# The Great American Eclipse of August 21, 2017

## Submitted by: Phillip Lewis, Carson Newman University

**Grade:** 5

**Engaging phenomena or data**

The following links show what a total eclipse looks like in time lapse. Being in the right place at the right time along can be difficult. Also looking at a solar eclipse can be damaging to the eyes if not properly protected. Have the students notice when the solar flares become visible and point on the “diamond ring effect” that occurs before and after totality.

https://www.theguardian.com/science/video/2016/mar/09/time-lapse-footage-shows-total-solar-eclipse-pass-over-pacific-video

https://svs.gsfc.nasa.gov/4314

**Cultural Relevance**

Identify how some cultures through history thought of solar eclipses as a sign that something bad was happening or going to happen.

http://www.windows2universe.org/sun/atmosphere/eclipse_history.html

The students in this area will be about to see and live these phenomena. This makes this unique to them personally.

**E-Learning connections**

- Using Google Earth to watch how the Sun, Moon, and Earth rotate and revolve with each other. (Speed up motions with the calendar setting)
- Using Office 365 Class Note book for Science Notebooks
- IPad to record presenting of model

**Materials**

- Supply list listed with activity
- Possible misconceptions (optional)
    - The Earth, Moon, and Sun are the same size.
    - Everybody on Earth can see a solar and lunar eclipse.

**Prior knowledge needed (optional)**

- The Sun is the center of our solar system.
- The moon does not produce its own light.

| Lesson Section/Time | Teacher and Student Activities | Key Questions |
|---|---|---|
| **Engage** | Pre-Assessment: Students will be asked to draw the position of the sun, moon, and earth during a total solar eclipse and a total lunar eclipse in their science journals.<br><br>Show two videos of a total solar eclipse:<br>1. https://www.theguardian.com/science/video/2016/mar09/time-lapse-footage-shows-total-solar-eclipse-pass-over-pacific-video<br>2. https://svs.gsfc.nasa.gov/4314<br><br>• Activate prior knowledge of a solar and lunar eclipse.<br>• Discuss how we will be able to view the Total Solar Eclipse during school on August 21, 2017.<br>• Explain how solar eclipses have incited fear in civilizations throughout history before they knew the science behind them.<br>• Discuss some instances and stories of Solar Eclipses throughout history:<br>o Thomas Jefferson – http://founders.archives.gov/documents/Jefferson/03-04-02-0217<br>o Ancient Civilizations – http://www.windows2universe.org/sun/atmosphere/eclipse_history.html<br>• Students will plot the path of the viewing area during the total solar eclipse that will occur on August 21, 2017 *(refer to last sheet of this document)*<br>• Read and discuss the origin myth, "How the Fifth Sun Came to Be."<br>• Compare and contrast a solar and lunar eclipse in the students' science notebooks | • What does solar mean?<br>• What does lunar mean?<br>• What does eclipse mean?<br>• Why did some civilizations fear solar eclipses?<br>• What are some fears that you have overcome after you learned the science behind the fear?<br>• How could knowledge be powerful in ancient times? |
| **Explore** | The objective is to learn about the motion of the earth, sun, and moon, in relation to each other, by building and using a model of the solar system to discover how and why eclipses happen.<br>• TTW<br>o Divide the class into small groups<br>o Pass out materials for each group<br>▪ Tape, flashlights, two empty toilet paper rolls, scissors, aluminum foil, sturdy but bendable wire (about 20 inches), Styrofoam ball (the size of an orange), ping pong ball, large strip of cardboard (24"x8"), stacks of books or magazines<br>o Discuss what each object represents in the model and how to build the basic structure for the model.<br><br>1. Take one cardboard tube and make a series of | • During a solar eclipse, what would you see if you stood on the moon and looked at the earth?<br>• What is the phase of the moon during a solar eclipse? |

small (2cm deep), even, vertical cuts around the circumference of each end.

