National Aeronautics and Space Administration

2024 Total Solar Eclipse U.S. Pinhole Projector Activity

Next Generation Science Standard MS.ESS1-1 - Develop and use a model of the Earth-Sun-Moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and Moon, and seasons.

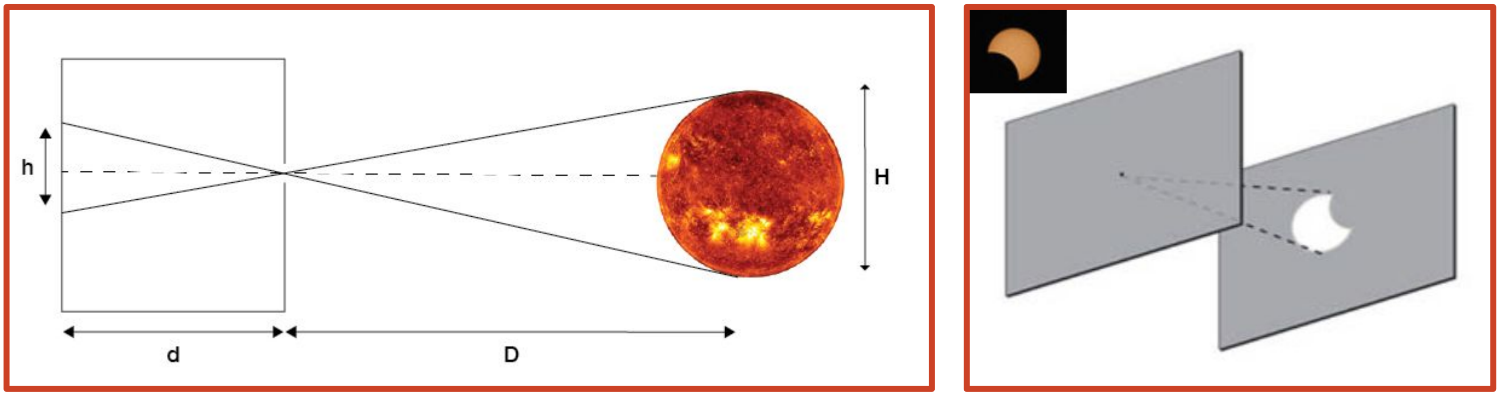


Figure 1. Left diagram shows the relationship between the height of the projected image (h), projection distance (d), distance to the object (D), and the height (diameter) of the Sun (H). See 'Educator Extensions' section for a math equation on how to calculate the Sun's diameter using a pinhole projector. The right diagram shows the shape of the Sun during the partial phase of a solar eclipse through a simple pinhole projector. Credit: NASA

Pinhole projectors allowed early scientists to view the shapes of illuminated objects, like the Sun, by shining the light from the object through a very small hole, projecting the image of the object onto the ground, wall, or other flat surface. Make this easy pinhole projector with your learners, see Figure 2, and have them experiment with the shape and size of the pinhole in this short (25- to 30-minute activity). See educator extensions for more ways to engage your learners.

Credit: NASA/Aubrey Gemignani

Your back should always be to the Sun when using a pinhole projector. Do NOT look at the Sun through the pinhole!

