ACTIVITY 2

Earth Orbits the Sun

OBJECTIVES

Students model and demonstrate an orbiting satellite. They learn that the gravitational force between the Sun and its satellites creates the planetary orbits.

The students

- explore the concept of *satellite*
- build and manipulate a model satellite system
- relate the concept of *gravity* to the orbits of satellites

SCHEDULE

About 40 minutes

VOCABULARY

force
gravitational attraction
gravity
mass
moon
orbit
satellite

MATERIALS

For each student

1	Activity Sheet 2
	safety goggles*

For each team of two

1	ball, foam, drilled
1	tube, plastic
1	washer

For the class

2	balls, foam, drilled
1 spool	fishing line
1 pair	scissors*
1	tube, plastic
1	washer

*provided by the teacher

PREPARATION

1. Make a copy of Activity Sheet 2 for each student.
2. Cut a 1-m (about 3-ft) length of fishing line for each team of two and another for your demonstration model.
3. **Satellite System Model Setup:** Construct one demonstration model.
   - Tie one end of a 1-m length of fishing line to the washer.
   - Thread the other end of the line through the plastic tube and then through the hole in the ball. Tie this end around the ball as shown in Figure 2-1.
   - Grasping the plastic tube as shown in the figure, raise your fist above your head and move it in small circles so that the ball swings around your fist. The ball represents a satellite in orbit.
4. Each team of two will need a foam ball, a washer, a plastic tube, and a 1-m length of fishing line.

BACKGROUND INFORMATION

An object that travels around a larger object in space is called a ***satellite.*** All the planets in our Solar System are satellites of our Sun. A ***moon*** is a satellite of a planet. Earth's Moon is one of many satellite moons in the Solar System.

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A ***force*** is a push or a pull on an object. ***Gravity*** is an attractive force that exists between objects.

The ***mass*** of an object is a measure of how much material it contains. All objects have mass. The magnitude of the force of attraction between two objects depends on the mass of both objects and the distance between them. The greater the combined mass of the two objects, the greater the force of attraction between them. The greater the distance between the two objects, the lesser the force of attraction between them.

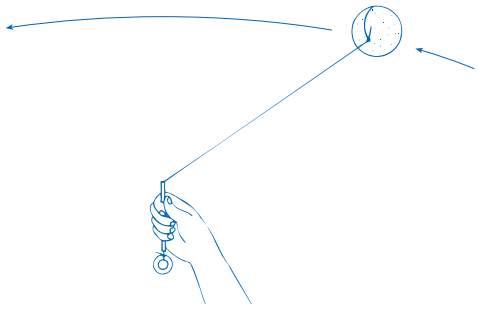
This force of attraction is what keeps the planets in ***orbit*** around the Sun. It is also what keeps moons and all smaller satellites in orbit around the planets.

The shape of a satellite's orbit is determined by the ***gravitational attraction*** between it and the object it is orbiting and, to a lesser degree, by the force of attraction (the gravitational force). Slight changes to the orbit are caused by gravitational attraction between the satellite and other nearby bodies.

▼ **Activity Sheet 2**

Earth Orbits the Sun

1. Make a satellite system model like the one shown below.
   - Tie one end of the fishing line to the washer.
   - Thread the other end of the line through the tube and then through the hole in the ball. Tie this end around the ball.
   - Hold the washer next to the bottom of the tube. Raise your fist above your head and begin rotating your fist so that the ball circles your fist.

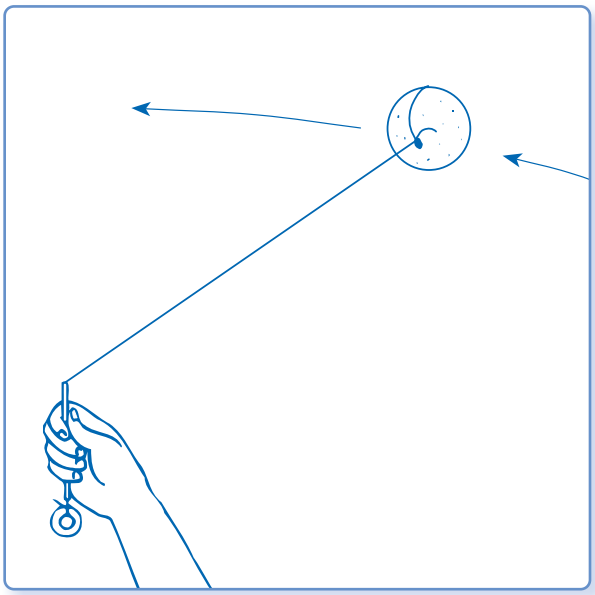


2. What is the satellite in this model? the ball
3. What is the satellite orbiting? my fist
4. Imagine that this is a model of our Solar System.
   a. What object is represented by your fist? the Sun
   b. What object is represented by the ball? a planet

Guiding the Activity

1 Demonstrate the satellite system model to the class. Hold the tube above your head and move your fist so that the ball swings in a circle (see Figure 2-1).

