Reflect

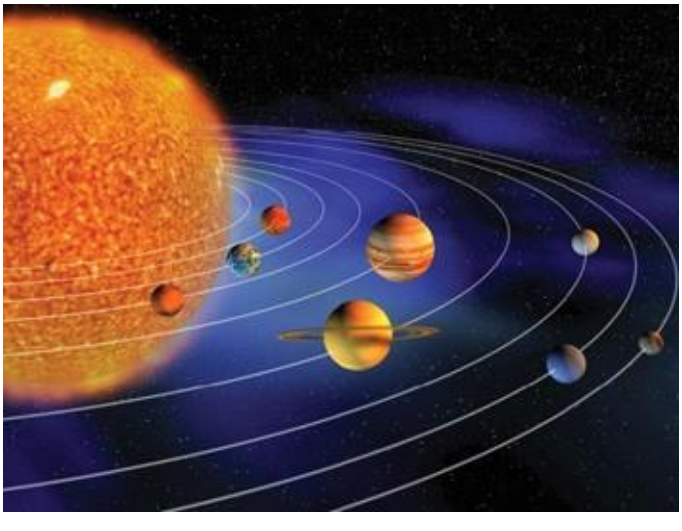
Isaac Newton developed the law of universal gravitation.
According to the law of universal gravitation, as the distance between objects with mass increases, the gravitational attraction between those objects decreases. In other words, the farther apart two objects move, the weaker their gravitational attraction becomes. Earth is very massive, so it has a strong gravitational pull. You would have to move very far away from Earth to escape its gravitational pull.

Look Out!

People often use mass and weight as though these terms mean the same thing. However, mass and weight are different properties of objects. Mass is a measure of the amount of matter in an object. Your mass is the same no matter where you are in the universe.

Weight is a measure of the force of gravity on an object. Objects with more mass than Earth have stronger gravitational pulls, and objects with less mass than Earth have weaker gravitational pulls. This would make your weight different on other planets and moons. For example, if you weigh 100 pounds on Earth, you would weigh only 16.6 pounds on the Moon! However, you would weigh 236.4 pounds on Jupiter. This is because the Moon is much less massive than Earth and has a weaker force of gravity, while Jupiter is much more massive and has a stronger force of gravity. Astronauts floating in space appear to weigh nothing. However, an astronaut's mass remains the same regardless of where he or she is in space.

The Solar System
Gravity holds together the solar system. The Sun is the most massive object in the solar system. Therefore, it has the strongest gravitational pull. The Sun's gravity causes other objects in the solar system—including planets, comets, and asteroids—to orbit or move around the Sun. (An orbit is also the path an object follows as it revolves around a more massive object.) The planets, comets, and asteroids all have their own gravitational pulls. They revolve around the Sun because the Sun is much more massive.



Reflect

Other objects in the solar system with orbital paths include moons and man-made satellites. Instead of revolving around the Sun, these objects revolve around planets. For example, the Moon revolves around Earth because it is much closer to Earth than to the Sun. Though the Moon is less massive than Earth, its gravitational pull is strong enough to affect the planet. The Moon's gravity pulls on Earth's oceans as it revolves around the planet. When the Moon is closer to an ocean or a lake, it pulls the water away from Earth. As the Moon moves away, the water falls back toward Earth. We call these regular movements of water tides.

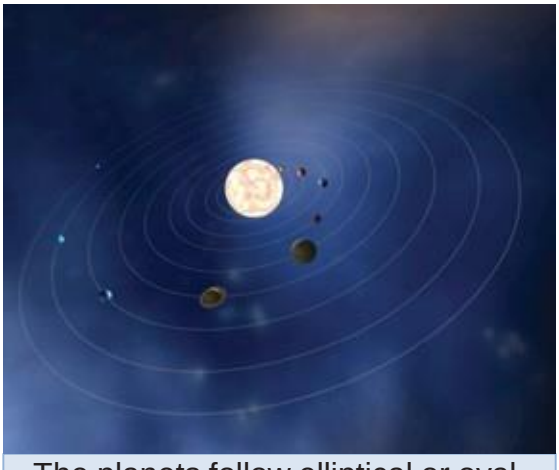
The planets and comets orbit the Sun, while moons orbit planets.

