5 The Moon's Orbit

MODELING

Most diagrams and models of the Moon's orbit around Earth are two-dimensional, or flat. In these diagrams, it looks like we should see a solar eclipse and a lunar eclipse every month. A **solar eclipse** is when the Moon passes directly between Earth and the Sun, causing some places on Earth to experience darkness during daytime. A **lunar eclipse** is when the Moon passes into Earth's shadow, and people on Earth see the Moon darken even though it is a full moon. In reality, there are an average of four eclipses every year. So why are two-dimensional images and models of the Sun–Earth–Moon system inaccurate? In this activity, you will use a three-dimensional model to investigate this question.

GUIDING QUESTION

Why don't we see lunar and solar eclipses more often?

A time-lapse photograph of the solar eclipse that occurred on August 21, 2017.

A time-lapse photograph of the lunar eclipse that occurred on April 14, 2015.

MATERIALS

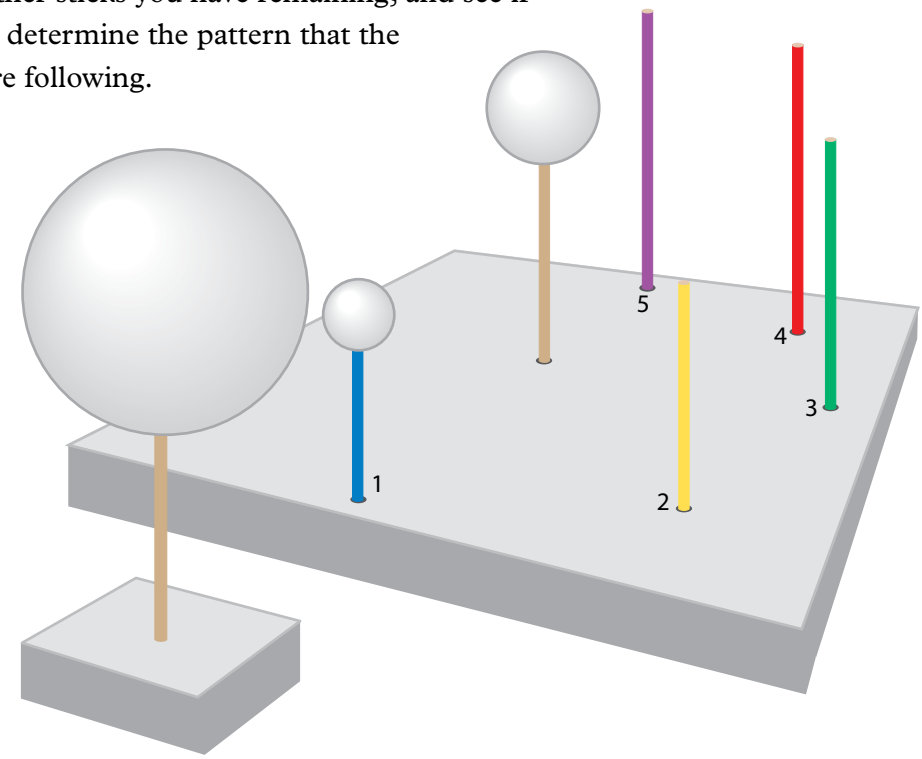
For each group of four students

- 1 Earth model: a medium white foam ball attached to a stick
- 1 Sun model: a large white foam ball attached to a stick
- 1 Moon model: a small white foam ball with a hole in it
- 1 blue stick
- 2 yellow sticks
- 2 green sticks
- 2 red sticks
- 1 purple stick
- 1 foam board with an Earth and Moon positions template attached
- 1 piece of foam with a Sun position template attached
- 1 blank sheet of paper
- 1 marker

PROCEDURE

Part A: Completing One Orbit

1. Set up Earth and the Sun as instructed by your teacher.
2. Place the blue stick in position #1, and add the Moon to the top of the stick. Discuss with your group which moon phase you would see from Earth. Record your ideas in your science notebook.
3. Place a yellow stick in position #2, a green stick in position #3, a red stick in position #4, and a purple stick in position #5. Look at the other sticks you have remaining, and see if you can determine the pattern that the sticks are following.



4. Decide with your group which stick should go in which remaining position. Place the sticks in those positions.
5. Move the Moon ball from stick to stick, making sure to observe the height of the Moon compared with Earth and the Sun. Discuss with your group what the Moon's phase is at each position. Record your observations in your science notebook.
6. Move the Moon ball to the stick in the position it needs to be in for there to be a full moon, and discuss whether there would be a lunar eclipse.

   Note: Lunar eclipses can only happen during a full moon.

Part B: The Orbital Plane

7. Remove Earth, the Moon, and the Sun from your model, but leave the sticks in their positions.
8. Have one member of your group hold a piece of paper so that it touches the top of each stick. This piece of paper is a model of the Moon's **orbital plane**, the flat two-dimensional plane where the Moon is at any point in its orbit. Notice how the Moon's orbital plane is tilted relative to the line between Earth and the Sun.
9. Have a different member of your group use a marker to put a dot where each stick touches the modeled orbital plane.
10. Add a dot in the center of your drawing and label it "Earth."
11. At one end of your paper, add arrows that represent light coming from the Sun toward Earth and the Moon.
12. Looking at where you added the sunlight and where Earth is located, discuss where the different phases of the Moon would occur.
13. As a group, label each dot with which phase of the Moon it represents.
14. Keep your model set up as you work on the Analysis.

ANALYSIS

1. The Moon takes about 29 days to orbit Earth. In this activity, there were eight positions the Moon could be in.
   a. How many days would it take for the Moon to get from position #2 to position #4 in its orbit?
   b. What phases would the Moon go through as it traveled from position #2 to position #4?
2. In Step 9, you created a two-dimensional drawing of the Moon's orbit. What information about the Moon's orbit is missing from the two-dimensional drawing?
3. There are two points during the Moon's orbit around Earth when the Moon, Earth, and Sun are all in the same plane. In your model, this is represented when the Moon is on the green stick such that the Moon, Earth, and Sun are all at the same height.
   a. If the Moon is on the green stick in position #6, in what phase is the Moon? Draw what that phase looks like, and explain why it looks that way.
   b. If the Moon is on the green stick in position #1, in what phase is the Moon? Explain what people on Earth would observe.
   c. When the green stick is in position #1, what color stick should be in position #5? Explain.
4. **Reflection**: How have your ideas about the reason for the phases of the Moon changed since you began this unit?

EXTENSION

Visit the *SEPUP Third Edition Solar System and Beyond* page of the SEPUP website at **www.sepuplhs.org/middle/third-edition** for more information about solar and lunar eclipses.