

The Outer Planets

as you read

What You'll Learn

- **Describe** the characteristics of Jupiter, Saturn, Uranus, and Neptune.
- **Describe** the largest moons of each of the outer planets.

Why It's Important

Studying the outer planets will help scientists understand Earth.

Review Vocabulary

moon: a natural satellite of a planet that is held in its orbit around the planet by the planet's gravitational pull

New Vocabulary

- Jupiter
- Great Red Spot
- Saturn
- Uranus
- Neptune
- Pluto

Outer Planets

You might have heard about *Voyager*, *Galileo*, and *Cassini*. They were not the first probes to the outer planets, but they gathered a lot of new information about them. Follow the spacecrafts as you read about their journeys to the outer planets.

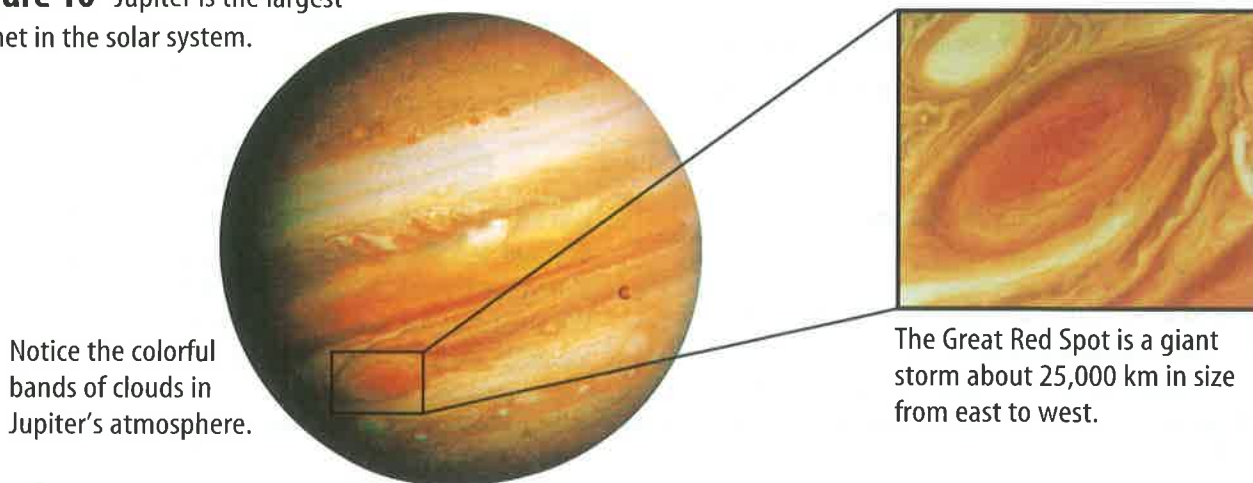
Jupiter

In 1979, *Voyager 1* and *Voyager 2* flew past **Jupiter**, the fifth planet from the Sun. *Galileo* reached Jupiter in 1995, and *Cassini* flew past Jupiter on its way to Saturn in 2000. The spacecrafts gathered new information about Jupiter. The *Voyager* probes revealed that Jupiter has faint dust rings around it and that one of its moons has active volcanoes on it.

Jupiter's Atmosphere Jupiter is composed mostly of hydrogen and helium, with some ammonia, methane, and water vapor. Scientists hypothesize that the atmosphere of hydrogen and helium changes to an ocean of liquid hydrogen and helium toward the middle of the planet. Below this liquid layer might be a rocky core. The extreme pressure and temperature, however, would make the core different from any rock on Earth.

You've probably seen pictures from the probes of Jupiter's colorful clouds. In **Figure 10**, you can see bands of white, red, tan, and brown clouds in its atmosphere. Continuous storms of swirling, high-pressure gas have been observed on Jupiter. The **Great Red Spot** is the most spectacular of these storms.

Figure 10 Jupiter is the largest planet in the solar system.



Notice the colorful bands of clouds in Jupiter's atmosphere.

The Great Red Spot is a giant storm about 25,000 km in size from east to west.

Table 2 Large Moons of Jupiter

Io The most volcanically active object in the solar system; sulfurous compounds give it its distinctive reddish and orange colors; has a thin atmosphere of sulfur dioxide .

Europa Rocky interior is covered by a smooth 5-km-thick crust of ice, which has a network of cracks; a 50-km-deep ocean might exist under the ice crust; has a thin oxygen atmosphere.

Ganymede Has a heavily cratered crust of ice covered with grooves; has a rocky interior surrounding a molten iron core and a thin oxygen atmosphere.

