Informal Science Education Enhancement

TRPP Lesson Plan

Exploring Eclipses Activity

(Updated for SEEd Standards 2017)

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THE LIVING PLANET AQUARIUM

UTAH MUSEUM OF NATURAL HISTORY
The University of Utah

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Alignment to Utah Core Curriculum

Grade Level

6th Grade

Strand 6.1

The solar system consists of the Sun, planets, and other objects within Sun's gravitation- al influence. Gravity is the force of attraction between masses. The Sun-Earth-Moon sys- tem provides an opportunity to study interactions between objects in the solar system that influence phenomena observed from Earth. Scientists use data from many sources to determine the scale and properties of objects in our solar system.

Standard 6.1.1

Develop and use a model of the Sun-Earth-Moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and Moon, and seasons. Examples of models could be physical, graphical, or conceptual.

Scientific and Engineering Practices Utilized:

- Developing and using models
- Analyzing and interpreting data
- Constructing explanations and designing solutions

Crosscutting Concepts:

- Patterns
- Cause and effect: mechanism and explanation
- Scale, proportion, and quantity

Background:

Setup:

For details, refer to setup for "The Reasons for the Seasons" activity in this binder. In general, place the 4 halogen lamps in the center of a 12-foot diameter circle shining out at 90 degree angles to each other. Globes should be positioned on the outer edge of the circle at the N, S, E, and W directions. Each lamp should face 1 globe.

Teacher Background:

Eclipses occur when an object in space casts a shadow upon another object. On Earth, two types of eclipses can occur, solar and lunar. A solar eclipse is when the Moon passes in front of the Sun and casts a shadow on a small portion of the Earth. A solar eclipse always occurs during the new Moon phase. The disk of the Moon is just the right size to cover the Sun. However, the Moon is not the same size as the Sun; it looks like the same size because the Moon is closer to us. The Sun is 400 times larger than the Moon, but the Moon is 400 times

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Solar Eclipse

closer to us. In the small area of the Earth shadowed by the Moon during a total solar eclipse, day seems to turn to early night as even stars begin to become visible.
A lunar eclipse occurs when the Moon passes through Earth's shadow in space. The Moon is in its full moon phase during the eclipse. When passing through the Earth's shadow, the Moon is usually at least slightly visible. This is because light from the Sun is refracted through our atmosphere. Most of the light is scattered (the reason we have a blue sky) but long red wavelengths of light make it through the atmosphere. During totality, the only light getting to the moon is light that has passed through Earth's atmosphere. This causes the Moon to become a reddish color during a lunar eclipse.

Lunar Eclipse

Eclipses do not occur every month because the Moon's orbit is tilted by about 5º compared to Earth's. This causes the Moon to pass a little above or a little below the Earth's shadow every month. Only about twice each year do the Sun, Moon, and Earth line up just right for an eclipse to occur.

Common Misconceptions:

1. It is dangerous to be outside during a ***lunar*** eclipse. There is <u>no danger</u> at all. However, a solar eclipse should only be viewed with appropriate solar filters or other safe methods such as image projection.

Activity:

Length of Activity:

Setup: 15 minutes (unless it is done after the "Seasons" activity, then setup is already done)
Activity: 15-30 minutes

Materials Needed:

- Darkened multipurpose room or classroom with adequate room to move 4 groups of 4-8 students around 4 stations (area of about 16 ft. in diameter)
- 1 (or more) electrical outlet(s)
- 5 desks or small tables (must be level, the same height, and large enough to hold all of the station materials.)
- pencil/pen (one for each student)
- Eclipse and Moon Phases Dates 2006-2016 data sheet (one for each student)
- Eclipse PowerPoint (optional)

Materials Provided:

(4) 500 Watt halogen lamps
(4) Globes and bases
(1) Extension Cord

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(2) Power Strips
(36) Golf balls with nails (one for each student)
Activity Sheets for Students
PowerPoint for teacher

Helpful Hints:

During your classroom discussion about eclipses you can mention the recent total solar eclipse that occurred in the US on August 21, 2017 (which students may have seen) or another similar recent event.
*It is important that students are thinking about moon phases so if it has been a while since they learned about them, a short review of lunar phases before the activity would be extremely helpful. *

Student Performance Outline:

Phenomenon- Solar and lunar eclipses do not occur randomly, but instead follow a specific pattern.

Individual Student Performance

- Analyze the eclipse data sheet and look for patterns in the data

Group discussion
Group Performance

- Develop and use a model of the Sun-Earth-Moon system to describe the two types of eclipses
- Construct an explanation supported by evidence for how the position and revolution of the Earth-Moon system create the phases of the moon

Individual Performance

- Use observations and experiences from the Moon Phase activity to develop an explanation for why lunar eclipses do not happen every month.
- *OPTIONAL:* Analyze lunar eclipse diagrams as an aid to determine why lunar eclipses don't occur every month

Group discussion

Procedure:

Ask students if they have ever seen an eclipse. Solar or lunar? What is the difference? Hand out the Eclipse and Moon Phases Dates 2006-2016 data sheet and project the same data using the PowerPoint. To avoid confusion, make sure to tell students that only moon phase dates that are near the dates of eclipses are listed. Ask students to look for patterns in the data either individually or in small groups. The five patterns that they should identify are

1. Solar eclipses occur during a new moon
2. Lunar eclipses occur during a full moon
3. Eclipses don't occur every month
4. Solar eclipses and lunar eclipses occur roughly 15 days apart
5. The pairs of eclipses occur roughly every six months.

