

# Paper Plate Phases

## MODELING LUNAR CYCLES

### OVERVIEW —

Students use paper plates with various phases to create a three dimensional model of the lunar phases relative to the Earth and Sun, as both an assessment of their understanding and to continue to build a conceptual model through kinesthetic activities.

### OBJECTIVE —

The students will:

- Determine the position of each Moon phase with respect to the Earth and Sun.
- Create and observe a model of the Sun-Earth-Moon system from a variety of aspects.
- Use their observations of a 3D model to create a 2D diagram.

**Ages:** 5th grade – high school

**Duration:** 25 minutes

#### Materials:

For each group of 10 students

- A large open space
- A chair (preferably one that swivels)
- 8 paper plates
- Yellow and black markers
- 8 popsicle sticks
- Tape
- A large ball to represent the Sun

**BEFORE YOU START:** Do not introduce this topic unless the students already understand the cause of the Moon's phases and have done an individual activity modeling the phases.

Prepare the paper plates for this activity: use yellow and black markers to draw each of the 8 phases on the paper plates (yellow to denote the bright area and black for the dark regions). Tape a popsicle stick as a handle at the bottom of each plate.

### ACTIVITY —

1. Discuss the Moon phases with the students to remind them of what they have learned.
  - *What are the names of the phases?*
  - *What do they look like?*
  - *What causes the Moon to change phases?*
2. Explain to the students that they will build a new model of lunar phases, using paper plates to represent the different phases.
3. Divide the class into groups of 9 to 10 students. Designate an area for each group to conduct this activity, and place a chair at the center of that space.
4. Hand out the paper plate Moon phases to 8 of the students in each group. One other student will be the Earth and should sit in the chair (optional: the Earth can rotate in the chair). The remaining student will be the Sun and should stand holding the ball at a more distant location in the classroom. (Note: groups can all share the same "Sun.")



5. Ask each of the students holding a paper plate to examine it and determine which Moon phase that plate represents, and then walk to the correct spot relative to the Earth, Sun, and other Moon phases.
6. As the students arrange themselves out into a circle around the Earth, ask them to hold their plates so that the Earth can see them (facing Earth).
  - *Are the plates in the correct order?*
  - *Is the part of the Moon (paper plate) in the direction of the Sun bright or dark? (For instance, is the bright right half of the first quarter Moon plate closer to or further from the "Sun" compared to the dark left half of the plate?)*
  - *Do all of the students in the group agree that this is correct, or should someone move?*
7. Ask the students to trade roles so that each student in turn can be the "Earth" and spin around to observe the phases.
8. Invite the students to suggest how they could alter this model, and then proceed to make changes. (For example, students may reposition the "Sun" or the "Earth," or may have the Earth spin once for each day, altering which lunar phase is showing. Students may wish to add multiple phases for each crescent and gibbous phase.)
9. Ask the students to draw a 2-dimensional diagram of the Sun and Earth, with their last position for their lunar phase indicated in the diagram along with the name of that phase.



## EDUCATOR QUESTIONS —

To explicitly connect this activity to the science and engineering practices and the cross-cutting concepts, consider a class discussion around questions to review what the students did, their observations, and their conclusions:

- *What phenomenon does this model simulate? What are the limitations of this model?*  
(Answers regarding the phenomenon could include: the motions of the Moon, the Moon's phases, or the Earth-Moon system. Limitations include, but are not limited to: the model does not accurately reflect the scale of the Earth-Moon system, or the rotation of the Earth, and does not include the changing appearance of the Moon for all of the waxing and waning crescent and gibbous phases.)
- *What does your model demonstrate about the components of your system?*  
Students may have a variety of ways to express their thoughts on this complex relationship between models and this system. This model demonstrates that the Moon's position relative to the Earth and Sun is connected to the phases we see.
- *How does the pattern of lunar phases relate to the cause of lunar phases?*  
Students may have a variety of ways to express their thoughts. This model indicates that the Moon's position relative to the Sun, as seen from Earth, is connected to lunar phases; students may recognize that the Sun's light illuminates the parts of the Moon facing the Sun.

