Names:____ Date: _______

Module 1C: Create a Pinhole Camera Lab Sheet

Objective:
Your team's mission is to safely observe the Sun and calculate its diameter by using a pinhole camera.

As a team, you will successfully
- Create and use a pinhole camera to project an image of the Sun in order to measure its diameter.
- Construct a scale model of the Sun, Earth, and their distance apart.

Background Information:
The Sun is the largest object in our solar system; it contains more than 99% of all its mass (matter)! How is it possible to study the Sun since it is not safe to look directly at it for a long period of time? Pinhole cameras are a safe way to observe the Sun. Most optical instruments, like cameras and telescopes, rely on refraction or reflection to provide an image on a screen or piece of film. A pinhole camera is a simple device that does not use lenses or mirrors to produce its image but only a small circular aperture (pinhole) that light passes through to project an image with great detail. The issue with a pinhole camera is that the sharpness of the image requires a small aperture relative to the screen distance –which means less light gathering power. However, even with this shortcoming, a pinhole camera is still is a very good instrument for observing the sky's brightest object, the Sun.

Pinhole Camera Diagram

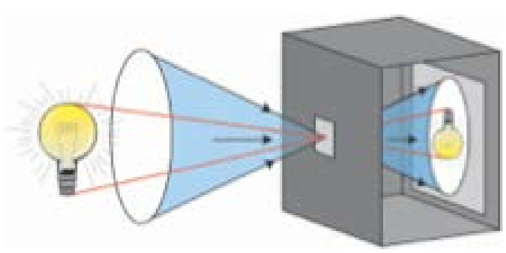


Image: NASA

Material
- Sturdy box with lid (shoe box)
- 2 index cards (plus extra)
- Pin
- Tape
- Aluminum foil
- Ruler
- Meter stick
- Scissors or utility knife
- Pencil
- Sunny day!

Predict:

1. How can you measure the size of an object from a distance?

2. Does the distance from an object affect the accuracy of measurements?

3. What method(s) can be used to measure the length of the Sun's diameter?

4. What is your team's estimate of the length of the Sun's diameter? Draw a simple sketch of the Sun and draw a diameter across it. On the diameter line, write your team's estimation of the Sun's diameter including units.

Pinhole Camera Procedure:

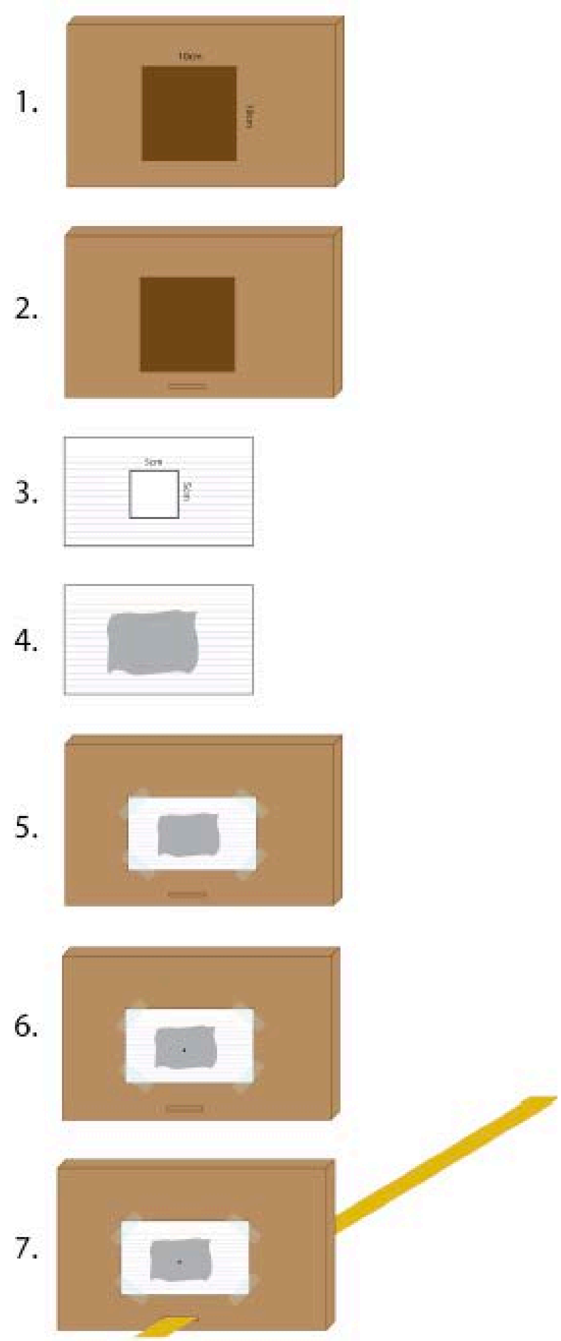


Image: NASA

1.Take the lid of the shoebox and cut an 8cm x 10cm square hole in the center.

