ACTIVITY 25

Modeling Moon Phases

BROWARD COUNTY ELEMENTARY SCIENCE BENCHMARK PLAN

Grade 5—Quarter 3
Activity 25

SC.E.1.2.2
The student knows that the combination of Earth's movement and the Moon's own orbit around Earth results in the appearance of cyclical phases of the Moon.

SC.H.1.2.2
The student knows that a successful method to explore the natural world is to observe and record, and then analyze and communicate the results.

SC.H.1.2.3
The student knows that to work collaboratively, all team members should be free to reach, explain, and justify their own individual conclusions.

SC.H.1.2.4
The student knows that to compare and contrast observations and results is an essential skill in science.

SC.H.1.2.5
The student knows that a model of something is different from the real thing, but can be used to learn something about the real thing.

SC.H.2.2.1
The student knows that natural events are often predictable and logical.

ACTIVITY ASSESSMENT OPPORTUNITIES

The following suggestions are intended to help identify major concepts covered in the activity that may need extra reinforcement. The goal is to provide opportunities to assess student progress without creating the need for a separate, formal assessment session (or activity) for each of the 39 hands-on activities at your grade.

1. Ask the class why the title of this activity is "modeling" moon phases. (We used physical, mental, and drawn models of the moon, Earth and the Sun to help us understand moon phases.) Have the students list the objects that are involved in moon phases and whether or not each of these objects moves. (The Sun, the moon, and Earth; the Sun does not move, but Earth and the moon do.) Ask students to describe these motions. (Earth rotates on its axis while orbiting the Sun; the moon rotates on its axis as it orbits Earth.)

2. Use the Activity Sheet(s) to assess student understanding of the major concepts in the activity.

In addition to the above assessment suggestions, the questions in bold and tasks that students perform throughout the activity provide opportunities to identify areas that may require additional review before proceeding further with the activity.

ACTIVITY 25

Modeling Moon Phases

OBJECTIVES

To gain an understanding of why we see phases of the Moon from Earth, students will model the motions of the Moon in relation to Earth and the Sun.

The students

- model the orbit of the Moon around Earth
- learn how the orbit of the Moon results in the phases we observe from Earth

SCHEDULE

About 40 minutes

VOCABULARY

crescent
first quarter Moon
full Moon
gibbous
new Moon
phase
third quarter Moon

MATERIALS

For each student

1	Activity Sheet 25
1 pr	safety goggles*

For each team of four

1	ball, foam, large
1	ball, foam, small
1	globe
1	globe base
1	pencil, sharpened*

For the class

	bedsheets, to cover windows (optional)*
2	extension cords
1	globe, inflatable
2	light bulbs
2	light sources
	DSR *Earth, Moon, and Sun*

* provided by the teacher

PREPARATION

1. Make a copy of Activity Sheet 25 for each student.
2. You will need to be able to darken the room as much as possible for this activity. Collect bedsheets to cover windows, if necessary.
3. Just before beginning the activity, place one light source at the center of the room. The bulb should be slightly higher than the heads of the students. This usually can be accomplished by placing the light source on a chair and the chair on a desk.

BACKGROUND INFORMATION

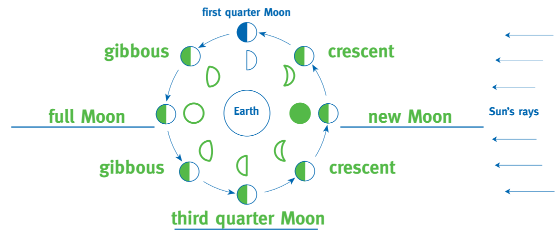
Because different portions of the Moon are illuminated by the Sun at different times during the Moon's orbit around Earth, the Moon changes in appearance. We call these various changes in appearance the ***phases*** of the Moon.