## EXTENSIONS —

1. Invite the students to examine their own phase and the one that is opposite them. *How are they related?* (The parts that are illuminated and dark are switched.)
2. Create enough Moon phases so that there are 30 to observe a full lunar cycle over each day of a month. (Images are available at <http://www.lpi.usra.edu/education/workshops/phasesSeasons/resources/moonPhases/MoonPhases.pdf> and could be printed and used instead of, or cut out and taped to, paper plates.) Assign a plate to each student, as they move into position around the “Earth” chair. Ask the students to hold up their plates one at a time, so that as the Earth spins, only one Moon phase is seen per “day.” Discuss this model with the students: *how does it succeed? What aspects of phases does this fail to model?*

## BACKGROUND —

This activity is intended as a formative assessment after some initial lunar phase activities have been conducted. This activity can demonstrate the students’ abilities to apply their understanding of lunar phases in a new way. Understanding the cause of lunar phases is a spatially complex topic that confuses many people. Instructors should take care not to rely exclusively upon two dimensional models and should require all students to model the phases themselves. Most activities can accidentally reinforce misconceptions if not done carefully.

Students with a thorough understanding of why we see lunar phases will (possibly after some practice) be able to take a lunar phase and position themselves correctly relative to the other phases and the “Earth” and “Sun.” The person holding the New Moon plate should be positioned between the Earth and Sun, facing the Earth. The student holding the Full Moon plate should be positioned on the far side of the Earth, relative to the Sun, again facing the Earth.

### Why do we see lunar phases?

The “amount” of Moon that we see as we look from Earth changes in a cycle that repeats about once a month (29.5 days). The relative positions of our Sun, Earth, and Moon, cause these changes. The side of the Moon facing the Sun is always illuminated, just like Earth’s daylight side is illuminated by the Sun. From our perspective on Earth, we see different parts of the Moon’s illuminated surface as the Moon orbits the Earth. Additional information is available at [http://www.lpi.usra.edu/education/skytellers/moon\\_phases/about.shtml](http://www.lpi.usra.edu/education/skytellers/moon_phases/about.shtml).



## ADDITIONAL RESOURCES —

### Space Place: The Moon's Phases in Oreos

<http://spaceplace.nasa.gov/oreo-moon/en/>

This article explains the monthly variations in the Moon's appearance as seen from Earth. Directions for using Oreo cookies to illustrate the four major phases of the Moon are provided. The article is targeted to children ages 10-12.

### Explore: Marvel Moon

Background: <http://www.lpi.usra.edu/education/explore/marvelMoon/background/>

Activities: <http://www.lpi.usra.edu/education/explore/marvelMoon/activities/>

This informal education program explores NASA's investigations into the ongoing saga that has shaped our Moon. Discover our scientific, cultural, and personal understanding of Earth's nearest natural neighbor.

## **Sustainable Trainer Engagement Program: Lunar Phases**

[http://www.lpi.usra.edu/education/step2012/participant/lunar\\_phases/](http://www.lpi.usra.edu/education/step2012/participant/lunar_phases/)

This website has activities and resources for teaching lunar phases to middle school students.

## **Moon Posters**

[http://www.lpi.usra.edu/education/moon\\_poster.shtml](http://www.lpi.usra.edu/education/moon_poster.shtml)

Three posters, designed for students in 6<sup>th</sup> through 9<sup>th</sup> grades, explore how the Moon formed and changed through time, spacecraft missions measuring different wavelengths of light reflected off the Moon's surface, and how we can use the available materials to support future lunar outposts.

## **Unknown Moon Institute**

<http://www.lpi.usra.edu/education/workshops/unknownMoon/agenda.html>

This website has a series of activities, data sets, and resources for high school classroom teachers, related to lunar exploration, lunar science, and lunar phases.

## ***TIES TO STANDARDS —***

### ***Next Generation Science Standards***

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

#### **Disciplinary Core Idea: 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. (MS-ESS1-1)

#### **Disciplinary Core Idea: ESS1.B: Earth and the Solar System**

- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2),(MS-ESS1-3)
- 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. (MS-ESS1-1)

#### **Science and Engineering Practices: Developing and Using Models**

- Develop and/or use models to describe and/or predict phenomena.

#### **Crosscutting Concepts: Patterns**

- Patterns can be used to identify cause-and-effect relationships. (MS-ESS1-1)

## ***Texas Science Standards***

### **8<sup>th</sup> grade Science Concept Standards (TEKS)**

- (7) Earth and space. The student knows the effects resulting from cyclical movements of the Sun, Earth, and Moon. The student is expected to:
- (B) demonstrate and predict the sequence of events in the lunar cycle.