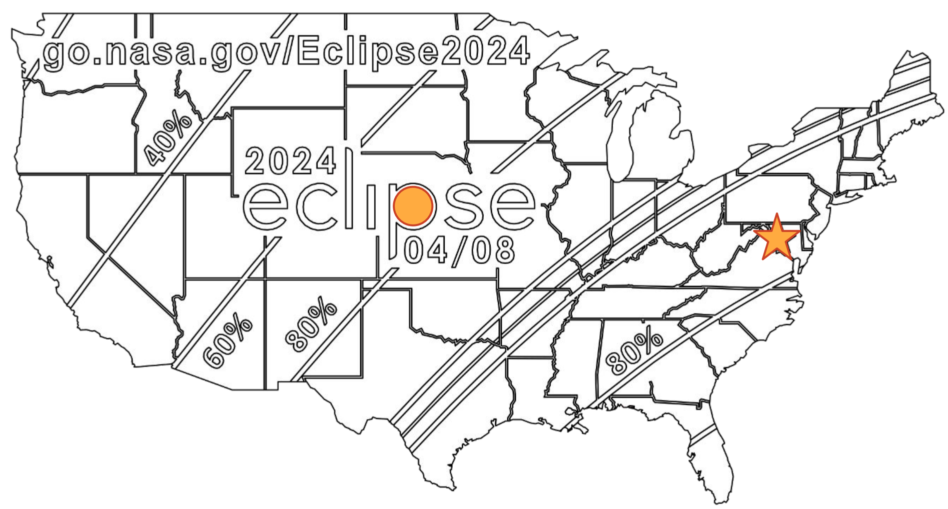


Figure 2. A 2D paper cut U.S. map for the Monday, April 8, 2024, total solar eclipse. Not to scale. See Learner Handout. Credit: NASA HEAT/J. Patrick Haas

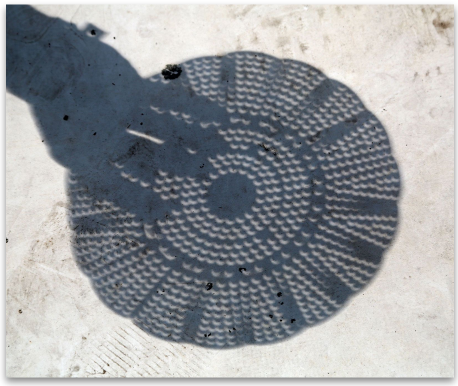
Remember to never look directly at the Sun without proper safety equipment.

Safety Messaging
Total Solar Eclipse 04.08.24

Two options for safely viewing a partial or total solar eclipse:

- Use a pinhole projector or other indirect safe viewing methods.
- Use a solar filter, like solar viewing glasses.

Indirect Viewing Method: Project images of the Sun using your hands. Credit: AAS



Indirect Viewing Method: Project images of the Sun using a colander. Credit: NASA/Joy Ng

YES!

View the eclipse with special solar viewing glasses.

NO!

Regular sunglasses are not safe to view the eclipse.

Direct Viewing Method: Wear solar viewing glasses. Credit: NASA

A total solar eclipse is about as bright as the full Moon — and just as safe to look at. But the Sun at any other time is dangerously bright. View it only through special-purpose solar filters that comply with the transmission requirements of the ISO 12312-2 international standard for filters for direct viewing of the Sun.

Follow these safety guidelines for viewing a total solar eclipse. Credit: AAS

If you choose to use solar eclipse glasses with your learners, those in the path of totality may remove their glasses during the brief period of totality, when the Moon completely blocks the Sun. Put glasses on during the partial phases of the eclipse. People experiencing a partial solar eclipse will need to wear their solar eclipse glasses for the entire duration of the eclipse.

Learner Handout

Directions:

1. Cut out the 2D paper map in Figure 3 and the box containing 5 different sized circles in Figure 4.
2. Use the **circle** and the **star** hole puncher to punch out the existing shapes in the 2D paper cut map.
3. Use a hole puncher with a shape *other than a circle or star* to punch a hole in the 2D paper cut map somewhere else, such as where you live. Try a **triangle**, **square**, or a **heart**.
4. **Make a prediction!** What shape will the Sun be when it shines through each hole?
5. Standing with your back toward the Sun, hold the map approximately one meter above the ground, out in front of you, to allow sunlight to shine through the holes in the 2D paper cut map onto the ground. Do NOT look at the Sun through the pinhole!
6. Repeat the experiment with the size of the hole using Figure 4.

   Predict: Will the size of the hole affect the projection?