When the illuminated side of the Moon is facing away from Earth, we call the phase the ***new Moon.*** Just before or just after the new Moon, we see the ***crescent*** phase. Next, the Moon enters the ***first quarter Moon*** phase, when one-half of the disk appears to be illuminated. (Actually, one-half of the disk is equal to one-quarter of the sphere—hence the phase name.) When the entire Moon appears illuminated, the phase is called the ***full Moon.*** Just before and just after a full Moon, the illuminated portion is shaped like an upended football and is in the ***gibbous*** (GIB-us) phase. Finally, the Moon enters the ***third quarter Moon*** phase, when the opposite half of its disk appears to be lit.

▼ **Activity Sheet 25**

Modeling Moon Phases

1. Label the four major phases of the Moon. On the outer ring of Moons, shade the side of the Moon that is dark during each phase. Then, next to each Moon, draw the shape of the Moon as it appears from Earth. (The first quarter Moon is completed for you.)



2. Draw and label the actual illumination and the apparent shape of the two crescent phases of the Moon.
3. Draw and label the actual illumination and the apparent shape of the two gibbous phases of the Moon.

Guiding the Activity

1 Remind students that the Moon orbits around Earth approximately once a month. Earth, in turn, orbits around the Sun once a year. As Earth and the Moon move, their positions relative to each other and to the Sun change. The changes in position are linked to two notable events—the apparent changes observed in the Moon's shape each month and the changes in seasons we experience on Earth (Activities 28 and 29).

As appropriate, read or review pages 14 and 15 from the Delta Science Reader *Earth, Moon, and Sun*.

Begin by arranging the entire class in a semicircle facing the light source. Using a pencil, poke a hole into the top or bottom of a large foam ball. Push the pencil into the hole to create a "handle" for the foam ball.

Additional Information

Guiding the Activity

Additional Information

Explain that the light source represents the Sun and the foam ball, the Moon.

Remind students that the sizes and distances they will use in this model are not to scale.

Point out to students that the real Moon does not produce any light of its own; it simply reflects the light of the Sun. Explain that, accordingly, the side of the Moon model facing the light source (Sun) is brightly illuminated, while the other side is dark.

Write *phase* on the board. Then darken the room and hold the Moon in front of the light source and ask students from various parts of the semicircle, **How much of the Moon appears to be lit?**

Students from various parts of the semicircle should answer differently, since they are viewing the Moon from different angles. Remind them that although they can see only part of the illuminated side of the Moon, one-half of the Moon always is illuminated—except during lunar eclipses.

Explain that the **phases** of the Moon are apparent differences in the shape of the Moon as a result of changes in the amount of light that is reflected toward us as we view the Moon. This patch of light changes in a predictable pattern as the Moon orbits around Earth, and so we are able to call the various appearances of the Moon "phases."

2 Hold the inflatable globe so that it faces the dark side of the Moon model. Ask, **If you were standing on the Earth globe, how would the Moon appear to you?**

Students may realize that, from the vantage point of the globe, an observer would be looking at the dark side of the Moon model.

Explain that when Earth, Moon, and Sun are aligned this way in the real sky, the side of the Moon facing Earth is dark and it is impossible for us to see the Moon in the sky at that time.

Ask, **When the Moon cannot be seen in the sky from anywhere on Earth, what Moon phase is occurring?**

Students may know that this phase of the Moon is called the ***new Moon.*** *This phase is traditionally considered the beginning of the monthly lunar cycle, hence the name. Since the Earth rotates much more quickly than the Moon orbits the Earth, people everywhere on Earth see the same phase during any one day.*

Write *new Moon* on the board.

