EclipseMob

LESSON TITLE: WHEN DOES A SOLAR ECLIPSE HAPPEN?

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LESSON GOALS AND OBJECTIVES:

Students will be able to:

1. Explain the difference between a solar and lunar eclipse
2. Demonstrate a solar and lunar eclipse using a physical Earth, sun, moon system model
3. Identify which moon phase a solar and lunar eclipse occurs during.
4. Explain why an eclipse doesn't happen every month.
5. Determine who will be able to observe an eclipse on Earth and explain why everyone won't be able to observe it.
6. Create a visual model of the lunar and solar eclipses.

BROAD GOALS:

The activities aim to help students understand
1) what a solar eclipse is
2) the differences among total, partial and annular eclipses
3) why these eclipses don't happen every month, and 4) why not everyone on Earth can view the eclipse.

NGSS STANDARDS:

MS-ESS1-1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of the lunar eclipses of the sun and moon, and seasons.

HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.

HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

MATERIALS REQUIRED:

1. Tennis ball
2. Marble

BACKGROUND INFORMATION:

This lesson is part of a larger unit called “What is an Eclipse Anyway?” This lesson could be covered in one long class session, or the individual activities could be used as needed.

The activities start on page two and aim to help students understand 1) what a solar eclipse is, 2) the differences among total, partial and annular eclipses, 3) why these eclipses don’t happen every month, and 4) why not everyone on Earth can view the eclipse.

The first few activities are basic but challenge activities are offered near the end of the lesson. You may use all, one or a few of the activities depending on your students.

These activities can be tailored for 6th grade through 12th grade students.

NOTE: Solar eclipses happen during the NEW MOON phase.
Students will have an easier time with this lesson if they first understand that Earth orbits the sun, that the moon orbits Earth, and how the sun, moon and Earth are aligned during a new moon phase. A good lesson on moon phases is here: http://www.jpl.nasa.gov/edu/teach/activity/moon-phases/ (we will soon be posting a moon phases one to EclipseMob.org).

This lesson addresses the following National Science Education Standards:

Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses.

Suggested vocabulary: (definitions are at the end with the key)
Revolution/Orbit
Rotation
Eclipse
Total solar eclipse
Partial solar eclipse
Lunar eclipse
Umbra
Penumbra
Orbit
Eccentric orbit

LESSON PLAN OUTLINE:

ACTIVITIES (use the worksheet at the end of this file if you would like something for students to write on and turn in)

Activity #1 (from VanCleave, Janice. *Earth Science for Every Kid*.)
Materials:
Tennis ball
Marble

1. Place the tennis ball in your left hand
2. Hold the ball at arm's length in front of your face
3. With your right hand, hold the marble in front of the ball
4. Close your left eye and slowly move the marble toward your open, right eye.

Ask students to write down what they observe. Encourage them to do this in a notebook where they are keeping daily notes for class. Check what the students have written and discuss their observations with them.

BIG IDEA: Students should realize that, even though the marble is smaller than the tennis ball, from the student's perspective it can appear that the marble blocks their view of the tennis ball.

NEXT: ACTIVITIES 2 and 3 REINFORCE EACH OTHER:

BIG IDEA for Activities 2 and 3: A solar eclipse will happen only when the moon is at a new moon phase AND the moon's orbit happens to be crossing the plane of the ecliptic. Both conditions must be met, which is why there is not a solar eclipse every month, even though the moon is in new moon phase every 28 days.

Activity #2: The moon's orbit

You can use two hula hoops to demonstrate the concept that the moon's orbit is tilted 5 degrees relative to the plane of Earth's orbit (see the Lesson on orbits if students have trouble with this concept). The plane of Earth's orbit is also called the **Plane of the Ecliptic** (a good explanation is on nasa.gov here: https://www.nasa.gov/multimedia/imagegallery/image_feature_635.html

Source: http://ncisla.wceruw.org/muse/earth-moon-sun/materials/build/material2E/inotes/index.html

Activity: Demonstrate this concept with the hula hoops or challenge students to do so. Then ask students to draw the picture above. Vocab words: UMBRA, PENUMBRA. After they draw the picture, ask students to draw in where the moon's shadow will fall. Will it fall on Earth?
Here's how things need to be in order for eclipses to be observed (Source: http://astro.wsu.edu/worthey/astro/html/lec-celestial-sph.html:

NOTE: Also, the moon orbits Earth in an ellipse, not a circle. So sometimes the moon is relatively close to Earth (perigee) and sometimes it is a little farther (apogee).
Activity #3: You can make your own worksheet around this or use the one provided at the end of this lesson.

Materials (per team of two students):
Globe (or basketball or some large ball to represent Earth)
Flashlight
3-inch diameter styrofoam ball or small ball

Students can work in teams to illustrate both a solar and lunar eclipse. The goal in this demonstration is that students understand that a solar eclipse is **1) when a portion of Earth is in the moon's shadow and that 2) a solar eclipse is something that would be observed by people on the "daylight" side of Earth.**

NOTE: the demo is a variation on the **moon phases lab of Lesson 2** (itself adapted from the Jet Propulsion Laboratory website). It would be fun to do both activities in one day; the activities reinforce each other.