2. Bend the cut pieces out at each end and then stand the tube upright. The cut edges should fan out like a flower.
3. Using adhesive tape, fasten one end of the cardboard tube to the cardboard strip to create the base of the model. The tube should be at least 30cm from one end of the cardboard strip.
4. Using tape or glue, attach the larger ball to the top of the tube. This ball represents the earth.
5. Cover the smaller ball with aluminum foil, with the shiny side facing out. This will be the moon.
6. Insert one end of the wire into the top of the earth so that the wire is vertical.
7. Measure approximately a finger's length along the wire and bend the wire here at a right angle, creating a horizontal arm.
8. About halfway between the earth and the far end of the cardboard strip, measure a finger's length along the wire and bend it again. This time, bend it downward at a right angle, toward the cardboard base.
9. Insert the other end of the wire into the "moon." The moon's equator should be at least the same height as the earth's equator.

- Groups are to make a model of a solar eclipse and lunar eclipse.
- Students will illustrate their models in their science journals.

Citation: Creating Eclipses in the Classroom. (n.d.). Retrieved July 28, 2016, from http://www.unawe.org/activity/eu-unawe1302

http://www.unawe.org/static/archives/activities/pdf.eu-unawe1302.pdf

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|---|---|---|
| **Explain** | • Groups will create a video demonstration of their model of a solar and lunar eclipse. In the demonstration, the students will provide the following information:<br>  o Solar Eclipse<br>    1. What is the placement of the sun, moon, and earth during a solar eclipse?<br>    2. To view, do you look at the moon or sun?<br><br>  o Lunar Eclipse<br>    1. What is the placement of the sun, moon, and earth during a lunar eclipse?<br>    2. To view, do you look at the sun or moon?<br>• Groups will upload videos to class website (if available)<br><br>Watch presentations, question results, and ask follow-up questions.<br><br>(Informal Assessment)<br><br>• How would a solar eclipse change on earth if the moon was smaller than it is now?<br>• What other factor, other than size of the sun and moon, determines how a solar and lunar eclipse is viewed from the earth?<br>• What would you see if you were on the moon during a solar eclipse?<br>• What would you see if you were on the moon during a lunar eclipse?<br>• Do eclipses occur on other planets? | |
| **Elaborate** | • Reinforce the concept of the sun and moon's size in relate to each other through math skills and engineering (division, fractions, and exponents).<br>• Talk about the dangers of looking at eclipses without proper eye protection<br><br>**Activity 1:**<br><br>Create a pinhole camera to calculate the diameter of the sun: http://www.jpl.nasa.gov/edu/learn/project/how-to-make-a-pinhole-camera/<br><br>**Objectives:**<br><br>• Students make a pinhole camera to safely view the sun<br>• Students will use simple proportions to calculate the diameter of the sun | |

**Materials:**

Per pair of students:

- A4 sheet of white card
- A4 sheet of white paper
- Square of aluminum foil (approximately 4cmX4cm)
- Drawing pin or sharp point
- Tape
- Scissors
- Ruler
- Candle (electric, LED light, flashlight, Christmas lights)
- Calculator

This activity needs to be done on a sunny day and students should work in pairs. They will use a simple pinhole camera to project an image of the sun onto a piece of paper and simple math to calculate how large the sun is.

**Activities**

The materials should be prepared in the classroom. Cut a 2cm square out of the center of your card. Place the tinfoil over this opening and tape it down at the edges. Use a pin or sharp point to make a small hole (1mm to 2mm in size) in the center of the foil. You now have a pinhole camera.

If you would like to test the camera, hold it a few centimeters away from a lit candle with the piece of white paper on the other side of the candle. You should see an image of the flame projected onto the piece of paper. The image of the flame will be upside down.

