**HCDE Secondary Science Lesson Plan for the Great American Eclipse**

**August 21, 2017**

**Unit Essential Question:** What causes an eclipse?

**Focus Questions:** What causes both a total and partial eclipse? How does location affect what you see?

**Core Science Idea:** The movements and positions of the earth, moon and sun affect what we see in the sky both during the day and at night time.

**Science background for the teacher:**

-The moon is always half lit (the side facing the sun), we just don’t always see the entire lit portion because of the positioning of the earth, moon and sun system.

-The moon travels in a counterclockwise orbit around the earth.

-The moon phases are caused by the position of the moon in its orbit around our earth.

-When the earth casts a shadow on the moon, that is a lunar eclipse and happens only rarely within a year’s time.

- When the moon passes between the sun and earth and casts its shadow on earth, that is a solar eclipse.

- The last total eclipse that occurred in our area was in the year 1478. The next total eclipse is expected in the year 2566.

- Total solar eclipses occur less than once a year when there is a new moon in Perigee (orbit point closest to Earth).

-The moon’s umbra is the full shadow and the penumbra is the half shadow which determines where an eclipse will be total or just partial.

*Source: National Research Council. (2012). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral Social Sciences and Education. Washington, DC: The National Academies Press.*

**Possible Misconceptions:**

1.) Students may think that the phases of the moon are caused by earth’s shadow or the shadow of some other object in our solar system. Reality: Occasionally, the earth casts a shadow on all or part of the moon. This is called a lunar eclipse and is not related to the phases of the moon.

2.) Students may think an eclipse is to be feared or can happen frequently. Reality: This may happen because they do not have a clear understanding of what an eclipse actually is. The patterns of movement of the sun, moon, earth when they align cause this rare phenomena.

3) Students may think that if they are not in the path of totality, they won’t see anything. Reality: Most of the U.S. will see a partial eclipse.

**Engage**: Show the Simpson’s Video

**Explore: Model Movements**

1. Have a student represent the sun and stand in middle of the room. Use a flashlight or other light source to help illuminate the model.
2. Select another student to represent Earth and model how Earth orbits, rotates, and revolves.
3. Finally select another student to represent the moon. The student’s face should always look at the “earth” student. Slowly have the moon student orbit Earth. Have them stop when they are aligned in the pattern Sun, Moon, Earth.

(Note: Do not express this idea until discussion at step 6: This is a model of the Solar Eclipse. A solar eclipse occurs when the moon’s shadow is cast on earth (happens during the day).

1. Have them move again to align in the pattern Sun, Earth, Moon.

(Note: Do not express this idea until discussion at step 6: This is a model of a Lunar Eclipse, when Earth’s shadow is cast onto the moon (happens during the night).

1. Allow students PRT around the model.
2. Have them discuss in AB Dyads their thoughts about what an eclipse is and what might actually cause it to occur.
3. Have students illustrate in their journals their noticings about the “people” models created.

**Explain: Simulations**

 Simulation1: <https://eclipsemega.movie/simulator?lat=35.137265&lng=-85.2368219>

Note: you can change the city in the top center of the screen.

 Simulation 2: <https://www.nasa.gov/feature/goddard/2016/preparing-for-the-august-2017-total-solar-eclipse>

**Explore:** Interactive map: <https://eclipse2017.nasa.gov/sites/default/files/interactive_map/index.html>

-Students could: choose their home/ a family members home/ where they went on vacation/ place they would like to view from/ etc.

**Explore:**

*Map of Total and Annular Solar Eclipse Paths 2001-2020:* Students could generate their own questions and answer. Discussions around these questions: What do the different colors represent? What is the difference between a total and annular eclipse? Why are they different shapes? Why are they sizes? Durations?

*Chart of Five Millennium Catalog of Solar Eclipses:* Students could generate their own questions and answer. Discussions around these questions: What kind of eclipse happens most/least frequently? Why? What patterns do you see? What patterns did you expect to see that aren’t evident?

