Name ______________________ Class ______________ Date ______________

CHAPTER 20 Formation of the Solar System

SECTION 4

Planetary Motion

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What is the difference between rotation and revolution?
- What are Kepler's three laws of planetary motion?
- How does gravity affect the orbits of planets?

National Science Education Standards
ES 3b

How Do Scientists Describe the Motions of the Planets?

Remember that the Earth, like all planets, spins on its axis. Scientists use the term **rotation** to describe the motion of a body spinning on its axis. As the Earth rotates, different parts of its surface face the sun. It is daytime in the part that faces the sun. It is night in the part that faces away from the sun. At any time, only one-half of the Earth faces the sun.

In addition to rotating, all planets move around the sun. The path that a planet follows around the sun is called its **orbit**. One complete trip around the sun is called a **revolution**.

STUDY TIP
Summarize After you read this section, make a chart describing Kepler's laws of planetary motion.

Critical Thinking
1. Infer Venus rotates more slowly than the Earth. On which planet does daytime last longer?

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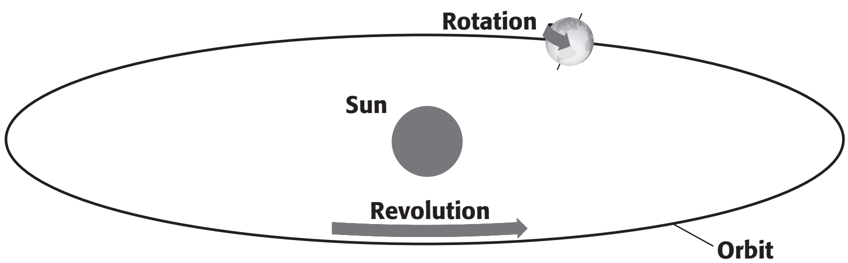

TAKE A LOOK
2. Describe What are two ways that planets move?

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The amount of time it takes for a planet to complete one revolution is called its *period of revolution*. Each planet has a different period of revolution. For example, Earth's period of revolution is 365.24 days. Mercury's is only 88 days.

What Do We Know About How Planets Move?

Scientists have not always known how the planets move. Until the 1600s, scientists did not know the shapes of the planets' orbits or their periods of revolution accurately.

In the 1600s, a German scientist named Johannes Kepler made detailed observations of the motions of the planets. After analyzing his observations, he developed three laws of planetary motion. Kepler's observations and calculations were so accurate that scientists still use his laws today! ☑

READING CHECK

3. Describe How did Johannes Kepler come up with his three laws of planetary motion?

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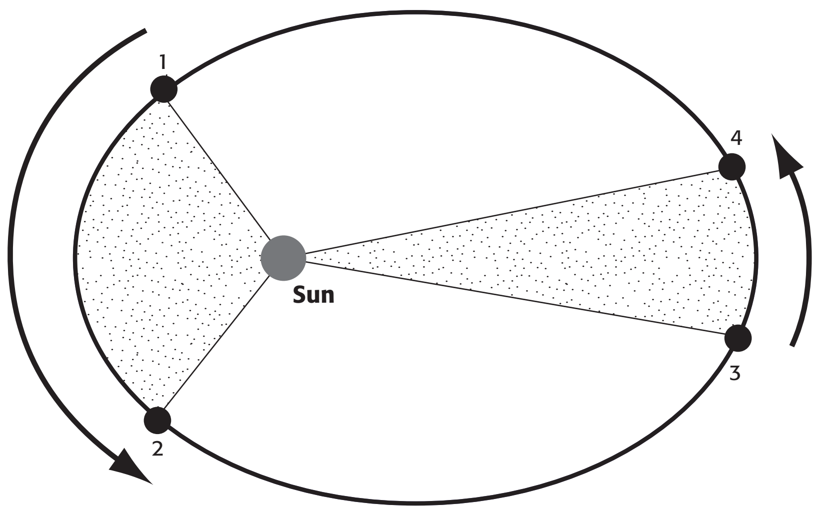
KEPLER'S FIRST LAW

Kepler carefully observed the path that Mars takes through the sky. When he analyzed his observations, he found that Mars' orbit is not a perfect circle. Instead, it is shaped like an *ellipse*, or oval. Kepler's first law of planetary motion states that the orbits of all planets are ellipses.