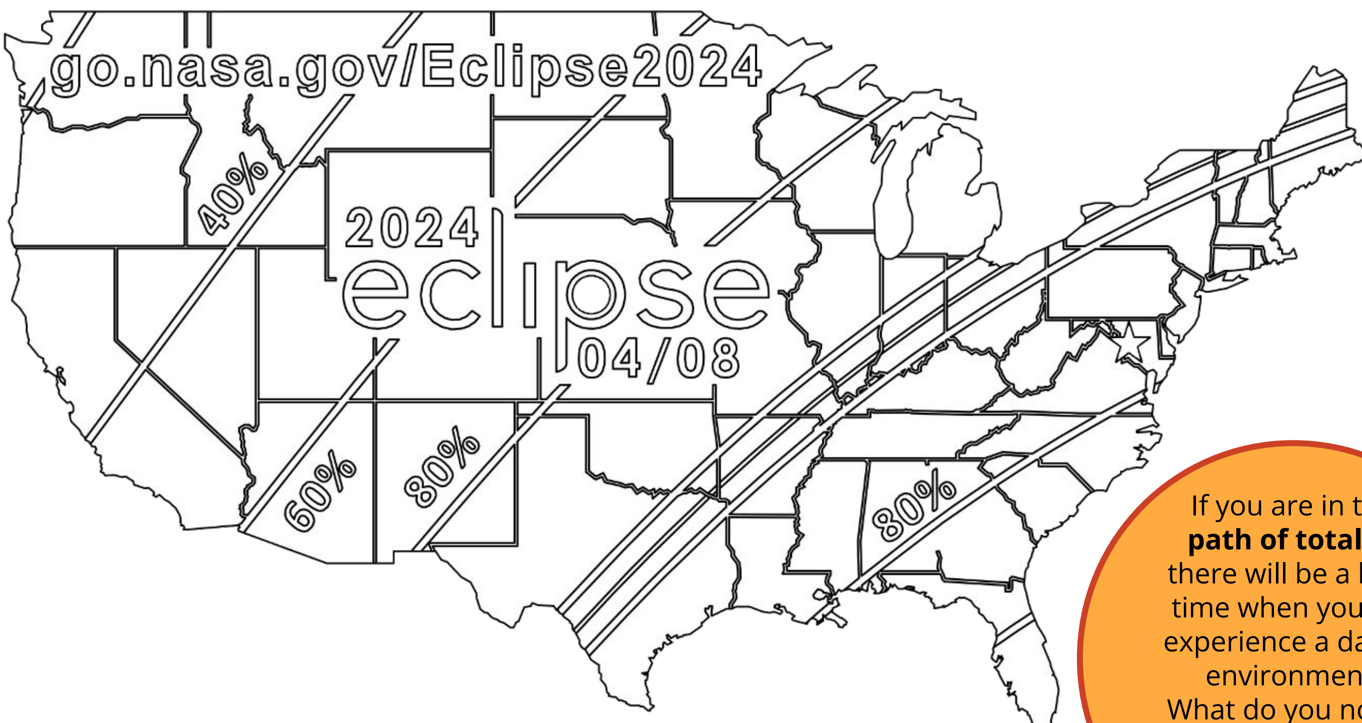


Figure 3: A 2D paper cut U.S. map for the Monday, April 8, 2024, total solar eclipse. Credit: NASA HEAT/J. Patrick Haas

If you are in the **path of totality** there will be a brief time when you will experience a darker environment. What do you notice around you? What do you hear? What do you feel?

Materials:

- ❑ Scissors
- ❑ Hole Punchers, 5 mm:
  - ❑ Circle
  - ❑ Star
  - ❑ At least one other shape, e.g., square, triangle, heart

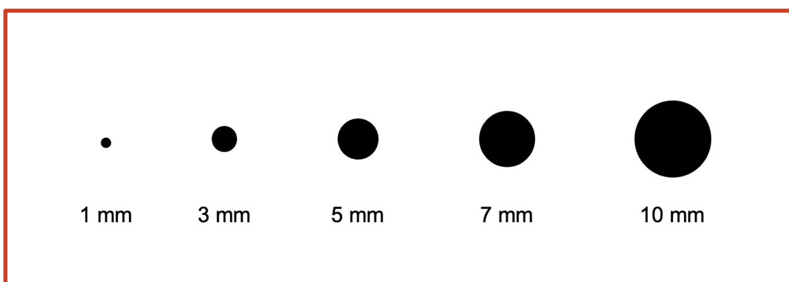


Figure 4: Experiment with sizes by cutting out these different sized circles. Credit: NASA HEAT

Print a 2D paper cut or 3D printed U.S. map pinhole projector using the link below to access files for indirect viewing, or use solar viewing glasses to observe the upcoming total solar eclipse on Monday, April, 8, 2024!