Guiding the Activity

Additional Information

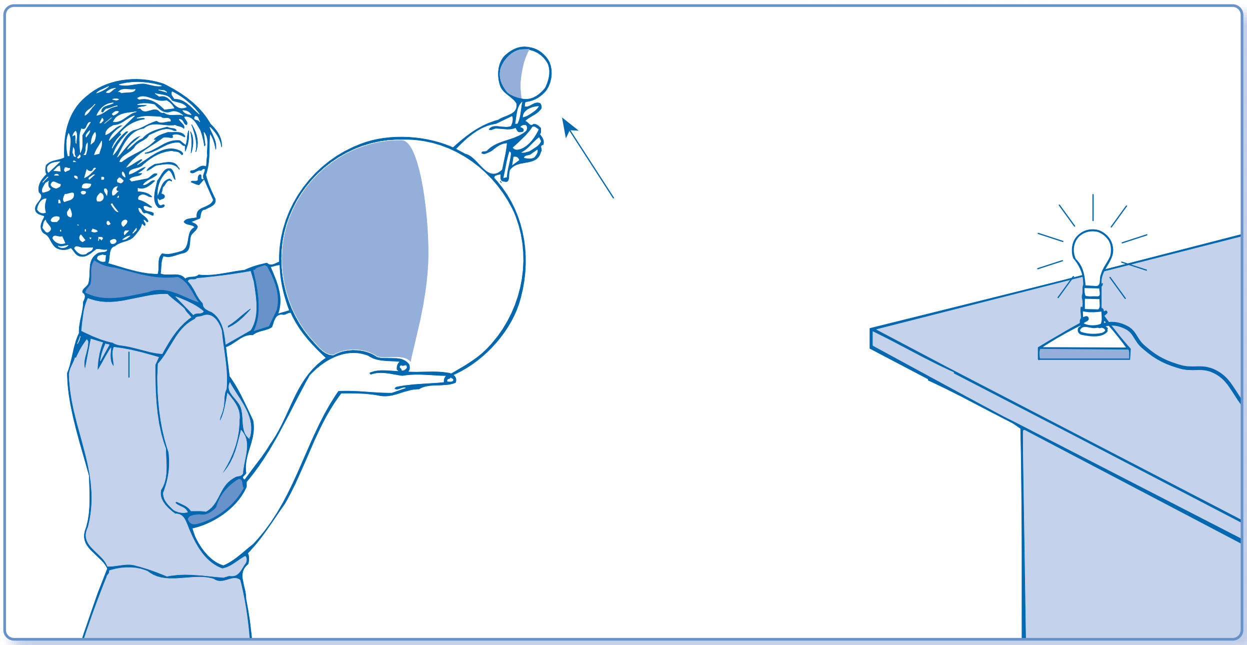
Demonstrate a quarter Moon. Move the Moon one-quarter of the way around Earth in a counterclockwise direction until it looks like Figure 25-1, as seen from the vantage point of Earth.

Explain that one-quarter of the Moon is now visible from our vantage point on Earth. The Moon also has traveled one-quarter of the way in its orbit around Earth.

Ask, **When the Moon looks like this from everywhere on Earth, which phase is it in?**

*Students may know that this phase is called a quarter Moon. This is actually the **first quarter Moon.** Students might respond that this is a half Moon, a common name arising from the fact that the side of the Moon facing the Earth is half-illuminated. While this is in fact true, students should be led to the conclusion that quarter Moon is a more appropriate name because during this phase only one-quarter of the Moon's entire surface is visible from Earth.*

Write *first quarter Moon* on the board.



▲ ***Figure 25-1.*** *Modeling the first quarter.*

Next, move so that the globe is between the light source and the Moon and the students are facing the illuminated side of the Moon.

You will have to move the Moon slightly above or below the inflatable globe so that the light is not blocked.

