**Eclipse Lessons by Asia Burgett at Indiana University 2023**

**Description:** The following is a series of five lessons that break down the physics and astronomy concepts behind solar eclipses. The lessons build upon each other so that they can be taught in succession, however, they can be, and it is encouraged that the lessons be adapted to be done in isolation. If lessons are done in succession as a unit, there are two recommended additional lessons. The first additional lesson has students create a hypothesis and amend their hypothesis into a factual statement through the lessons. The second additional lesson should take place after the 3 content-centered lessons, where students share their final statements and “teach” their community about solar eclipses. The lessons are designed to be taught in a 3rd-5th grade setting, however, they can, and it is encouraged if needed, be adapted for grades as young as 1st. All lessons are formatted in the Launch, Explore, Summarize lesson model. The grade standards assigned to each lesson range from 1st to 5th grade and come from the Common Core Standards (as used by 41 states)

**The Lessons**

i.) Inquiry/Hypothesis Introduction (optional)

1. Casting Shadows
2. Sun-Earth-Moon System
3. Periods & Cycles

v.) Information fair(optional)

**The Standards:**

1. **MS-ESS1-1.**Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of eclipses. Patterns can be used to identify cause-and-effect relationships. lunar phases, eclipses of the sun and moon, and seasons.
2. **1-ESS1.A.1**  Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.
3. **5-ESS1-2.** Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.
4. **3-PS2-2.** Make observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion.

**The Lessons:**

1. *Creating a hypothesis* (OPTIONAL)
	1. Big Question: What is a solar eclipse? How and why do solar eclipse happen?
	2. Learning and performance goals
		1. L | Solar eclipses are astronomical events where the shadow of the moon is cast on the earth.
		2. P | Students will be able to explain what a solar eclipse is and draw a picture of what it looks like from Earth. Students will synthesize a hypothesis about how solar eclipses happen.
	3. Launch
		1. Read-aloud: Plan an interactive read-aloud with the following books. Emphasize what a solar eclipse looks like. Prompt students to think about the position of the sun, earth, and moon. You may also use a different book as long as the book speaks about solar eclipse without explaining the phenomenon:
			1. *Someone is Eating the Sun* by Ruth A. Sonneborn and Eric Gurney
			2. Select excerpts from *Where Did the Sun Go? Myths and Legends of Solar Eclipses Around the World Told with Poetry and Puppetry* by Janet Cameron Hoult
	4. Explore
		1. Split students into groups of 3 or 4. Provide students with large paper, markers, and other art materials if desired.
		2. Have students come up with diagrams that explain how solar eclipses happen.
	5. Summarize
		1. Have students explain their diagrams and create a list of common words/phrases being used among the groups. Use these words to create a “hypothesis” explaining how solar eclipses happen.
2. Casting, Shifting, & Tracing Shadows
	1. Big Question: What are shadows and how can they be changed?
	2. Learning Goals and performance goals
		1. L - Shadows are areas where light from a light source is being blocked. Shadows can be manipulated by changing the position of the object that is blocking the light or by changing the position of the light source.
		2. P - Students will Cast shadows and record observations when different objects are used and when the distance from the light source changes. | Students will trace their shadow and record how it changes over time.
	3. Launch

*If possible and if the weather is sunny and relatively clear, at the beginning of the school day, have students trace each other’s shadows with chalk. Give them specific colors and initial their shadows as they will be revisiting them.*

* + 1. Ask students to draw pictures of shadows in realistic scenarios (i.e. seeing their shadow when walking, a shadow of their water bottle on a table, etc. NOT a fictional depiction of shadows like “shadow people” or *Shadow* from the *Sonic the Hedgehog* universe.). If they remember, have them write or depict the time of day.
		2. Have students pair share, creating a list of things they have in common and things that are different.
		3. Collect pictures as they will be used during the SUMMARIZE phase.
	1. Explore

*If possible, the room should be as dimmed as possible but still be safe. This will vary depending on the age group.*

* + 1. Split students into groups of 3-4. Give each group a large white foam board, a small foam sphere on a stick (approx. 2.5 inches), a flashlight, and observation paper (as shown below).
		2. Ask students to follow the following procedure:
			1. 1-Stick the sphere into the middle of the foam board
			2. 2-Move the flashlight around the sphere
			3. 3-Draw a picture for at least 3 different positions. For each picture, draw where the flashlight is, where the sphere is, where the shadow is, and what the shadow looks like.
			4. 4-Write 1-2 sentences explaining each picture
		3. Give students a second smaller sphere on a longer stick. Have them follow the following procedure:
			1. 5-Keep the flashlight still in one position.
			2. 6-Hold the smaller sphere upside down and move it around the larger sphere.
			3. 7-Repeat steps 3 & 4.
	1. Summarize
		1. Have students organize their drawings into piles. Each pile should be in a different orientation.
		2. Go over each pile and describe the characteristics of the shadow (darkness, shape, position).
	2. Follow-up/Extension
		1. *If possible, go outside and have students trace a new shadow in a different color chalk. Have them talk to a peer(s) about what they notice.*
		2. Give the following question as an exit ticket: In our activity, between the flashlight, the larger sphere, and the smaller sphere, which one would be the sun? Which one would be the moon? Which one would be the earth?
1. Sun-Earth-moon
	1. Big Question: How do the Sun, Earth, and Moon interact?
	2. Learning and Performance Goals
		1. L - The moon orbits the earth and the earth orbits the sun, all in an elliptic (“circular”) orbit.