Callisto Has a heavily cratered crust with a mixture of ice and rock throughout the interior; has a rock core and a thin atmosphere of carbon dioxide.

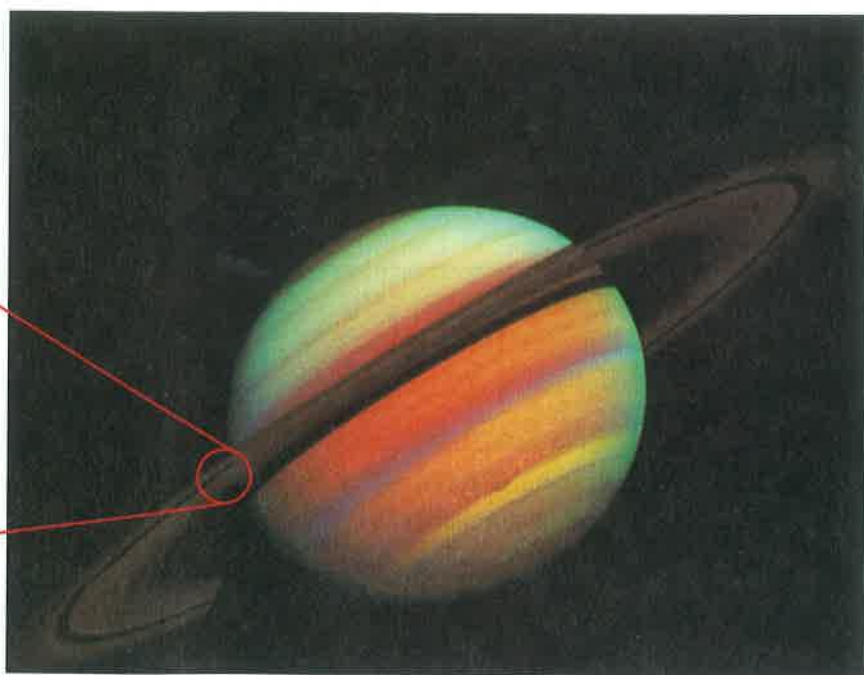
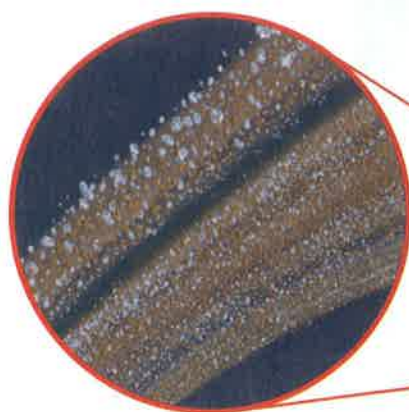


Moons of Jupiter At least 63 moons orbit Jupiter. In 1610, the astronomer Galileo Galilei was the first person to see Jupiter's four largest moons, shown in **Table 2**. Io (I oh) is the closest large moon to Jupiter. Jupiter's tremendous gravitational force and the gravity of Europa, Jupiter's next large moon, pull on Io. This force heats up Io, causing it to be the most volcanically active object in the solar system. You can see a volcano erupting on Io in **Figure 11**. Europa is composed mostly of rock with a thick, smooth crust of ice. Under the ice might be an ocean as deep as 50 km. If this ocean of water exists, it will be the only place in the solar system, other than Earth, where liquid water exists in large quantities. Next is Ganymede, the largest moon in the solar system—larger even than the planet Mercury. Callisto, the last of Jupiter's large moons, is composed mostly of ice and rock. Studying these moons adds to knowledge about the origin of Earth and the rest of the solar system.

Figure 11 *Voyager 2* photographed the eruption of this volcano on Io in July 1979.



Figure 12 Saturn's rings are composed of pieces of rock and ice.



Mini LAB

Modeling Planets

Procedure

1. Research the planets to determine how the sizes of the planets in the solar system compare with Earth's size.
2. Select a scale for the diameter of Earth.
3. Make a model by drawing a circle with this diameter on paper.
4. Using Earth's diameter as 1.0 unit, draw each of the other planets to scale.

Analysis

1. Which planet is largest? Which is smallest?
2. Which scale diameter did you select for Earth? Was this a good choice? Why or why not?



Saturn

The *Voyager* probes next surveyed Saturn in 1980 and 1981. *Cassini* reached Saturn on July 1, 2004. **Saturn** is the sixth planet from the Sun. It is the second-largest planet in the solar system, but it has the lowest density.