KEPLER'S SECOND LAW

Kepler reasoned that the planets must move through their orbits faster in some places than in others. To understand why this is so, look at the figure below. The distance between point 1 and point 2 is longer than the distance between point 3 and point 4. The planet takes the same amount of time to travel both distances. Therefore, the planet must be moving faster between points 1 and 2 than between points 3 and 4. This is Kepler's second law.



TAKE A LOOK

4. Identify Label the place in the planet's orbit where it is moving the fastest.

KEPLER'S THIRD LAW

Kepler observed that planets that are far from the sun, such as Saturn, take longer to orbit the sun. This is Kepler's third law of planetary motion.

STANDARDS CHECK

ES 3b Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses.

Word Help: **predictable**
able to be known ahead of time

Word Help: **phenomenon**
(plural *phenomena*) any fact or event that can be sensed or described scientifically

5. Identify Relationships How is the distance of a planet from the sun related to its period of revolution?

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How Does Gravity Affect a Planet's Orbit?

Kepler never knew why planets orbit the sun. Another astronomer, Sir Isaac Newton, solved the puzzle. He combined the observations of earlier scientists with mathematical models to describe the force of gravity.

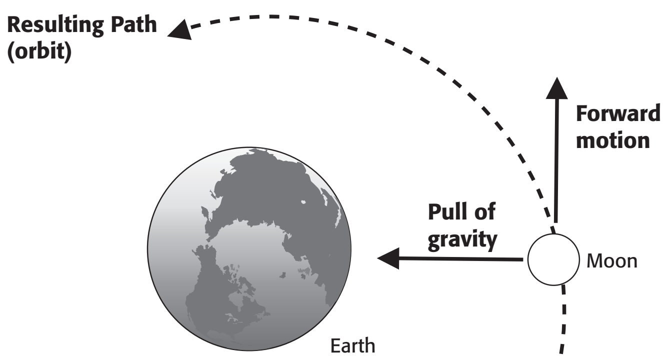
Newton observed that objects fall toward Earth. He reasoned that all objects are attracted to each other through the force of gravity. The strength of the force depends on two factors—the masses of the objects and the distance between them.

Newton's *law of universal gravitation* describes how the force of gravity is related to these two factors. When the masses are large, the force of gravity is strong. When the objects are far apart, the force of gravity is weak.

ORBITS AND GRAVITY

If gravity is pulling on the moon, why doesn't the moon fall to Earth? The answer has to do with the moon's inertia. *Inertia* is an object's resistance to changes in its speed or direction.

Gravity is like a string holding the moon in orbit around the Earth. Without gravity, the moon would move in a straight line away from the Earth. The moon's orbit is a balance between its inertia and the force of gravity. This balance is the reason that all bodies in orbit, including the Earth, travel along curved paths.



Gravity pulls the moon toward the Earth. Inertia keeps it moving in a straight line. The result is a curved orbit.

TAKE A LOOK

6. Explain Why doesn't the moon move away from the Earth in a straight line?

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Section 4 Review

NSES ES 3b

SECTION VOCABULARY

orbit the path that a body follows as it travels around another body in space	**revolution** the motion of a body that travels around another body in space; one complete trip along an orbit **rotation** the spin of a body on its axis

1. **Compare** How is rotation different from revolution?

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2. **Define** Explain Kepler's second law of planetary motion in your own words.

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3. **Describe** Fill in the blank spaces in the table.

Factor	How it affects the force of gravity
Mass of the objects	
Distance between the objects	

4. **Identify** What two factors must be balanced in order for an object to remain in orbit?

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5. **Predict Consequences** What would happen to an object in orbit around a planet if the planet's force of gravity were stronger than the object's inertia?

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6. **Apply Concepts** Imagine a planet with two moons. Moon A is twice as far from the planet as moon B. Which moon will take longer to orbit the planet once? Explain your answer.

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