Name: ____________________________

The Solar System and Gravitational Forces

Suppose you tried to play basketball on the moon. When you jump, you realize you can leap far higher than you can on Earth. You may have heard people say that this is because gravity is weaker on the moon, but how does one object have less gravity than another?

A **gravitational force** is an attractive force between all objects that have mass. For example, you and Earth have mass, and the gravitational force between you and Earth pulls you and Earth together. If you jump up, you come back down because the gravitational force pulls you toward Earth.

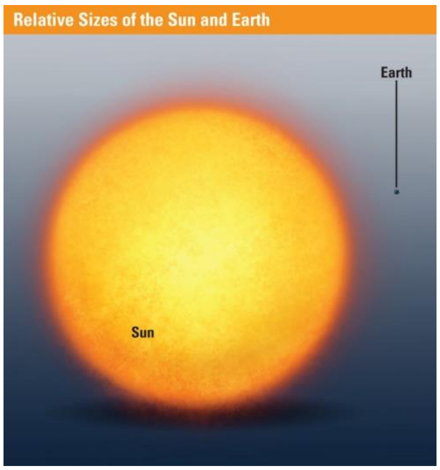

Figure 1
The more massive an object is, the more gravitational force it applies on other objects. The sun is a massive star in the center of the solar system. Earth may seem very large to you, but it is tiny compared to the sun.

The strength of a gravitational force depends on two things: mass and distance. The gravitational force between the objects increases as the masses of the objects increase. If you were standing on the moon, you would experience less gravitational force than if you were standing on Earth. This is because the moon is less massive than Earth.

The strength of gravitational force also depends on the distance between masses. Gravitational force decreases quickly as the distance between the objects increases. The planet Venus has less mass than Earth, so you might expect the gravitational force between Venus and the sun to be less than the force between Earth and the sun. But Venus is closer to the sun than Earth, so the gravitational force between it and the sun is greater than the gravitational force between Earth and the sun.

Gravitational forces between celestial objects hold together our entire solar system. A **solar system** is made up of a star and all the objects that travel around it. The star in our solar system is the sun. Objects that travel around the sun include Earth, other planets, dwarf planets, moons, and many smaller objects.

Gravitational forces may seem to be strong because they hold huge planets together in the solar system. However, most gravitational forces are actually very weak. Only very massive objects exert gravitational forces strong enough to notice. Earth is massive, so you feel and see the effects of its gravitational force. On the other hand, people do not have large masses. So, you do not notice gravity pulling you toward your classmates when you pass them in the hall. The sun contains 99.8% of the mass of the solar system. The sun's large mass means that large gravitational forces exist between the sun and other objects in the solar system. These large gravitational forces are what hold all other objects in the solar system in orbit around the sun.

Earth Revolves Because of the Gravitational Force

"Catch!" your friend says as he tosses a ball so it falls in front of you at your feet. By throwing a ball, your friend exerted a force on the ball; this force caused it to change its motion from still to moving. Gravitational forces can also change objects' motion. In fact, the gravitational force between the ball and Earth made the ball fall to the ground.

Forces can change an object's motion in other ways. Suppose that you tie a string around a ball and twirl the ball over your head. The ball moves in a circle because the string exerts a force on the ball, which pulls the ball toward your hand. However, the ball is moving fast enough that it is not pulled into your hand; it just keeps moving around your hand.

Something similar happens in the solar system. The gravitational force between the sun and Earth pulls on Earth, but Earth is not pulled into the sun. Instead, Earth moves perpendicularly at a very high speed, about 30 km/s, while being pulled by the force. As a result, Earth constantly moves so that it revolves around the sun. If Earth was not moving as quickly, it would fall toward the sun until they collided.

Figure 2 models how gravity causes Earth to revolve around the sun. The right side of the figure shows the direction that Earth is moving and the direction that the gravitational force pulls on Earth. If the gravitational force were not there, Earth would move off in a straight line in the direction of the red arrow. The gravitational force, shown by the black arrow, is nearly perpendicular to the direction that Earth moves. The force makes Earth change directions. But even as Earth changes directions, the force keeps pulling perpendicularly to the direction it is moving. Thus, Earth constantly changes directions and moves in a nearly circular orbit, as shown on the figure's right side.

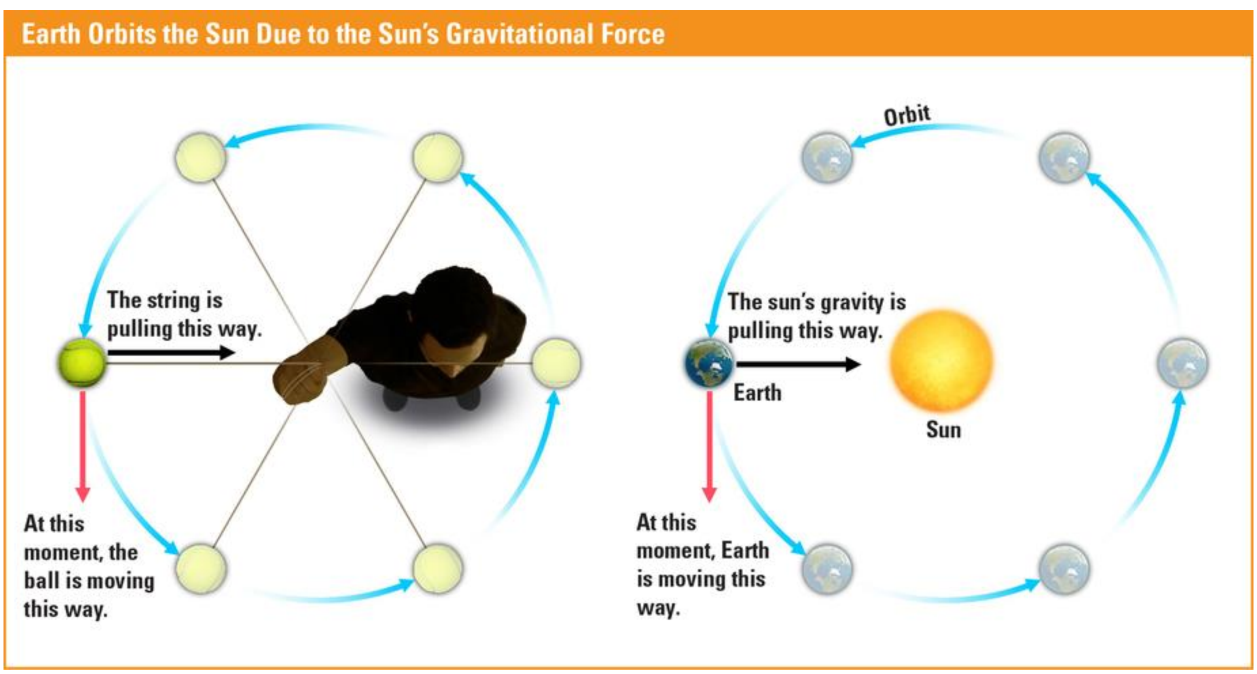

Figure 2
The sun's gravitational force pulls on Earth as Earth travels quickly through space. The force causes Earth to "fall around" the sun in a slightly elliptical orbit.