Additional Information



▲ *Figure 2-1. A satellite model.*

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Guiding the Activity

	Additional Information
Ask, **What is the ball doing? What is the ball traveling around?**	*Responses will vary, but encourage those that mention that the ball is moving in a circle and that it is traveling around your fist.*
Write the word *mass* on the board. Tell students that the **mass** of an object is a measure of how much material it contains.	
Write the words *satellite* and *orbit* on the board. Tell students that a **satellite** is an object that travels around a larger object and that an **orbit** is the path the satellite takes as it moves around that object.	
Explain that the term *orbit* is also used as a verb meaning "to travel the path of the orbit."	
Ask, **In this model, what is the satellite?**	*the ball*
Ask, **What is the ball orbiting? What is the shape of the orbit?**	*The ball is traveling around your fist in a circular orbit.*
2 Remind students that a solar system is made up of a star and the objects that travel around it. Ask, **Knowing what you know about our Solar System, what does my fist represent?**	*the Sun*
Ask, **If my fist is the Sun, what is the name of one object that the ball could represent?**	*The name of any planet would be a correct response.*
Explain that all the planets are satellites because they all travel around, or orbit, the Sun.	*Asteroids, meteoroids, and comets are other types of satellites and will be discussed in a later activity.*
Ask, **Can you think of another type of satellite—one that orbits Earth?**	*Most students will name the Moon, though many will know that artificial satellites also orbit Earth.*
Write *moon* on the board and explain that a **moon** is a satellite that orbits a planet. Our Moon is a satellite of Earth. Also in orbit around Earth are a number of artificial satellites used for communication, weather reporting, and space observation.	

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Guiding the Activity

	Additional Information
3 Give a copy of **Activity Sheet 2** and a pair of safety goggles to each student. Distribute a foam ball, a washer, a plastic tube, and a 1-m length of fishing line to each team.	
Tell students to build and operate the satellite model system and then complete Activity Sheet 2.	***Safety Note:*** *Tell students to wear their safety goggles when operating the satellite model system.*
	Offer help as needed in building the models.
4 When all students have completed the activity sheet, ask, **What keeps the ball from flying off across the room when you spin it around?**	*the string*
What do you think keeps Earth and the other planets from flying off into space away from the Sun?	*Accept all reasonable answers.*
Write the terms *force, gravity,* and *gravitational attraction* on the board. Introduce the terms by explaining that **force** is a push or a pull on an object. **Gravity** is a force that exists between objects.	
The force of gravity causes objects to be attracted to one another. This is called **gravitational attraction.**	
The gravitational attraction between the Sun and the planets keeps them from flying off into space.	
Explain that the amount of gravity depends on the masses of the objects and their distance. The greater the combined mass, the stronger the force of gravity. The farther away the objects are from one another, the weaker the force of gravity.	
5 Hold a foam ball at shoulder level and let it fall to the floor. Ask, **What happened to the ball? Why?**	*Students may suggest that gravity caused the ball to fall straight down to the floor.*

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Guiding the Activity

Explain to students that gravity acts between these two objects—the ball and Earth—just as it acts between the Sun and Earth. There is a gravitational attraction between them.

Ask, **What effect does Earth's gravity have on your body?**

Additional Information

Students may say that gravity keeps them on the ground or that it keeps them from flying off into space.

Reinforcement

Encourage students to create other satellite models using different materials. Have them identify the objects in their model and verify that one is in fact a satellite of the other.

Science Journals

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

Cleanup

Have students return the intact satellite system models to the kit. Return the demonstration model you made as well. Unused fishing line should be replaced in the kit.

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Connections

Science Extension

▶ Ask the "Mercury" team to report additional information they have found and to record Mercury's data on the class master chart.

Additional Facts about Mercury

Volume (Earth = 1): 0.056

Mass (Earth = 1): 0.055

Density (water = 1): 5.43

Surface temperature: –292°F to +800°F (–180°C to +425°C)

Composition: iron and nickel core, rocky mantle

Distinctive features: surface is pitted with impact craters, like surface of Earth's Moon

▶ Find a large drawing or photograph of the Moon with its features labeled, and make a photocopy for each student. Ask students to look at the Moon when it is full or close to full and find as many of the features as they can. Encourage them to use binoculars or telescopes if they have access to them. (*Note:* You may want to include this activity when the class observes the night sky as suggested in the second Science Extension connection for Activity 12.)

Science and Language Arts

Challenge students to list as many song titles and lyrics as they can that refer to the Sun, the Moon, or a planet. Encourage them to ask older family members and friends to suggest additional titles and lyrics that they may not be familiar with themselves.

Science and Social Studies

Suggest that students find out who Galileo was and what he did that was so important for our understanding of the Solar System. (Galileo was the first person, in the early 1600s, to use the newly invented telescope to study the planets. He proved that the Sun does not orbit Earth, as commonly believed at that time, but that Earth orbits the Sun. Galileo also discovered Jupiter's largest moons.)

Science, Technology, and Society

▶ Encourage interested students to find out about various types of artificial satellites that orbit Earth. For example, *Landsat* takes pictures of Earth that are used in making maps, studying ecological conditions, and looking for oil and mineral supplies. Ships and aircraft use signals from *Navstar* to plot journeys and identify their location. Weather satellites relay photographs of Earth to weather stations on Earth's surface, where computers interpret the information to help predict weather conditions. Communications satellites relay television, radio, and telephone signals around the world.

▶ Students might enjoy doing the following activity to see how communication satellites work. Use lumps of clay to stand a mirror on a table near the open classroom door. Ask one student to stand somewhere in the hallway where he or she can see the mirror, and ask a second student to stand somewhere in the classroom and shine a flashlight at the mirror. Let the two students adjust their positions until the student in the hallway can see the light beam without seeing the student holding the flashlight. Let other pairs of students also try the activity. Explain that in this same way, a signal sent to an orbiting satellite is bounced back to a receiver on Earth thousands of miles from the sender. Also point out that the mirror-and-flashlight setup is a model of the way a communications satellite works.

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