1. Ask students to write down this very simple definition of a solar eclipse: when a portion of the Earth is in the moon's shadow.
2. Ask students write down this definition of a lunar eclipse: when the moon is in Earth's shadow.
3. Turn off the classroom lights.
4. In each team, one student holds the flashlight toward both the globe and the "moon" (styrofoam ball).
5. The other student lets the "moon" orbit Earth counterclockwise. NOTE: If you could hover above Earth's north pole, you would observe the moon orbiting Earth counterclockwise. In fact, all the planets of the solar system also orbit the sun counterclockwise. See the **orbits lesson**.
6. Both students should observe the location of the "moon's" shadow as it orbits and of Earth's shadow relative to the moon
7. Encourage students to imitate the moon's titled orbit
8. Challenge the students to figure out when the daylight side of Earth ends up in the moon's shadow (where does the moon have to be in its tilted orbit, what phase does the moon need to be in; **they should observe that it needs to be in the NEW MOON phase.**).
9. Now see if they can figure out the alignment for a lunar eclipse as per the definition provided (**they should observe FULL MOON phase**).
10. Encourage students to figure out which alignment is a solar eclipse (as per the vocabulary definition) and then to draw a model of that alignment. They should record observations and their model in their notebook or in some form they can turn in.
11. **After doing the demo, students should be able to answer the question**: Can *everyone* on the daylight side of Earth observe a total solar eclipse when it occurs? Why or why not?

[[Answer: No; an eclipse WILL be visible on the daylight side, but not for everyone. The moon's shadow is much smaller than Earth, so only a portion of the daylight side will be in the moon's umbra, the darkest part of the moon's shadow]]

NOTE: Some students may perceive that you have to be on the nighttime side of Earth to witness an eclipse because "you only see the moon at night." If you get a lot of these responses, you may want to consider the moon phases lesson if you haven't already. For example, when the moon is relatively close to Earth, it can be seen during the day.

A short video clip to reinforce:.
"**WATCH: Shadow Of The Moon Crosses Earth During Solar Eclipse." The moon's shadow on Earth of the March 9, 2015, total solar eclipse as seen from geostationary satellites.**
http://www.npr.org/sections/thetwo-way/2016/03/11/470079890/watch-shadow-of-the-moon-crosses-earth-during-solar-eclipse

Activity #4: Drawing the three types of solar eclipses

In their class notebooks or on a separate piece of paper, students should draw and label models showing the three types of eclipses. It is important for students to show the relative alignment of Sun, Earth and moon in each scenario and the position of the moon's shadow. Also they should clearly delineate umbra and penumbra and understand that a total solar eclipse is observed by those in the umbra and a partial eclipse observed by those in the penumbra. You can also have students draw the alignment for annular solar eclipse, when the moon is relatively far from Earth and, though in eclipse alignment, its shadow does not reach Earth.

A useful guide for their drawing (textbooks will also have useful images). Image source: exploratorium.edu

Challenge Activity:
Use online data about the moon's orbit and moon phases to predict the next solar eclipse.
https://eclipse.gsfc.nasa.gov/SEhelp/moonorbit.html
Figure out how often solar eclipses happen (once a year, twice a year?). When will be the next total solar eclipse after the 2017 eclipse?
https://eclipse.gsfc.nasa.gov/solar.html

Reading activity:
Read about solar eclipses happening in other parts of the solar system:

Good websites:
http://education.gsfc.nasa.gov/ess/Units/Unit5/U5L09A.html

http://astro.wsu.edu/worthey/astro/html/lec-celestial-sph.html

STUDENT HANDOUTS:

Name :
Title :
Background information: moon's orbit and phases as seen from Earth….or list of what they should already know (moon phases)

Pre-lab-activity?

Learning Objectives: for this activity: Understand what an eclipse is; know the differences among total, partial and annular eclipses; explain why these eclipses don't happen every month; and explain why not everyone on Earth can view the eclipse.

Activity #1:Observing
Materials:
Tennis ball
Marble
Directions: ●

1. ● Place the tennis ball in your left hand
2. ● Hold the ball at arm's length in front of your face
3. ● With your right hand, hold the marble in front of the ball
4. ● Close your left eye and slowly move the marble toward your open, right eye.

1. Use words to describe what you observe, or draw and label a picture:

2. If the tennis ball represents the sun, the marble represents the moon, and you represent the Earth, use words to explain this phenomenon in terms of the sun, moon, and Earth.

Activity #2:

3. Draw a picture of the moon orbiting Earth, with the moon's orbit tilted from the plane of Earth's orbit. Then draw in where you think the moon's shadow will be (assume the sun is on the left side of your drawing):

4. When the moon is tilted above or below the plane of Earth's orbit, will the moon's shadow touch Earth? _____

Activity #3 : Modeling eclipses

5. Write down the definition of a **solar eclipse** your teacher provides:

6. Write down the definition of a **lunar eclipse** your teacher provides:

7. [Your teacher will provide directions for this lab activity.] After you do the lab activity, draw how your flashlight (sun), globe (Earth), and styrofoam ball (moon) were lined up in order to meet the definition of a **solar eclipse**:

What phase is the moon in when this occurs? _____

8. Now draw how your flashlight, globe and styrofoam ball were lined up in order to meet the definition of a **lunar eclipse**:

What phase is the moon in when this occurs? _____

9. INFERENCE: Can everyone on the daylight side of Earth observe a solar eclipse? Why or why not?

Activity #4: Drawing the three types of solar eclipses:

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Use the illustration your teacher gives you or your textbook to draw 1) how each type of eclipse would appear to an observer on Earth 2) how the sun, Earth and moon would be lined up (or aligned) for each type of eclipse and 3) Where the moon's umbra goes and where it's penumbra goes.

Want to know more? Visit these websites:

http://education.gsfc.nasa.gov/ess/Units/Unit5/U5L09A.html

http://astro.wsu.edu/worthey/astro/html/lec-celestial-sph.html

ANSWER KEYS:

Available upon request.

Email : eclipsemob2017@gmail.com

ASSESSMENT:

Coming soon...