Remember to never look directly at the Sun without proper safety equipment.

Eclipse Information

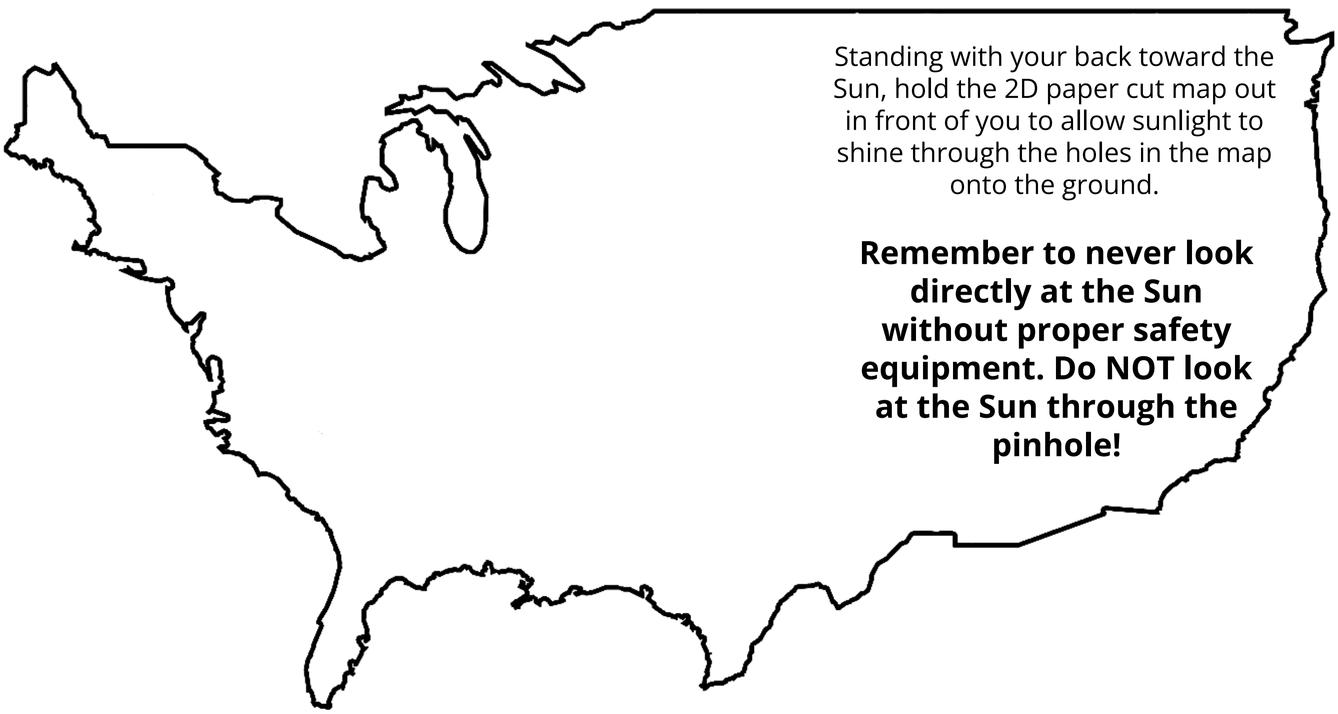
go.nasa.gov/Eclipses

2024 Total Solar eclipse THROUGH THE EYES OF NASA

Pinhole Projector Files

nasa3d.arc.nasa.gov/detail/usa-eclipse-2024

This product is supported by the NASA Heliophysics Education Activation Team (NASA HEAT), part of NASA's Science Activation portfolio.