Saturn's Atmosphere Similar to Jupiter, Saturn is a large, gaseous planet. It has a thick outer atmosphere composed mostly of hydrogen and helium. Saturn's atmosphere also contains ammonia, methane, and water vapor. As you go deeper into Saturn's atmosphere, the gases gradually change to liquid hydrogen and helium. Below its atmosphere and liquid layer, Saturn might have a small, rocky core.

Rings and Moons The *Voyager* and *Cassini* probes gathered information about Saturn's ring system. The probes showed that there are several broad rings. Each large ring is composed of thousands of thin ringlets. **Figure 12** shows that Saturn's rings are composed of countless ice and rock particles. These particles range in size from a speck of dust to tens of meters across. Saturn's ring system is the most complex one in the solar system.

At least 47 moons orbit Saturn. Saturn's gravity holds these moons in their orbits around Saturn, just like the Sun's gravity holds the planets in their orbits around the Sun. The largest moon, Titan, is larger than the planet Mercury. It has a thick atmosphere of nitrogen, argon, and methane. *Cassini* delivered the *Huygens* probe to analyze Titan's atmosphere in 2005.

Uranus

Beyond Saturn, *Voyager 2* flew by Uranus in 1986. **Uranus** (YOOR uh nus) is the seventh planet from the Sun and was discovered in 1781. It is a large, gaseous planet with at least 27 moons and a system of thin, dark rings. Uranus's largest moon, Titania, has many craters and deep valleys. The valleys on this moon indicate that some process reshaped its surface after it formed. Uranus's 11 rings surround the planet's equator.

Uranus's Characteristics The atmosphere of Uranus is composed of hydrogen, helium, and some methane. Methane gives the planet the bluish-green color that you see in **Figure 13**. Methane absorbs the red and yellow light, and the clouds reflect the green and blue. Few cloud bands and storm systems can be seen on Uranus. Evidence suggests that under its atmosphere, Uranus is composed primarily of rock and various ices. There is no separate core.

Figure 14 shows one of the most unusual features of Uranus. Its axis of rotation is tilted on its side compared with the other planets. The axes of rotation of the other planets are nearly perpendicular to the planes of their orbits. However, Uranus's axis of rotation is nearly parallel to the plane of its orbit. Some scientists believe a collision with another object tipped Uranus on its side.



Figure 13 The atmosphere of Uranus gives the planet its distinct bluish-green color.

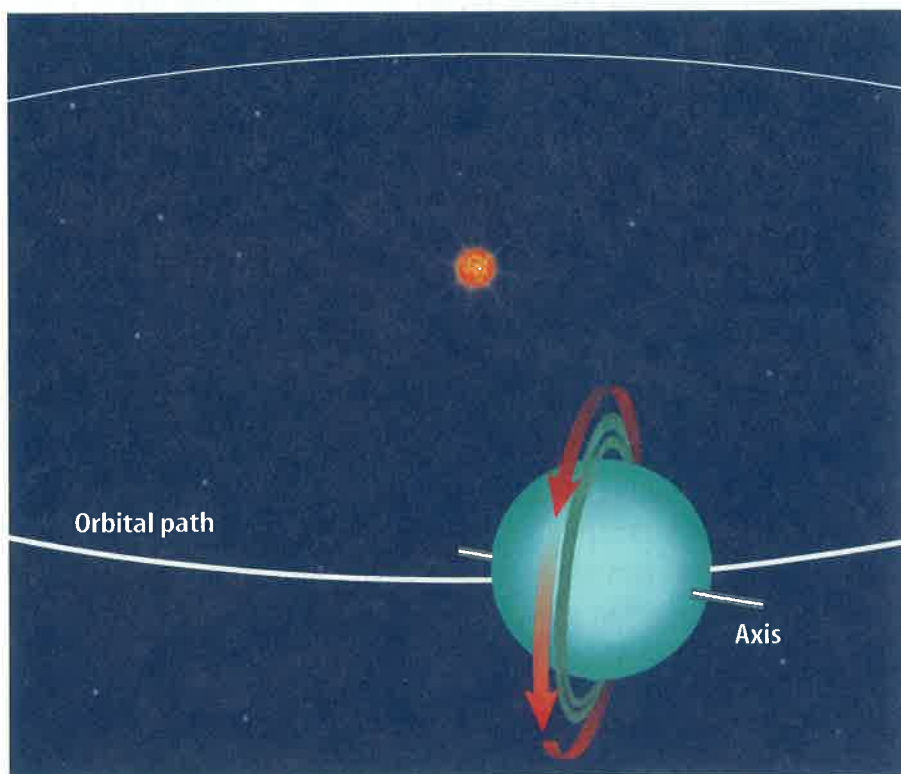


Figure 14 Uranus's axis of rotation is nearly parallel to the plane of its orbit. During its revolution around the Sun, each pole, at different times, points almost directly at the Sun.