*Remember – never look at the sun directly. It will damage your retinas. There are no pain receptors in your retina, so you will not feel the damage being done.*

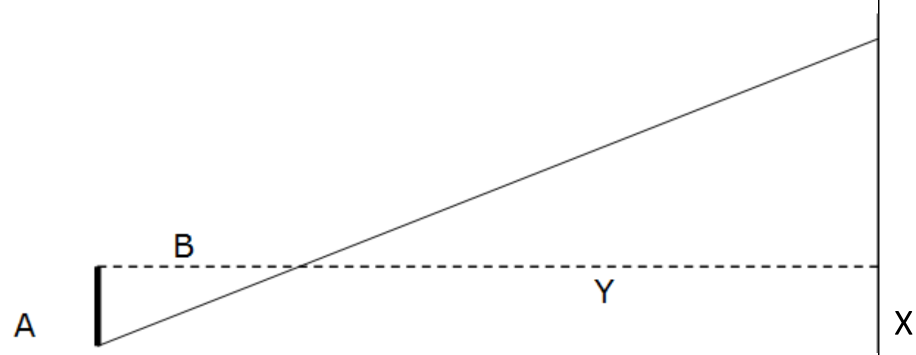
Hint: Try to make the distance between the pinhole viewer and the paper as large as possible while still being able to see the image of the sun.

Using your ruler, measure the following:

- The distance from the pinhole (in the foil) to the white paper
- The diameter of the image of the sun on the paper

There is a mathematical law, which states,

A=X
B=Y




The diameter of the sun can be calculated using this ration. In our situation,

A = the size of the projected image of the sun
B = the distance between the pinhole and paper
X = the size of the sun
Y = the distance between the pinhole and the sun (140 million km)

The accepted diameter of the sun is $1.4x10^6$km (1.4 million km)

Citation: Astronomy and Space Education. (n.d.). Retrieved July 29, 2016, from http://www.mssl.ucl.ac.uk/outreach/short_activities.html

**Activity 2**

5.NBT.A.2: Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.

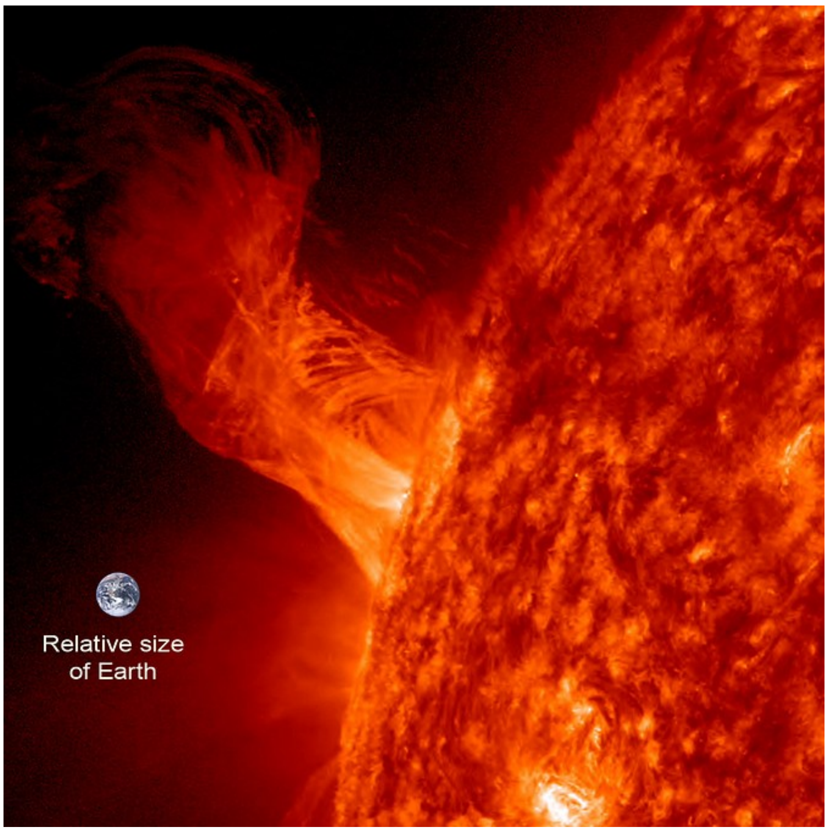
**Science example:** The sun is about 1011 meters from earth. Sirius, another star, is about 1017 meters from earth. Write these two numbers without exponents; position the numbers, one directly below the other, aligning on the one. How many times farther away from the earth is Sirius when compared to the sun?