EDUCATOR EXTENSIONS

Math Extension

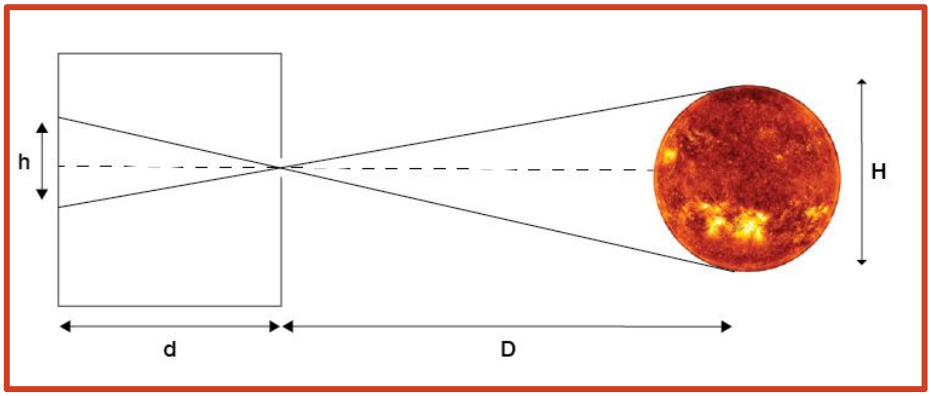
Calculate the diameter of the Sun using measurements taken with a pinhole projector.

Common Core Math Standard 6.RP.A.1 - Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

For a pinhole projector, the relationship between the Sun's height, the Sun's distance from Earth, the projection distance, and projection image height can be expressed as an equivalent ratio:

$$\frac{H}{D} = \frac{h}{d}$$

H = Height of the Sun
D = Distance to the Sun
h = Height of the projected image
d = Projection distance



Relationship between projection image height h, projection distance d, Sun distance D, and Sun height (diameter) H

To calculate height (Diameter) of the Sun (H):

1. **Define (d):** The pinhole projector is held about 1 meter (m) above the ground, which is the projection distance **(d)**.

   (d) = 1m

2. **Define (h):** The hole in your pinhole projector has a diameter of 5 millimeters (mm), creating a projection of the Sun on the ground of about 9mm in diameter, when you hold the pinhole projector 1 meter above the ground. We will use 9mm as the height **(h)** value.

   → To convert millimeters (mm) to meters (m), divide the **(h)** value by 1000.

   (h) = .009m

3. **Define (D):** The average distance from you (on Earth) to the Sun **(D)** is about 150 million kilometers (km), or 1.5×10^{11} meters (m).

   (D) = 1.5×10^{11} m

4. **Calculate (H):** Using the values for **D, h, and d,** calculate the diameter of the Sun **(H)** using the equation above. *Make sure to use scientific notation. For example, to enter 1.5×10^{11} into a computer/smartdevice calculator, type "1.5" [the "EE" button] "11". Or ask your instructor how to use the scientific notation feature on your specific calculator model.

5. **Try it!** Go outside and use your pinhole projector to measure **(d)** and **(h)**. Do you get the same result for **(H)**?

Remember to always keep your back to the Sun when using a pinhole projector. Do NOT look at the Sun through the pinhole!

This product is supported by the NASA Heliophysics Education Activation Team (NASA HEAT), part of NASA's Science Activation portfolio.

Make a Prediction!

Print and cut these prediction slips to encourage your learners to make predictions like NASA scientists do.

Make a prediction by using hole punchers on the - - lines to show the shape of the projection of the Sun through each hole:

The projection of the Sun through the ● hole will be in the shape of a - -

The projection of the Sun through the ★ hole will be in the shape of a - -

The projection of the Sun through the ■ hole will be in the shape of a - -

The projection of the Sun through the ▲ hole will be in the shape of a - -

The projection of the Sun through the ♥ hole will be in the shape of a - -

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Show What You Know!

Print and cut these assessment slips for a quick, easy way to see what your learners discovered.

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NP-2023-6-083-GSFC (1/2)