As a class discuss the student's observations and use the data to help them reach any of the conclusions they may have missed. Then divide them up into 4 groups (one group to each station) and ask them the following

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two questions.
1. What are the relative positions of Earth, Moon and Sun at the time of a solar eclipse? (Sun, Moon, Earth)
2. What are the relative positions of Earth, Moon and Sun at the time of a lunar eclipse? (Sun, Earth, Moon)

Have them make a diagram of each type of eclipse on a sheet of paper.

Assuming the students are familiar with the Reason for the Seasons activity, refresh their memories by asking what represents the sun (lamps) and what represents the Earth (globes). Ask them what can be used to represent the moon (golf balls-used in moon phases activity). Distribute 1 golf ball (with nail) to each group. Turn on the (4) 500 W halogen lights in the center of the room to represent the Sun. Turn off the main room lights. Globes should be positioned 6 feet from the lamps as in the setup for "Reasons for the Seasons" activity. Make sure to tape the power cord down to the floor for safety.

Tell students to use their group drawings to model the conditions for a **solar eclipse**. If their model is not correct guide them by reminding them to go back to the data sheet and figure out what phase the moon is in during a solar eclipse (new) and then to use their knowledge of lunar phases to create the right set up.

Next, instruct students to use their group drawings to model the conditions for a **lunar eclipse**. If their model is not correct guide them by reminding them to go back to the data sheet and figure out what phase the moon is in during a lunar eclipse (full) and then to use their knowledge of lunar phases to create the right set up.
*****Students will NOT rotate to another station, as the same conditions are close to the same at all stations (at least for 6th grade students).

During the Moon Phases activity students should have experimented with moving the "moon" up and down in the full moon position. From this they should be able to start thinking about why we don't see lunar eclipses every month (The moon orbits at a tilt). Ask students to try and use that knowledge and their new knowledge of eclipses to develop a hypothesis to explain why lunar eclipses don't happen every month.

OPTIONAL: Turn the room lights back on, turn the "Sun" off, and go to the closer look at lunar eclipses part of the PowerPoint. Looking at the slide showing the Total Lunar Eclipse of 2003 and reading the information at the top of the student sheet help students to be clear on the fact that the dotted line in all three diagrams, labelled "Ecliptic" is a projection of Earth's orbit around the Sun into space and that the arrows in all three diagrams show the direction of the Moon's motion and also show the Moon's orbit around Earth. The umbra is the part of Earth's shadow where all the Sun's light is blocked by Earth. The penumbra is the part of Earth's shadow where only part of the Sun's light is blocked by Earth.

Ask them to individually look at the three different diagrams showing the three lunar eclipses and to look for patterns. Then come back together as a class and ask the three questions on the PowerPoint.
1. Is the Moon's orbit around Earth in the same plane as Earth's orbit around the Sun? (No, it is tilted by about 5 degrees)
2. When there is no lunar eclipse at the time of a full moon, where is the Moon in relation to Earth's shadow? (Outside of the penumbra)
3. Can we model the motion of the Moon to account for the phenomena using the set up already created?

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Continue here if not using optional activity
Tell students to go back to the station they were at and see if they can make a model of their hypothesis so that lunar eclipses (and solar eclipses) don't occur and give them 2-5 minutes to explore. They may have trouble visualizing what the orbit would look like since they are holding only one golf ball. Students may try to hold the golf ball above or below their head for the entire orbit. Remind them that orbits must pass by the center of the Earth so if it is above their head on one side then it must be below their head on the other side.

Students may struggle to visualize how to model this because it can be hard to visualize the orbit path of the moon. To help students understand why lunar eclipses don't happen every month we recommend using a hula hoop to show the tilted orbit. Give students a hula hoop and see if they can use that to model the orbit of the moon.
Guiding questions after students have started to try tilting the hula hoop:

- What do we know about the Earth's tilt as it moves around the sun? (It does not change)
- Does the moon's orbit of the Earth change as it moves around the sun? (No)
- Have students try moving their tilted hula hoop from one globe to another. Now is there an eclipse? (Depends on what their starting position was)
- Once students have reached the conclusion that the moon's orbit is tilted in comparison to Earth's, ask them how much do they think it is tilted by? (Answers will likely be in the 30°-35° angle range because that is what is necessary to make a discernible difference in this model)
- Tell students that it is actually only tilted 5°. Ask students why holding it at a 5°angle wouldn't work in this model. (Inaccurate scale)
- Next, have student's move the tilted hula hoop from one globe to the next and have them point out where eclipses occur and where they don't. This serves to reinforce that at some places in the Earth's orbit, the moon's orbit aligns to make eclipses occur and how at others it is above or below so that eclipses do not occur.

