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### STUDY GUIDE: OUR SOLAR SYSTEM

The solar system contains the sun, the nine planets that revolve around the sun, and the moons that revolve around the planets. Comets, asteroids, and meteoroids are also found in our solar system.

#### THE SUN:

The sun composes 98% of the mass of the solar system and is located in the center of the solar system. It is a star made mainly from hydrogen and helium gases. It produces energy and light for the solar system. This energy is released during a nuclear reaction called **fusion** that occurs when hydrogen atoms fuse into helium atoms.

The sun is the largest object in our solar system. Approximately 1.3 million Earths would fit into the interior of the sun. However, the sun is only a medium-sized star compared to other stars in the universe, and is yellow in color.

The sun's atmosphere is divided into three layers, and another layer makes up its interior. This interior layer of the sun is called the **core**. The **fusion** of the hydrogen atoms into helium atoms occurs within the core, which is the hottest part of the sun, having an average temperature of 15 million degrees Celsius.

THE THREE LAYERS OF THE SUN'S ATMOSPHERE: The **corona**, **chromosphere**, and **photosphere**.

1) The **corona** is the outermost layer of the sun's atmosphere. It is the second-hottest area of the sun after the core, with temperatures that reach 1,700,000 degrees Celsius. This area of the sun becomes visible during a total solar eclipse.

2) The **chromosphere** lies beneath the corona and above the photosphere. It is the middle layer of the sun's atmosphere. The average temperature of this layer is about 27,000 degrees Celsius. Violent sun storms start in the chromosphere.

3) The **photosphere** is the innermost layer of the sun's atmosphere. It is the coolest area of the sun. Seldom do the temperatures in this layer exceed 6,000 degrees Celsius. Since this layer is directly above the core, it's often called the sun's surface.

There are three main types of **sun storms**, or **solar storms** that occur on the sun.

1) **Prominences**—Hot gases from the chromosphere burst through the corona and shoot outward before looping back onto the sun, sending much energy and gas into space.

2) **Solar flares**—Gases erupt suddenly from the sun's surface, causing an immediate increase in the temperature around this area. They are short-lived, but do release a huge amount of energy into space during their eruption.

3) **Solar wind**—The solar wind is caused by the escape of high-energy particles from the corona.

The dark areas that appear on the sun are **sunspots**. Sunspots are cooler areas on the surface of the sun.

## THE PLANETS:

There are **nine planets** that orbit the sun.

Order of planets from the sun:

1. Mercury
2. Venus
3. Earth
4. Mars
5. Jupiter
6. Saturn
7. Uranus
8. Neptune
9. Pluto

Size of the planets from smallest to largest:

1. Pluto
2. Mercury
3. Mars
4. Venus
5. Earth
6. Neptune
7. Uranus
8. Saturn
9. Jupiter

The inner planets: Mercury, Venus, Earth, Mars

The outer planets: Jupiter, Saturn, Uranus, Neptune, Pluto

The Jovian (gas giant) planets: Jupiter, Saturn, Uranus, and Neptune. All Jovian planets have a ring system.

The terrestrial planets: Mercury, Venus, Earth, Mars, and Pluto

### Mercury

Mercury is the planet closest to the sun and the planet having the shortest orbit. It takes Mercury 88 days to revolve one time around the sun. Because it takes such a short time to revolve around the sun, the planet was named after Mercury, the Roman winged-foot messenger of the gods.

Mercury is the densest of all the planets other than the Earth. It has a huge metal core surrounded by rock. Its surface is bare and rocky and is covered with craters and lava plains.

Most of the craters were formed by meteorites striking the planet's surface. The Caloris Basin is the largest impact feature on the planet.

Mercury is so small that it has little gravity, and is thus unable to hold an atmosphere around it. Therefore, there is no weather or winds on Mercury.

Mercury does spin on its axis. A day on Mercury is equal to nearly 59 Earth days.

The only spacecraft to visit Mercury was Mariner 10, which flew by in 1974 and 1975.