**Engineering Challenge:**

If the sun was the size of a yoga ball, 75cm in diameter, what object could you find in the classroom to represent the size of the earth?

Sun = 1,390,000km
Yoga ball = 75cm

Earth = 12, 742km
Answer: 0.7cm 109 times smaller in diameter (about the size of a pencil eraser)




Citation:
Image: (n.d.). Retrieved July 27, 2016, from https://www.nasa.gov/mission_pages/sdo/news/solar-ballet2.html#V5sJ22iAOko

NASA/SDO/Steele Hill

*Next Generation Science Standards: For states, by states*. (2013). Washington, D.C.: National Academies Press. Retrieved July 27, 2016, from http://www.nextgenscience.org/sites/default/files/Appendix-L_CSS Math Connections 06_03_13.pdf

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|---|---|---|
| | **Exit ticket:** Students will be asked to draw the position of the sun, moon, and earth during a total solar eclipse and a total lunar eclipse in their science journals. (This is the same question as the pre-assessment at the beginning of the lesson) | |
| **Evaluate** | • In the "Explore" section, the students will take the pre-assessment. They will take the same assessment as an exit ticket in their science journals.<br>o Students will be assessed on their compare and contrast section in their science journal<br>o Students will be assessed on the Total Solar Eclipse Viewing Path page (the last page of this document)<br>o In the "Explain" section, students will be informally assessed through their model and follow-up questions<br>o Students will be assessed in activities 1 and 2 from the "Elaborate" section | |

NGSS Performance Expectations

**MS-ESS1- Develop and use a model of the Earth-sun-moon system 1.**

**ESS1.A: The Universe and Its Stars**

- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.

**ESS1.B: Earth and the Solar System**

- This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year.

**To describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.** [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
|---|---|---|
| **Developing and Using Models**<br>Modeling in 6–8 builds on K– 5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems.<br><br>**Analyzing and Interpreting Data**<br>Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.<br><br>Analyze and interpret data to determine similarities and differences in findings. (MS- PS1-2) | ESS1.A: The Universe and its Stars: The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1)<br><br>ESS1.B: This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. | **Cause and Effect**<br>Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS- PS1-4)<br><br>**Scale, Proportion, and Quantity**<br>Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1- 1)<br><br>***Connections to Engineering, Technology, and Applications of Science*** |

