MOON ON A STICK

PRIMARY CONTENT
• Understanding the phases of the moon
• Predicting the next lunar phase in a sequence

PRIOR STUDENT KNOWLEDGE
Knowledge that the moon is only a reflector, not a producer, of light and that the moon is visible only as a result of sunlight reflected off its surface

PRE-ACTIVITY PREPARATION
1. Obtain for each group a white plastic foam ball, about 2.5 cm–5 cm (1 in.–2 in.) in diameter. Plastic foam balls are available at most hobby and craft supply stores.
2. Copy reproducibles Moon Phases (page 166) and Moon-Phase Prediction Sheet (page 167), one copy of each per student.

PROCESS SKILLS
Observing, comparing, classifying, inferring, predicting, recording data, experimenting

GROUP SIZE
2 students

MATERIALS PER GROUP
• 1 black broad-tip marker
• 1 white plastic foam ball
• 1 sharpened pencil
• 1 copy of reproducible Moon Phases for each student
• 1 copy of reproducible Moon-Phase Prediction Sheet for each student

TEACHER INFORMATION
It takes $29\frac{1}{2}$ solar days for the moon to make one complete revolution around the earth. Although one half of the moon (the half facing the sun) is always illuminated by the sun's reflected light, the lighted portion of the moon appears to change shape (as viewed from earth) during revolution. This is due to changes in the relative positions of the earth, the sun, and the moon during lunar revolution. These changes in the moon's appearance are called phases. During the first half of the moon's orbit, the moon's apparent shape grows (waxes) through the following phases: new-moon phase (not visible); waxing-crescent phase (right side visible as a crescent moon); first-quarter phase (right side visible as a half moon); waxing-gibbous phase (right side visible as a three-fourths moon); and full-moon phase (visible as a full round circle). During the remaining half of the lunar orbit, the shape of the moon appears to decrease (wane) in size. After a full-moon phase, the moon's shape progresses through the following phases: waning-gibbous phase (left side visible as a three-fourths moon); third-quarter phase (left side visible as a half moon); waning-crescent phase (left side visible as a crescent moon); and then back again to the new-moon phase to start another cycle.

The moon revolves around the earth in a counterclockwise direction (as viewed looking downward onto the North Pole of the earth). Therefore, during the waxing (growing) phases, the right side of the moon is illuminated. As the moon progresses through its waning phases, it is the moon's left side that is illuminated.
PROCEDURE

1. If necessary, review with students the concept of producers and reflectors of light. Also review the fact that the sun, like other stars, is a light producer; other celestial bodies, including earth's moon, are primarily reflectors of light.

2. Discuss how the moon orbits the earth at the same time that the earth orbits the sun. Draw a diagram depicting such on the chalkboard (see Figure 1).

3. Generate discussion about the moon with questions such as:
   - Does the moon always appear to be the same shape?
   - How would you describe the different shapes of the moon that you have seen?
   - Do the shape and size of the moon actually change?
   - Why does the moon appear to change in shape?

4. Use the last question to introduce the concept of lunar phases. Tell students that lunar phases refer to different positions of the moon in its orbit in relation to the earth and the sun. Indicate that one half of the moon is always illuminated by sunlight (except during lunar eclipses). At differing moon-earth-sun orientations, however, we on earth see differing amounts of the moon's lighted side.

5. Tell students that since a verbal explanation of phases is difficult to grasp, in today's activity they will be modeling lunar motion to actually see why phases occur.

6. Group students and distribute materials except the Moon-Phase Prediction Sheet. First have students note the moon-phase illustrations at the top of the reproducible Moon Phases. These show the shape of the moon (actually the shape of the lighted lunar surface as seen from earth) at the eight lunar phases. The name of each phase is indicated below its illustration.

7. Instruct each group to use the black marker to darken half of the plastic foam ball. The more perfectly they can divide the sphere into exact halves, the better. Also, the blacker they can make the dark half, the better.

8. Have groups each make a holder for their model by forcing a sharp pencil into the ball at any point on the black/white boundary (see Figure 2).