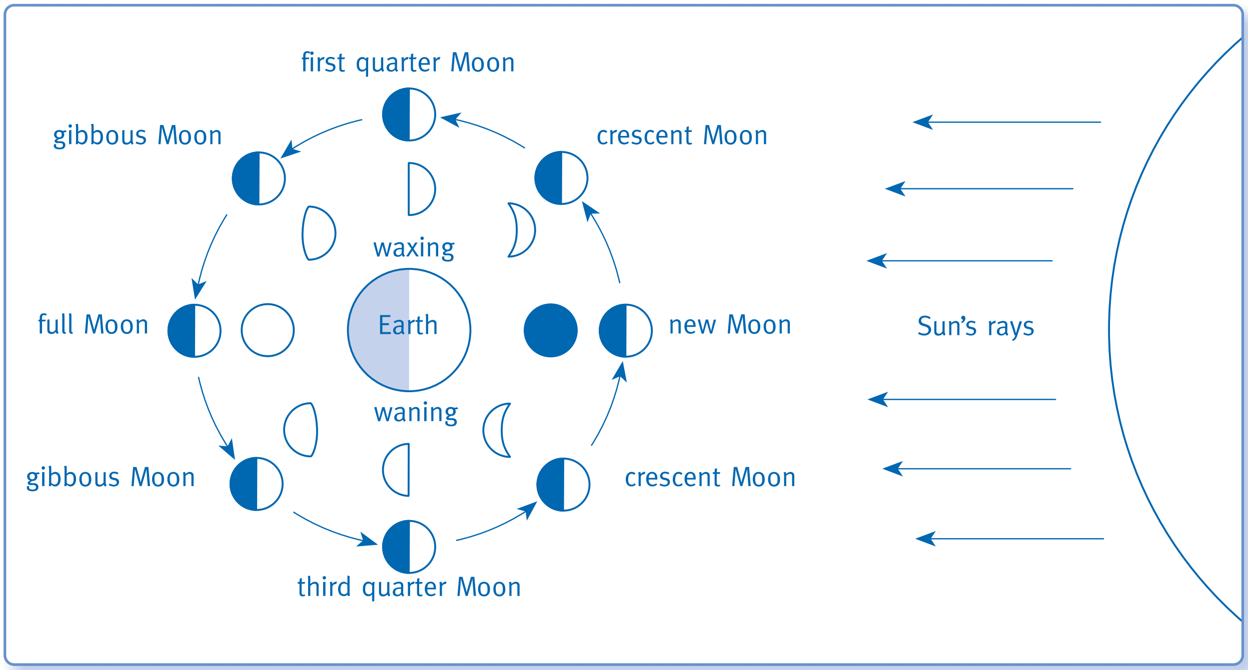
Guiding the Activity

Additional Information

Ask, **When the Moon looks like this from everywhere on Earth, which phase is it in?**

Students may know that a fully illuminated Moon is called a ***full Moon.***

Write *full Moon* on the board.



▲ ***Figure 25-2.*** *Phases of the Moon. The outer circle of Moons shows their actual illumination throughout the month. The inner circle shows their shapes as seen from Earth.*

Now move the Moon one additional quarter of the way around Earth to the third quarter position.

Ask, **Which phase is the Moon in now?**

Students may respond that the Moon is in a quarter phase again. Explain that this is correct. However, something has changed.

Ask, **What is the difference between the two quarters demonstrated?**

Write *third quarter Moon* on the board.

Students may notice that the illuminated portion of the Moon has reversed. Demonstrate a first quarter Moon and explain that this quarter phase occurs first in the lunar cycle and is called first quarter. Then model a ***third quarter Moon*** *and explain that it occurs three-quarters of the way through the lunar cycle and, therefore, is called the third quarter.*

Explain that this entire cycle takes approximately one month—the lunar cycle. (See Figure 25-2.) In fact, the word *month* is derived from an old Germanic word for Moon.

Guiding the Activity

Additional Information

3 Students will now create the phases of the Moon for themselves. Set up the second light source in another part of the room. The light sources both should be on level surfaces, such as desktops. Each student will need a copy of **Activity Sheet 25**. To each team, distribute a globe, a globe base, and a small foam ball to act as the Moon. Arrange the teams around the two light sources, allowing as much space as possible between teams. Tell students to demonstrate the counterclockwise motion of the Moon around Earth with their models.

Move from team to team to verify that students understand that the Moon orbits Earth and that Earth orbits the Sun in a counterclockwise direction. Otherwise, the models will not produce lunar phases in the order they actually occur.

Ask students to demonstrate the position of the Earth, Moon, and Sun that results in a particular phase. Show them how to lower their heads to the level of the model Earth so that they can see how the Moon appears to someone standing on Earth. As students place the model in the four positions, they should shade and label the associated lunar phases on their activity sheets.

Circulate among teams, checking and encouraging their understanding of the correct positioning of Earth and the Moon to create the four main phases of the Moon.