Total Solar Eclipse Viewing Path

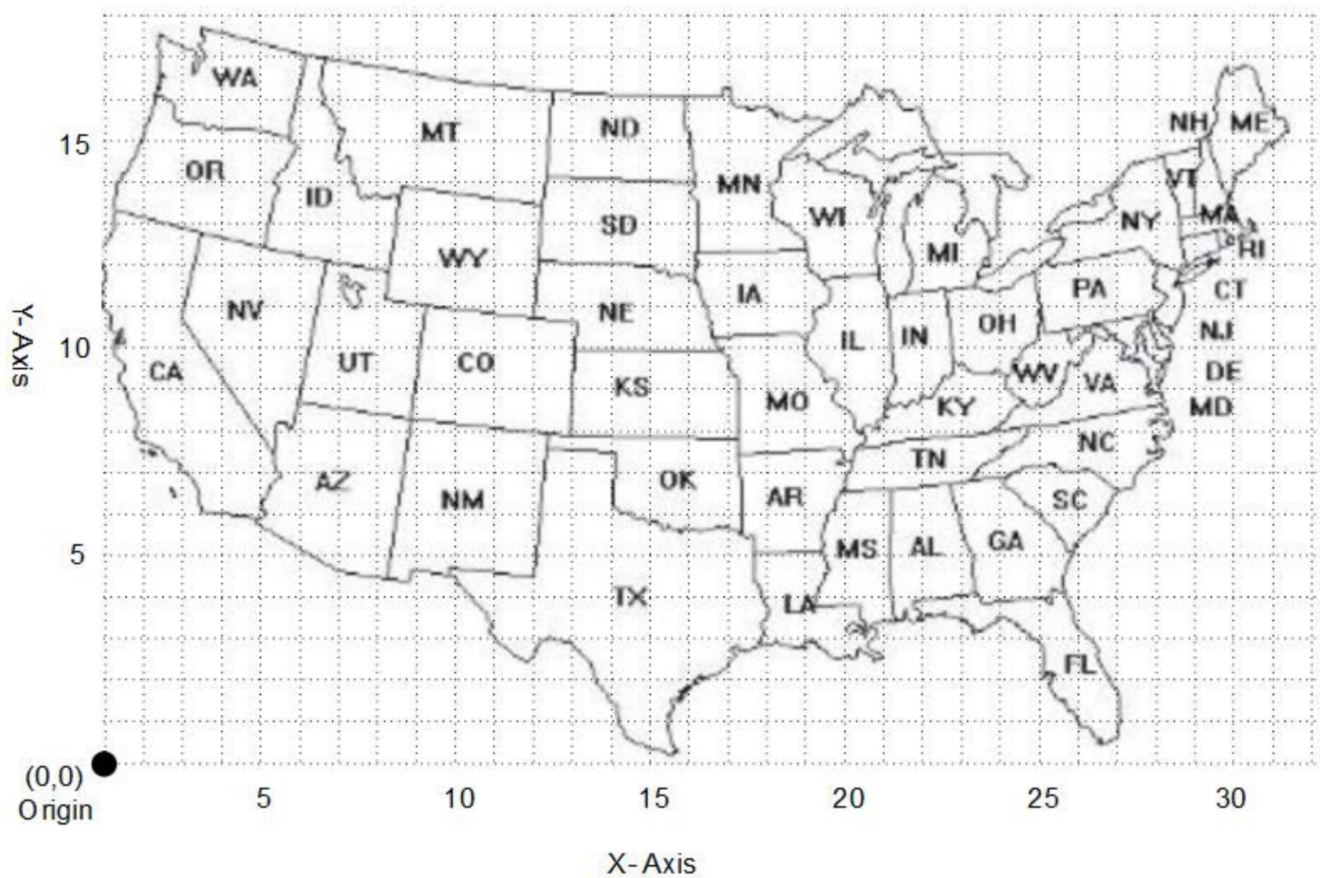


Chart the path of the viewing area of the total solar eclipse that will occur on August 21, 2017.

| Time of Viewing | (X,Y) Coordinates | Location |
|---|---|---|
| **1. 1:19 pm** | (4, 15) | Madras, Oregon |
| **2. 1:33 pm** | (8, 13) | Snake River Valley, Idaho |
| **3. 1:42 pm** | (11, 12) | Casper, Wyoming |
| **4. 1:49 pm** | (13, 11) | Sand Hills of Western Nebraska |

Question: What patterns do you see with the X and Y axes?

| Time of Viewing | (X, Y) Coordinates | Location |
|---|---|---|
| **5. 2:06 pm** | (17, 10) | St. Joseph, Missouri |
| **6. 2:20 pm** | (20, 9) | Carbondale, Illinois |
| **7. 2:27 pm** | (22, 7) | Nashville, Tennessee |
| **8. 2:35 pm** | (24, 7) | Great Smoky Mountains, Tennessee/North Carolina |

Question: Based on the data you have plotted, estimate where and when the total solar eclipse will be viewable in Columbia, South Carolina. Columbia is in the middle of South Carolina.