2.Cut an “I” shaped slit lengthwise on the top of the lid 1cm from one edge. This will be the “bottom” edge of the lid. Make the slit long enough to snugly fit a meter stick.

3.Take an index card and cut a 5cm x 5cm square hole in the center.

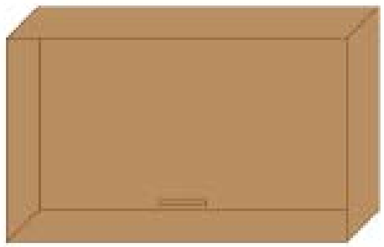
4.Tape a piece of aluminum foil over the hole in the index card.

5.Tape the index card over the hole in the lid of the shoebox. This creates an easily replaceable pinhole should the foil rip. Several of these cards can be made for each pinhole camera.

6.Using a pin or pencil lead poke a very small hole in the center of the aluminum foil. If you tear the foil replace it and try making the hole again.

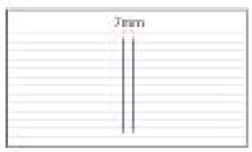
7.Slide the meter stick through the slit and tape the lid in place at the end of the meter stick.

8.



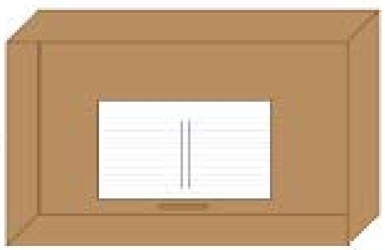
8.Cut an “I” shaped slit lengthwise on the bottom of the shoe box 1cm from one edge. This will be the “bottom” edge of the shoebox. Make the slit long enough to snugly fit a meter stick.

9.



9.Draw two parallel lines 7mm apart near the center of the second index card.

10.



10.Tape the index card to the center of the bottom of the inside of the box.

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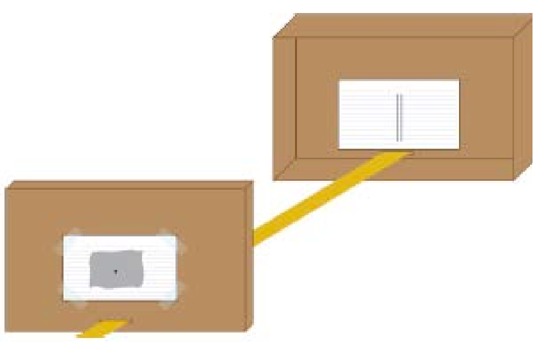

Image: NASA

11.Slide the free end of the meter stick through the slot in the shoebox so that the open side faces the lid. Leave this end of the box free to slide up and down the meter stick. Use a small piece of masking tape to hold it in place when needed. Take the pinhole viewer outside and point the end of the meter stick that holds the foil-covered card toward the Sun. *CAUTION: Do NOT look at the Sun!*

12. Move the meter stick around until the shadow of the foil-covered card falls on the other card. A bright image of the Sun will appear on the sliding card. Move the sliding card until the bright image of the Sun exactly fills the distance between the parallel lines (7mm). Measure the distance in mm between the cards on the meter stick and record it:

__________________________ mm

13. Return inside to calculate the diameter of the Sun using the formula below and your measurements of the distance between the cards and diameter of the Sun’s image (note: Earth is about 150,000,000 km from the Sun).

$$\frac{\textbf{Diameter of Sun(km)}}{\textbf{Distance to Sun (km)}} = \frac{\textbf{Diameter of Sun's Image (mm)}}{\textbf{Distance between Cards (mm)}}$$

Diameter of the Sun Calculation (use formula, measurements/units & show work)

Extension:
After you complete this investigation, experiment with different pinhole camera designs by testing different sized pinholes (apertures), number of pinholes, and changing the distance between the card with one or more pinholes and a blank card (screen). How do the images change? Which pinhole camera design produces the best image? You can even make a pinhole camera that uses film to take pictures (NASA's The Space Place: Make a Pinhole Camera with Film)!

Real-World Connection:

Once your team has calculated the diameter of the Sun, you can calculate a classroom sized scale model of the Sun and Earth.

Procedure to Create the Sun-Earth Model:

1. Choose a scale for the model. A good size is 10,000 km = 1 cm.
2. Calculate how big the Sun would be at that scale. (actual size of the Sun divided by the scale (10,000km) = diameter of the Sun in cm).
3. Repeat for the size of the Earth and for the distance between the Earth and the Sun.
4. Measure and cut out model Sun and Earth of the appropriate size.
5. Pace out the correct distance between the Sun and Earth. You may need to go outside the classroom to have enough room for this activity!

Was your team's Sun-Earth model what you expected? Explain with details.

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What are three observations about your team's scale model of the Earth and Sun? Explain with details.

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Resources:

Activity adapted from NASA SDO Science of the Sun Secondary Science Learning Unit: http://sdo.gsfc.nasa.gov/assets/docs/UnitPlanSecondary.pdf

Pinhole viewers explained:
http://users.erols.com/njastro/barry/pages/pinhole.htm