4 Distribute a sharpened pencil and large foam ball to each group. Arrange the students in each group in a circle around the light source. Have students push the pointed ends of the pencils into the balls.

Explain that in this model, their heads will be Earth and their foam balls, the Moon. Ask, **Are the Moon and Earth actually this size relative to each other? Are the distances between them to scale in this model?**

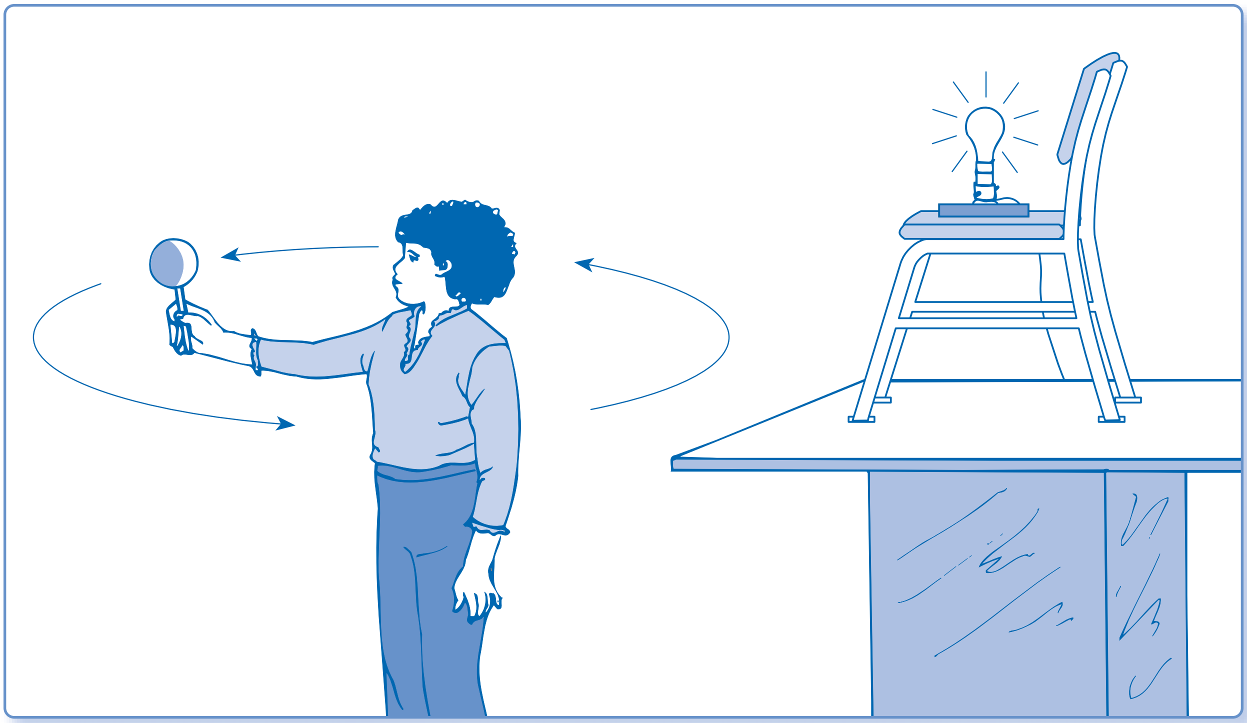
Students should recognize that sizes and distances in this model are not to scale.

Have students hold the spheres at arm's length in front of them while they are facing the light source. If they move their spheres slightly to one side or the other, a thin crescent of light will appear on their spheres.

Write *crescent* on the board. Explain that this phase, just before or after a new Moon, is called the **crescent** phase. Have students draw and label the crescent phases of the Moon on their activity sheets.

Guiding the Activity

Additional Information



▲ ***Figure 25-3.*** *Modeling lunar phases from the student's viewpoint.*

Starting with their foam balls directly in front of them, the students should begin to rotate counterclockwise holding the foam balls slightly above their heads. (See Figure 25-3.) By doing so, they are modeling the motion of the Moon around Earth. Have students stop when their spheres are completely illuminated.