What Do You Think?

You have learned that the planets and other objects in the solar system revolve around the Sun because the Sun is so massive. Why do you think these objects do not crash into the Sun?

Elliptical Orbits

As an object in space moves around the Sun, it has a certain amount of forward momentum. The object's orbital path represents a balance between this momentum and the Sun's gravitational pull. As long as this balance is maintained, the object will continue to orbit the Sun. Now, suppose the object collides with a large asteroid. The force of the collision could move the object closer to the Sun. The Sun's gravity might then be strong enough to overcome the object's forward momentum. If this were to happen, the object would spiral toward—and eventually collide with—the Sun. On the other hand, suppose the collision moved the object farther from the Sun. At a greater distance, the object's forward momentum might be strong enough to overcome the Sun's gravitational pull. If this were to happen, the object would break free of its orbital path and move out of the solar system entirely.



The planets follow elliptical or oval-shaped orbits around the Sun.

Reflect

The orbital paths of objects in the solar system are not perfect circles. Instead, their orbital paths are elliptical or oval shaped. This means that these objects are sometimes a little closer to, and sometimes a little farther from, the Sun. When an object is closer to the Sun, it is affected more by the Sun's gravity. As a result, the object moves faster along its orbital path. When the object is farther from the Sun, it is affected less by the Sun's gravity. As a result, the object moves more slowly along its orbital path.

Try Now

What do you know?

Read the following statements about gravity. Based on what you have learned, rewrite each statement to make it true.

1. The farther apart two objects are, the stronger the gravitational pull between them.

   _____

2. Weight is the amount of matter in an object. Mass is the measure of the force of gravity on an object.

   _____

3. Earth has the strongest gravitational pull in our solar system.

   _____

4. An object that orbits closer to the Sun is affected less by the Sun's gravity.

   _____

Connecting With Your Child

Exploring Gravity
Here are several activities for exploring the effects of gravity with your child.

Activity 1: In the Balance
You can learn about how gravity affects an object by attempting to balance the object on the edge of a surface. For example, try balancing a meter stick on the arm of a chair or a spoon on the edge of a bowl. Keep inching the object farther over the edge until it no longer balances. The point at which the object balances perfectly is the object's center of gravity.

Here are some questions to discuss with your child:
- How is Earth's gravitational pull affecting each end of this object when it is not balanced correctly?
- How is Earth's gravitational pull affecting each end of this object when it is balanced correctly?
- When the object is placed off-center, is Earth's gravity pulling evenly on both sides? How about when it is placed on its center of gravity?

Activity 2: Gravity versus Momentum
Follow this procedure to study the balance between Earth's gravitational pull and an object's forward momentum.

1. Cut a piece of twine or string to about two to three feet long.
2. Tie one end of the string around a small object, such as a ball or a keychain.
3. Go outside or to an area with plenty of open space. Make sure you are far away from any breakable objects!
4. Hold onto the other end of the string, letting the object dangle toward the ground.
5. Begin to spin around very slowly.
6. Now spin faster and faster until the string becomes horizontal and the object moves parallel to the ground. Make sure to slow down before you get dizzy!

When you ride a swing, your momentum speeds you up away from Earth. Earth's gravity slows you down as you rise and then pulls you back toward the ground.

Ask your child to explain the object's movement in terms of gravity and forward momentum. (When you are standing still, the object has no forward momentum. The object hangs down on the string because Earth's gravity is always pulling the object toward the ground.
When you spin very slowly, the object still hangs down. The momentum you give it by spinning is not enough to overcome Earth's gravitational pull. As you spin faster, the object's momentum increases until the object rises into the air. When you stop spinning, the object loses momentum and it is pulled back down toward the Earth.)

Here are some questions to discuss with your child:
- How is the object's motion similar to a planet's orbital path?
- How is the object's motion different from a planet's orbital path?
- What do you think would happen if you continued to spin faster and faster?