9. While students work on their moons, draw and label a large sun on the chalkboard.

10. Explain to groups that in all their lunar-motion models, the sun is represented by the drawing on the chalkboard. The plastic foam ball is the moon, with one side lighted by the sun (the white half) and the other side in black shadow (the dark half). The student in each pair not holding the moon on a stick represents the earth.

11. Select two students to demonstrate the procedure for the rest of the students.

Earth Science Activities (KSAM)
12. One student is to stand and face the sun on the chalkboard. This student is the earth. The second student is to hold the moon model in a line directly between the earth and the sun so that the white half of the moon directly faces the sun. The moon model should be roughly 1 m (3 ft) from the earth. This is position 1 as shown on the reproducible Moon Phases and in Figure 3 (shown after step 16). Earth is to look at the moon and observe how much of the lighted side is seen—in other words, what the moon would look like in this particular earth-moon-sun position.

13. The moon holder is then to walk slowly in a counterclockwise orbit around the earth, pausing at each position indicated on the reproducible. It is critical that the lighted half of the moon model always be kept directly facing the sun throughout the entire lunar orbit. Really stress this! Students have a tendency as they orbit not to rotate the model to keep the white side facing the sun.

14. As the moon orbits, earth is to turn as necessary to keep his/her gaze on the moon. In doing so, earth will be able to see all the phases of the moon (as well as the transitional shapes of the moon between phases) as the moon makes a complete orbit. Students really enjoy this!

15. Although you need not have this demonstrated, the two students should then change positions and repeat the process.

16. Inform the class that after both students in each pair have observed a full lunar cycle, the process should be repeated again for each student. On this second time through, pauses at the indicated positions should be a little longer so that the earth (with reproducible in hand) can draw the moon’s appearance and record the name of the phase at each position. (For your quick reference, moon appearances at each position are included in Figure 3.)

17. Set the students to work. Circulate as the modeling is going on to make sure that all moons are revolving counterclockwise and that their lighted sides remain facing the sun.

18. When groups have finished, discuss results and appropriate responses on the reproducible Moon Phases (see Answer Key on page 196). Also explain the terms waxing and waning and explain how one can know whether the moon is waxing or waning just by observing which side, left or right, is illuminated (see Teacher Information).

19. To check student comprehension of phases, distribute a Moon-Phase Prediction Sheet to each student. It consists of ten different lunar sequences. Each sequence shows anywhere from 1 to 3 moons in different phases. Students are each to draw in the appropriate missing phase or phases in each sequence. They are then to label the sequence as Waxing, Waning, or Waxing and Waning. All sequences should be read left to right.

20. (Optional) Allow students to use their models, if necessary, to complete any sequence of which they are unsure.

21. Review with students the correct sequence responses (see Answer Key on page 197).

EXTENSIONS AND ADAPTATIONS

1. Collect from magazines pictures of the moon in differing phases and have students identify the phases. Also see if students can predict the next phase based on a single picture.

2. Have students observe the moon for a specified number of nights and report on the phases observed.

MOON ON A STICK

MOON PHASES

Name

Directions: The first illustration above shows the appearance and name of each of the moon's eight phases. The second illustration shows the position of the moon at its eight different phases relative to the earth and the sun. These are the eight positions you should pause at as you model lunar phases with your Moon on a Stick.

In the table below, draw a picture of the moon's appearance at each of the eight positions. Then, using the above illustrations, record the name of the phase that the moon is in at each position. This way, you will learn the names of the moon's phases, what the moon looks like at each phase, and how the moon, earth, and sun are positioned at each phase.

<table>
<thead>
<tr>
<th>Moon Position</th>
<th>Moon's Appearance</th>
<th>Phase Name</th>
<th>Moon Position</th>
<th>Moon's Appearance</th>
<th>Phase Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MOON PHASE PREDICTION SHEET

Name

Directions: Following are ten moon-phase sequences. Read each sequence from left to right. Each sequence has one, two, or three missing moon phases. For each sequence, figure out which phase or phases are missing and draw them in. On the provided lines, label each sequence as Waxing, Waning, or Waxing and Waning.