## Venus

Venus is the second planet from the sun. It takes 224.7 days to revolve once around the sun. Because Venus is nearly the same size as Earth, it has been nicknamed "Earth's Twin," although it has very few other things in common with the Earth.

The surface of the planet is rocky, and the large number of lava plains and volcanic uplands suggest much prior volcanic activity on the planet. Maxwell Montes, a volcanic mountain, is the highest mountain on the planet and the second highest mountain in the entire solar system. Winds create fields of dunes and "wind streaks" on the surface.

Venus is surrounded by clouds of sulfuric acid. Its atmosphere is composed mostly of carbon dioxide. Infrared rays penetrate this dense carbon dioxide atmosphere and are unable to escape, creating an overwhelming greenhouse effect. Venus is the hottest planet in the solar system with surface temperatures that often exceed 900 degrees Fahrenheit. Because its cloud cover reflects light, it is also the brightest planet, and the second-brightest object in the solar system after our Moon. The Romans named this bright planet after Venus, the goddess of love and beauty.

Venus has no moons, and is the only planet to rotate clockwise on its axis. This type of motion is called **retrograde rotation**. It takes 243 Earth years to rotate once, so a day on Venus is longer than a year on Venus!

Since it is often visible in the early morning and early evening hours, Venus is known as the "evening star" or "morning star."

The Magellan space probe was launched in 1989. While orbiting the planet, it mapped the surface of Venus by emitting radio signals that bounced off the surface to the probe.

## Earth

Earth is the third planet from the sun and takes 365.26 days (365 days) to complete one revolution. It spins once on its axis every 24 hours and has one moon.

Earth's atmosphere is composed mainly of nitrogen. Oxygen and water vapor are also components of the planet's atmosphere. An entire study guide has been written about the Earth and its Moon.

## Mars

Mars is the fourth planet from the sun and takes 687 days to make a complete revolution around the sun. The surface of Mars is rocky, and dotted with many craters. Huge amounts of iron oxide, or rust, in the soil cause Mars to appear red when viewed through a telescope, so Mars has been nicknamed "The Red Planet." Because of its red color, the planet was named after the Roman God of War.

Valles Marineris, an extremely large canyon that would stretch from Los Angeles to New York, is located on Mars. This canyon is deeper than American's Grand Canyon. Olympus Mons, a large volcano on Mars, is the highest peak in the entire solar system. Many valleys and channels on the planet's surface were probably carved by running water, but running water is no longer found on Mars. However, carbon dioxide ice and ice formed from water is found on the surface of Mars in its polar icecaps. Many of the clouds that surround the planet have also been formed from ice crystals.

Two small moons, Phobos and Deimos, circle the planet. Their names were derived from the Greek words for fear and terror. It is very possible that both were asteroids that were captured by the planet's gravity.

Mars Pathfinder landed on Mars in 1997 with a small robotic rover named Sojourner. The rover failed to find any indication of life on the planet.

## **Jupiter**

Jupiter is the fifth planet from the sun. It takes 11.9 years to revolve once around the sun. Twenty-eight moons revolve around Jupiter. The four largest moons were discovered by Galileo in 1610 and are called the Galilean moons or Galilean satellites. The Galilean satellites in order of their size are Ganymede, Callisto, Io, and Europa. All four of these moons are larger than the planet Pluto.

**Ganymede** is the largest moon of Jupiter and the largest moon in the entire solar system. It is composed of rock and water ice, and has craters and possible earthquakes.

**Callisto** is the most heavily cratered object in the solar system. It has a huge bull's-eye crater called Valhalla, and its surface is also made of rock and ice.

**Io** is the innermost of Jupiter's large moons. Large deposits of sulfur on its surface cause it to appear brilliant orange, yellow, and red. Io is also covered with active volcanoes.