Students will have to hold the sphere slightly above the shadow of their heads.

Ask, **What can you see on your spheres? Which phase is this?**

Students should be able to identify this position as the fully illuminated Moon, or full Moon.

Ask, **What is the position of the Earth, Moon and Sun relative to one another at this point?**

Earth (their head) is between the Sun (light source) and Moon (foam ball).

Next, tell students to move just slightly, so that the illuminated part of the Moon looks like an upended football. Write *gibbous* on the board. Explain that when the Moon looks like this, either before or after a full Moon, it is called the **gibbous** (JIB-us) phase. Have students draw and label the gibbous phases of the Moon on their activity sheets.

Guiding the Activity

Additional Information

Have them continue the motions, stopping at each phase of the Moon to identify and discuss it. Explain that the Moon does not pass directly between the Sun and Earth each month.

This is so because the Moon's orbit is slightly tipped relative to Earth. Also, be sure that the students understand that the shadows being cast by Earth and the Moon on each other have nothing to do with phases. Shadows actually are the cause of eclipses.

REINFORCEMENT

Have students observe the moon every night for one week and compare what they see to their drawings on Activity Sheet 25. Which phase was the Moon in when they began their observations? Which phases did it pass through as they continued to observe? Which phase will come next?

SCIENCE NOTEBOOKS

Have students place their completed activity sheets in their science notebooks.

CLEANUP

Have students remove the pencils from the foam balls. Return all materials to the kit.

Connections

Science and the Arts

Display a reproduction of Vincent Van Gogh's *Starry Night* for the class to view. Which phase does Van Gogh's Moon probably represent? How should the Moon be shaped to be more scientifically accurate? Why might Van Gogh have chosen to paint the Moon as he did rather than as it really appears? How did Van Gogh use color to create the effect of illumination in the night sky?

Science and Careers

Astronaut is the career associated with exploration of the Moon, but in actuality, thousands of jobs exist on the ground for every one astronaut in space. There are aeronautical engineers, special-clothing designers, nutritionists, mechanics, building contractors, computer specialists, publicists, political lobbyists, manufacturers, accountants, trainers, astronomers, medical technicians, clerks, weather forecasters, purchasing agents, and many more workers who support satellite launches and space exploration.

Have students discuss how a knowledge of Earth science and astronomy might help them gain one of the positions that support work in space. For instance, a scientifically knowledgeable publicist would be better able to write press releases and make statements to reporters about the activities of NASA than one who is merely a good writer.

Science and Language Arts

What emotions does Walt Whitman express when he writes in *Song of Myself:*

> This day before dawn I ascended a hill and look'd at the crowded heaven,
>
> And I said to my spirit *When we become the enfolders of those orbs, and the pleasure and knowledge of every thing in them, shall we be fill'd and satisfied then?*
>
> And my spirit said *No, we but level that lift to pass and continue beyond . . . ?*

Ask each student to find a particular poem that describes his or her feelings when looking at the sky or considering the heavens. Students may use the index of titles or of first lines in a poetry anthology to lead them to poems that express their sentiments.

Science and Math

Some early peoples based their calendars on the lunar cycle of 29.5 days. But the cycle of seasons, based on the Earth's motion around the Sun, takes 365.25 days. Have students plot the lunar cycle as a wave function on graph paper. The x-axis should indicate the number of days, and the y-axis, the proportion of the Moon that reflects toward Earth. A full Moon, for example, could have a y-value of 1; a half Moon, 0; and a new Moon, –1. Plot at least 65 months.

Then have students plot the solar year, with winter solstice equaling 1; the equinoxes, 0; and the summer solstice, –1, on the y-axis. As in the lunar cycle,the x-axis tracks the days. Plot at least 5 years.

Lay the graphs over each other so that their starting points are the same, and then hold them up to light. How many solar cycles (years) does it take before the two functions meet again at the y-axis? How many lunar cycles (months) occur during that time? Can students write functions in terms of x and y that will describe the two equations? When they solve the two equations for $y = 0$, do they get the same answer as they obtained by inspecting the graph?