The Sun-Earth-Moon system results in changes on earth (i.e. moon phases & seasons)

* + 1. P- Students will create and use 3D models of the Sun-Earth-Moon system to model the orientation of these bodies for different phenomena (i.e. what would this system look like for winter in Indiana)
	1. Launch
		1. Open with the exit ticket question from lesson 2 (if doing this lesson independently of lesson 2, ask the class the following questions: which do you think is the biggest? Which do you think is the smallest? Which do you think is the closest to us (the earth)? Which do you think is the farthest from us?)
		2. Show students a model of the Sun-Earth-Moon system, using words from the discussion. Show students how the moon orbits the earth which orbits the sun while connecting what was talked about in lesson 2.
		3. Prompt students with the following question: How does this system affect what we see and feel on earth?
	2. Explore
		1. Split students into groups of 2-3. Give them each a Sun-Earth-Moon system model kit (as described below). Allow them time to paint and put the model together. Be sure they label where the United States is.
		2. As students to orient the model in at least 3 different positions. Ask them to draw and label the positions of each model using the observation paper. Have them write whether or not it would be day or night in the United States, if they think the weather would be cold, hot, or in between, and what the moon would look like in the United States.
		3. After drawing and writing observation for 3 orientations: As the students to orient a model and fill out an observations sheet for the following orientations:
			1. From left to right, align the moon, earth, and sun.
				1. Who would be in whose shadow? What does the moon look like from the U.S.?
			2. From left to right, align the earth, moon, and sun.
				1. Who would be in whose shadow? What does the moon look like from the U.S.?
	3. Summarize
		1. As a class, discuss the following prompts:
			1. Did anyone have any interesting observations they wanted to share?
			2. Think-pair-share: What are some things you observe when it is day in the U.S.? night?
				1. Explain or show the following media on a day and night cycle and the moon cycle: [Why Does the Moon Change?](https://youtu.be/yXe0yxzYkjo)
			3. Think-pair-share: What are some things you observe when the weather is hot? Cold? In between?
				1. Explain or show the following media on seasons: [Why Are There Seasons?](https://youtu.be/UQjT5uKp2hg) OR [Seasons and the Sun: Crash Course Kids 11.1](https://youtu.be/b25g4nZTHvM)
			4. Discuss the question from part 3 of the *Explore*. Specifically focus on how the moon and sun would look from earth and how it would relate to the previous lesson (and the book if applicable).
	4. Follow-up/Extension
		1. Give students a few minutes or assign as home to answer the following question: Remember our class hypothesis “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_,”

Do you still believe it to be true? If yes, why? If no, rewrite what should be changed.

1. Periods and Cycles
	1. Learning Goals and performance goals
		1. L |
		2. P |
	2. Launch
		1. Start by taking students outside in the morning. Have students pair up and trace each other’s shadows in the standing position. After bridging students inside, have students make predictions about whether their shadows will change and why?
		2. Take time to review the main concepts of lesson 3: *Sun-Earth-Moon* system. Introduce students to the fact that the sun and moon move at different speeds.
		3. Ask students to think about how often do solar and lunar eclipses happen?
	3. Explore
		1. Break Students up into groups of at least 4.
		2. Each group will be given 2 hoops, one large and one small (the hoops are optional but help with spacing and boundaries). Each student will be assigned to be the sun, moon, earth, or recorder.
		3. The students who are the sun will stand in the middle of the large hoop. The Student who is the earth will walk around the outside of the large hoop while holding the smaller hoop. The student who is the moon will walk around the person who is the earth. The recorder will keep track of of how many times a solar and lunar eclipse happens
	4. Summarize
		1. Students will share their results
		2. Pose the question: Why don’t we have solar eclipses more often? Have student take guesses
			1. Walk class through this short video [What determines when we have an eclipse?](https://youtu.be/T_uUHCbZJmU)
		3. Split students into groups and have them look back on the class hypothesis and the revised hypothesis from Lesson 3 exit slip. Have the groups create a 2-3 sentence explanation for eclipses.
2. Information Fair
	1. Have students create posters and diagrams to present their explanations of solar eclipse. Give students artistic control in how they want to present their information, however, make sure the information is accurate.
	2. Designate ½ a day where students can invite their family and friends and share the information with them. Students will present their information in the same groups they were assigned to in the optional lesson 1: *Creating Hypothesis* (if you did not do the optional lesson, you can decide if you want students to present individually or in assignment groups. )