*Reading: Solar Eclipses for Beginners Fred Espenak (©2009)*: Students could read, annotate, 3-2-1 (3 important facts, 2 surprises, 1 question you still have), Jigsaw around the types of eclipses, Jigsaw the entire article, etc. Note: This article does have all the “answers” as to why/how they happen.

**Explain:**

Artifact Creation:

**Question** (what are you trying to answer- What causes both a total and partial eclipse? How does location affect what you see?)

* **Claim** (what your answer is)
* **Evidence** (what proof do you have your claim is correct)
* **Reasoning/Justification** (what makes your evidence good)

**Evaluate:** Apply what you have learned about Solar Eclipses to Lunar Eclipses. How often do lunar eclipses happen? Explain your thinking.

**Further Resources**

Article: Ancient Eclipses and the Length of the Day 7

Article: The Extinction of Total Solar Eclipses

Article: Myths and Superstitions Around Solar Eclipses

**Further Explore:** Why Do Eclipses Happen?

*Materials:* bare light bulb (lamp with no shade)*,* Yard/Meter stick *,* 1” (2.5cm) ball on a toothpick (Earth model)*,*  ¼" (7 mm) bead on a toothpick (Moon model)*,* Binder clips to attach toothpicks to the yard/meter stick 30 inches (75 cm) apart

(Note: Build several models for student teams to try to use to demonstrate Lunar and Solar eclipses)

1. Attach the Earth model to the yardstick at 4 inches.
2. Attach the Moon model at the 34 inch mark.
3. Tell students to try to move Moon-bead into Earth-bead’s shadow and make a lunar eclipse. If the student is having difficulty, have them project the Earth’s shadow onto a card or their hand. Then line up the shadows on the card. (See photo – the arrow is pointing to the Moon bead’s shadow). The point you might want to make is that it is not easy for the Sun, Earth, and Moon to be perfectly aligned!
4. Would everyone on the night side of Earth be able to see the lunar eclipse? (Yes)
5. Great! Let’s make a solar eclipse. That’s when the Moon casts a shadow on the Earth. Where does the Moon have to be to do that? (on side of Earth nearest the sun)
6. Use Yardstick model: Have the students try to align the Moon-bead toward the Sun and cast a shadow on the Earth bead. (The arrow in the photo is pointing to the Moon bead’s shadow on the Earth ball.)
7. From where on Earth would the solar eclipse be visible? (Just the part where the Moon’s shadow crosses.)

**Explain:** [How to View the 2017 Solar Eclipse Safely](https://eclipse2017.nasa.gov/sites/default/files/publications/Safety_508.pdf) Article

**Explore: Ways to view a Total Solar Eclipse.**

While the best and safest way to view a total solar eclipse is through NASA approved glasses, there are many other ways to safely view this phenomena. But why can’t you look directly at the sun? The only time that the Sun can be viewed safely with the naked eye is during a total eclipse, when the Moon completely covers the disk of the Sun. It is never safe to look at a partial or annular eclipse, or the partial phases of a total solar eclipse, without the proper equipment and techniques. This is because the sun simply outputs more power than our eye is designed to handle, and exposing our eye to that kind of power can damage the retina. In a nutshell, solar eclipses are dangerous because the sun can come out from behind the moon and "surprise you" before you have a chance to look away.

Listed below are websites that will help you construct you own solar viewing devices.

1. Build a sun funnel: <https://www.astrosociety.org/tov/Build_a_Sun_Funnel2.pdf>
2. Pinhole Projector: <https://www.timeanddate.com/eclipse/make-pinhole-projector.html>
3. Cardboard Box: <https://www.timeanddate.com/eclipse/box-pinhole-projector.html>
4. Box Pinhole Projector: <https://www.timeanddate.com/eclipse/box-pinhole-projector.html>
5. Other ideas: <http://www.exploratorium.edu/files/eclipse/pdf/how.pdf>