**Europa's** surface consists of ice sheets that continually melt and resolidify.

Jupiter is called a gas giant. Although it may have a small solid core, the dense clouds surrounding the core are composed of hydrogen that may be liquefied in places. Its outer area is made mainly of hydrogen and helium gases and so it has no solid surface. Jupiter revolves very quickly, having a day of 9.8 hours. Jupiter bulges at the equator due to its rapid rotation and this rapid rotation may also be responsible for the continual storms on the planet. The Great Red Spot is Jupiter's most dominant feature. The Great Red Spot is a storm three times larger than the Earth. Astronomers believe that it has been raging for over 300 years on Jupiter.

Jupiter is the largest planet in the solar system. Because of its size, it was named after the Roman King of the Gods.

Jupiter has a faint ring system that is made from pieces of dust. These rings were discovered by the Voyager spacecraft.

## **Saturn**

Saturn is the sixth planet from the sun and takes 29.5 years to revolve once around the sun. This planet was first observed by Italian astronomer Galileo during the 17<sup>th</sup> century. It has

flattened poles, storm spots, and a banded atmosphere composed mainly of hydrogen and helium gases. These gas clouds form colored bands around the planet.

Saturn has 30 moons—more moons than any other planet in the solar system. Its largest moon is Titan. Titan is the second largest moon in the solar system. Only Jupiter's Ganymede is larger. Titan has been described as “a mini earth in a state of deep freeze,” because Titan is the only moon in the solar system with a thick atmosphere of mainly nitrogen. This atmosphere is very similar to Earth's. All of Saturn's moons are composed of ice mixed with silicate rock.

Saturn is known for its magnificent ring system composed of more than 1,000 rings made from billions of pieces of ice and rock. Galileo discovered Saturn's rings. Three of these rings can be detected from Earth. Its outer ring is called the A ring. The widest and brightest of these three rings is the B ring. The Voyager 2 space probes actually discovered that there were many rings surrounding the planet instead of just a few.

Although Saturn is the second largest planet in the solar system, it is the least dense, and would float in a huge body of water.

Saturn was named after the Roman father of Jupiter.

## **Uranus**

Uranus is the seventh planet from the sun and takes 84 years to make one complete revolution. Sir William Herschel, an amateur German astronomer, discovered Uranus in 1781. It was the first planet to be discovered with a microscope. Uranus is very unusual because it is tilted at a 98-degree angle and thus revolves around the sun on its side while it also rotates. During its 84-year revolution, the two poles take turns facing the sun.

Uranus has 21 moons. The five largest moons listed in order of their size are Oberon, Titania, Umbriel, Ariel, and Miranda. Oberon has many large craters, while Titania has no visible ones. Umbriel is covered with craters, one of which is a very large white crater called Wunda. Ariel shows very few craters or other old features. Pictures from Voyager 2 revealed that Miranda's landscape looks as if it has been patched together. It is very possible that Miranda was once broken up and then fused back together.

This planet is covered by a thick atmosphere composed of hydrogen, helium, and methane gases, which gives it a blue-green color. At least 11 faint rings circle the planet from top to bottom. Each ring is approximately 6 miles wide and is made of black ice.

Uranus was named after the Greek God of the Sky. According to Greek and Roman mythology, Uranus was the husband of Gaea, the earth, and became the father of the Titans.

## **Neptune**

Neptune is the next to the last planet from the sun. At times it appears farther from the sun than Pluto because the two orbits cross each other. It takes Neptune 164.8 years to revolve once around the sun.

The planet was discovered in 1846 by German astronomer Johann Galle. A few days later, Triton, the largest of Neptune's 8 moons was also discovered. Strangely enough, Triton orbits Neptune in the opposite direction of Neptune's rotation. The moon has an icy surface.

Neptune was named after the Roman God of the Sea because of its distinctive blue color. Triton was named for the son of Neptune, whom the Greeks called Poseidon. It is believed that Triton was formed elsewhere and was captured by Neptune's gravity.

Triton has a small rocky core surrounded by an ocean of warm water and thick clouds of methane and ammonia. Its atmosphere is composed mainly of hydrogen and helium.

Five rings encircle the planet. They appear to be made of dark, icy particles that range in size from minute pieces of dust to refrigerator sized boulders. At one time a Great Dark Spot was visible on the surface of the planet. It was believed to be a large hurricane-like storm. It is no longer visible.