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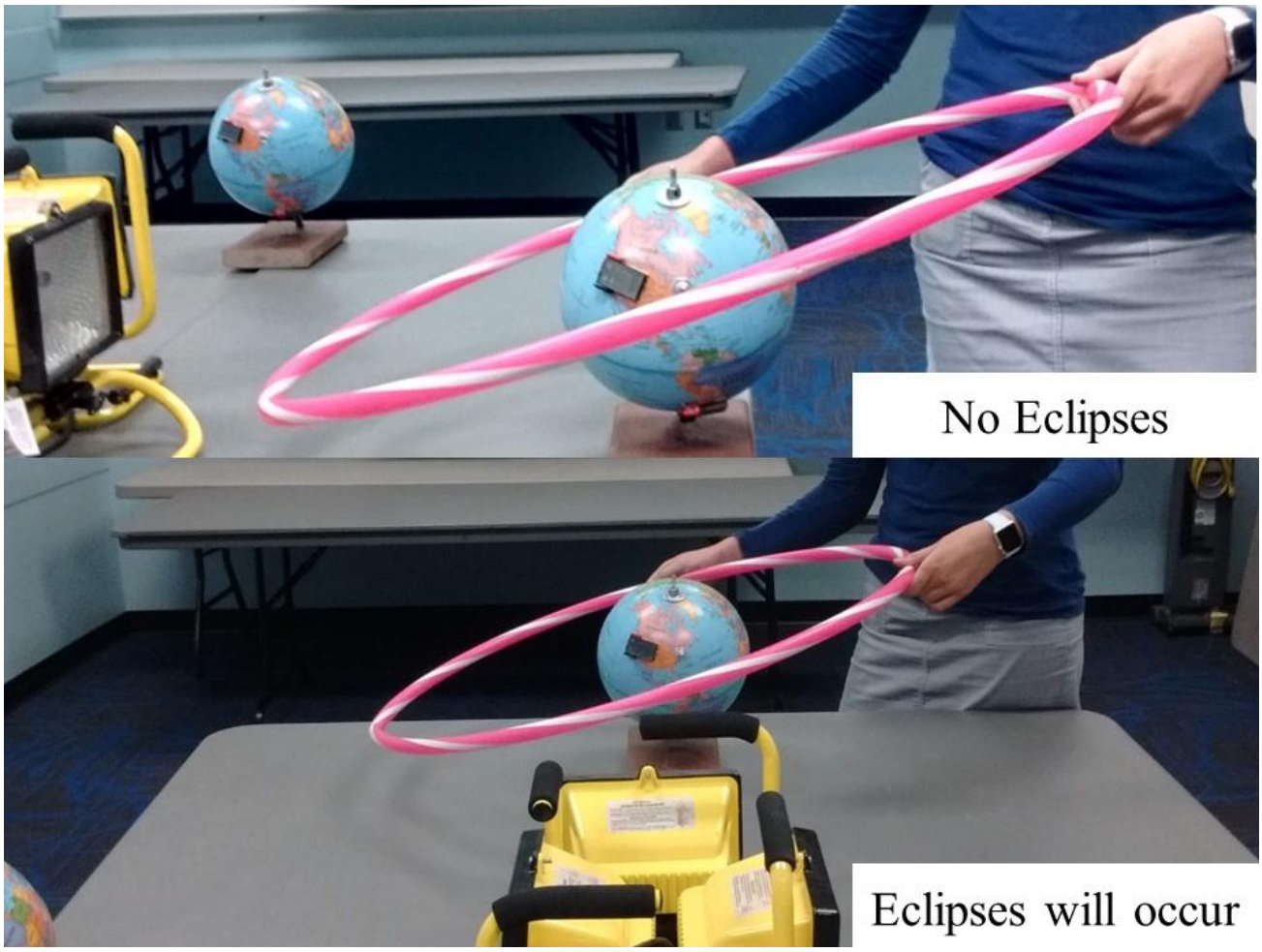

Notes on the figure: In the top image, no eclipse occurs because the moon is not on the same plane as the Earth during the full and new phases. In the bottom picture (3 months later in our model) the moon is on the same plane as the Earth during full and new phases so eclipses do occur. Notice that the tilt and orientation of the orbit around the globe remains the same relative to the Earth.

Come back together as a class with the lights on and has a discussion of the observations and conclusions the students reached.

Common observations: When the Moon is between the Sun and Earth (a solar eclipse), the shadow is small and only covers part of the Earth. (Ask: Would everyone on Earth be able to see the solar eclipse? Who would be able to see it? Who wouldn't?) By moving the Moon nearer or farther while creating a solar eclipse, it is possible to notice the Umbra (darkest part of the shadow) and the Penumbra (dim part of the Moon's shadow). Penumbral lunar eclipses are usually too dim to be detected by observers, even with telescopes. When the Moon is opposite the Sun in Earth's sky (a lunar eclipse), Earth's shadow covers the Moon completely (because it is MUCH larger than the Moon).

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Formative Assessment Strategies:
See attached master worksheet

Learning Extensions:

Booklist:

Agencies:

Websites:
www.nasaimages.org
http://wserver.scc.losrios.edu/~sah/physics/44Miscon.htm

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