approximately the length of two football fields (500-600 feet) and at one end, mark the spot with some painters' tape. This will be the location of your sun. Secure the balloon in place.

2. Start walking away from the balloon in a straight path and safe direction.
3. Periodically, check your progress. Turn around and face the balloon and, holding the pearl head pin at a **bent elbow distance** (about 15 inches or 38 cm) from your eyeball, see if the moon totally eclipses the sun.
4. Continue walking and checking until the moon completely eclipses the balloon, and **mark your location**.



5. Using the same size steps you previously measured, **count the number of steps** you have to take to get back to the balloon, and record that number below.

Number of steps back to the balloon _____ steps

6. Now, using the **number of steps** you walked back to the balloon, calculate the **total distance** (feet or m) between the **sun** and the **Earth-moon system** at the point of your total eclipse. *(Multiply your number of steps by the ratio of feet and steps you wrote previously.)*

For example, if you walked 303 steps back to the sun,

$$303 \text{ steps} \times \frac{30 \text{ feet}}{17.5 \text{ steps}} = 520 \text{ feet}$$

Write *your* calculation and final answer below,

7. Draw and label a diagram that shows the proportional distances between the Earth, Sun and moon during a solar eclipse, based on your model.

8. The table below compares the **actual** Earth, sun and moon distances and diameters. Enter the values you used in your experiment. You may use a marble diameter of about 5/8 inch (about 18 mm) to approximate your eyeball.

	Diameters (actual)	Diameters of eyeball, balloon, pin head)	Distance to Earth (actual)	Distance to Earth (from your experiment)
Earth	1.3×10^4 km	_____		
Sun	1.4×10^6 km	_____	1.5×10^8 km	_____
Moon	3.5×10^3 km	_____	3.8×10^5 km	_____

9. Using the **actual data** provided in the table above, write out your calculations for,

a. How many moons, side by side, would fit across the Earth?

b. How many Earths would fit across the diameter of the Sun?

10. Repeat these two calculations using **your data** and show your calculations for,

a. How many moons, side by side, would fit across the Earth?

b. How many Earths would fit across the diameter of the Sun?

11. Comment on the accuracy of the dimensions of your model, compared to the actual data.

12. Using the distance measurements of your own model, calculate how many times further the Sun is from the Earth, compared to the distance from the Earth (your eyeball) to the moon?

13. You created a total solar eclipse in this lesson by moving your point of view (your Earth-moon system) further away from the Sun until you reached totality. Describe how a naturally occurring eclipse differs from how you created your eclipse.