Voyager 2 has provided astronomers with most of their knowledge of Neptune.

### **Pluto**

Pluto is the ninth, and last planet from the sun. Its orbit crosses inside Neptune's orbit for 20 of the 248 years in its revolution around the sun. The planet was discovered by an amateur American astronomer named Clyde Tombaugh in 1930. Pluto is the smallest and coldest planet in the solar system. Since it is located so far away, very little is actually known about Pluto. It is the only outer planet that has not been visited by Voyager 2, and since no space probe has ever visited the planet, astronomers can only guess what it looks like.

Another American astronomer, Jim Christy discovered Pluto's one moon in 1978. Pluto's moon, called Charon, is just over half of Pluto's size and both of their orbits seem to be "locked together." Charon orbits Pluto with the same hemisphere always facing the same hemisphere on Pluto. For this reason, they are sometimes called a "double planet." Astronomers believe that Pluto and Charon both have large rocky cores covered by dirty water ice. Their surfaces are probably made of ice that is a mixture of nitrogen, carbon monoxide, and methane, thus giving them a slightly red color. Polar caps and dark spots appear near Pluto's equator.

Because the planet is a dark, icy body, it was named after the Roman God of the Underworld.

### **FACTS ABOUT THE PLANETS:**

Largest planet: Jupiter  
Smallest planet: Pluto  
Planet closest to the Sun: Mercury  
Planet that comes closest to Earth: Venus  
Fastest-moving planet: Mercury  
Slowest planet: Pluto  
Warmest planet: Venus  
Coldest planet: Pluto  
Longest day: Mercury  
Shortest day: Jupiter  
Least dense planet: Saturn

### **Other Interesting Facts:**

1. Jupiter has a gigantic magnetic field called the **magnetosphere**.
2. Jupiter gives off more heat than it absorbs from the sun.
3. All four of the gas giants have a ring system.

4. All the planets orbit the sun in the same direction.
5. The orbits of all the planets lie in a flat plane except for the orbit of Pluto, which is tilted compared to the other orbits.
6. Mercury and Venus are the only two planets that do not have at least one moon.
7. Mars looks like a red star in the sky.
8. Jupiter has a striped appearance when viewed through a telescope. These stripes are due to its rapid rotation.
9. Some of Jupiter's and Saturn's moons are very similar in size to the planet Pluto.

### **Asteroids**

Asteroids are defined as small, irregular bodies that are covered with craters. The largest asteroids are often referred to as minor planets. Most of the asteroids lie in the **asteroid belt**, which is located between the orbits of Mars and Jupiter. The largest asteroid is **Ceres**, which was discovered in 1801. Apollo, Icarus, and Adonis are three asteroids that actually pass inside Earth's orbit. Occasionally, pieces of asteroids fall to the Earth. Those that do not burn up from the friction and heat as they pass through the atmosphere are then called **meteorites**. Many scientists believe that the extinction of the dinosaurs was caused by a huge meteorite hitting the earth. If asteroids or grains of dust burn up in the earth's atmosphere, they are then called **meteors**. The common name for a meteor is a shooting star.

### **Comets**

Comets are balls of dust and ice that orbit the Sun. A comet has three basic parts: the **nucleus**, **coma**, and the **tail**. The **nucleus** is the core of a comet. Gas that evaporates from the nucleus forms a cloud of dust called the **coma**, which spins around the nucleus. Together, the nucleus and the coma make up the head of the comet. Solar wind blows the coma outward into a long tail which streams away from the sun. This **tail** is actually composed of two separate tails, a straight gas tail and a broader, curved dust tail.

Edmond Halley was the first astronomer to discover the regular orbiting patterns of comets. He observed a comet in 1682 and predicted its return in 1758. This comet, which did indeed return, came to be known as **Halley's Comet**.

The comet called Shoemaker-Levy smashed into Jupiter in 1994. The Hale-Bopp comet could be easily viewed from Earth in 1997.