Neptune has a distinctive bluish-green color.



The pinkish hue of Neptune's largest moon, Triton, is thought to come from an evaporating layer of nitrogen and methane ice.

Figure 15 Neptune is the eighth planet from the Sun.

Neptune

Passing Uranus, *Voyager 2* traveled to Neptune, another large, gaseous planet. Discovered in 1846, **Neptune** is the eighth planet from the Sun.

Neptune's Characteristics Like Uranus's atmosphere, Neptune's atmosphere is made up of hydrogen and helium, with smaller amounts of methane. The methane content gives Neptune, shown in **Figure 15**, its distinctive bluish-green color, just as it does for Uranus.

 **Reading Check** What gives Neptune its bluish-green color?

Neptune has dark-colored storms in its atmosphere that are similar to the Great Red Spot on Jupiter. One discovered by *Voyager 2* in 1989 was called the Great Dark Spot. It was about the size of Earth with windspeeds higher than any other planet. Observations by the *Hubble Space Telescope* in 1994 showed that the Great Dark Spot disappeared and then reappeared. Bright clouds also form and then disappear. Scientists don't know what causes these changes, but they show that Neptune's atmosphere is active and changes rapidly.

Under its atmosphere, Neptune has a mixture of rock and various types of ices made from methane and ammonia. Neptune probably has a rocky core.

Neptune has at least 13 moons and several rings. Triton, shown in **Figure 15**, is Neptune's largest moon. It has a thin atmosphere composed mostly of nitrogen. Neptune's dark rings are young and probably won't last very long.



Names of Planets The names of most of the planets in the solar system come from Roman or Greek mythology. For example, Neptune was the Roman god of the sea. Research to learn about the names of the other planets. Write a paragraph in your Science Journal that summarizes what you learn.

Dwarf Planets

From the time of its discovery in 1930 until 2006 Pluto was considered the ninth planet in the solar system. But with the discovery of Eris (EE rihs), which is larger than Pluto, the International Astronomical Union decided to define the term *planet*. Now, scientists call Pluto a dwarf planet.

Ceres Ceres was discovered in 1801. It has an average diameter of about 940 km and is located within the asteroid belt at an average distance of about 2.7 AU from the Sun. Ceres orbits the Sun about once every 4.6 years.

Pluto 1930 Pluto has a diameter of 2,300 km. It is an average distance of 39.2 AU from the Sun and takes 248 years to complete one orbit. It is surrounded by only a thin atmosphere and it has a solid, icy-rock surface. Pluto has three moons: Charon, Hydra, and Nix. The largest moon, Charon, has a diameter of about 1,200 km and orbits Pluto at a distance of about 19,500 km.

Eris Astronomers discovered Eris in 2005, originally calling it UB313. With a diameter of about 2,400 km, Eris is slightly larger than Pluto. Eris has an elliptical orbit that varies from between about 38 AU to 98 AU from the Sun. Eris orbits the Sun once every 557 years and has one moon, named Dysnomia (dihs NOH mee uh).

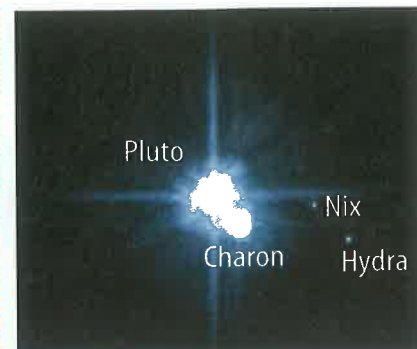


Figure 16 Hydra and Nix are about three times farther from Pluto than Charon is.

section

3

review

Summary

Jupiter

- Jupiter is the largest planet in the solar system.
- The Great Red Spot is a huge storm on Jupiter.

Saturn

- Saturn has a complex system of rings.

Uranus

- Uranus has a bluish-green color caused by methane in its atmosphere.

Neptune

- Like Uranus, Neptune has a bluish-green color.
- Neptune's atmosphere can change rapidly.

Dwarf Planets

- Pluto is made of ice and rock.
- Ceres is a dwarf planet within the asteroid belt.

Self Check

1. **Describe** the differences between the outer planets and the inner planets.
2. **Describe** what Saturn's rings are made from.
3. **Compare** Pluto to the eight planets.
4. **Explain** how Uranus's axis of rotation differs from those of most other planets.
5. **Think Critically** What would seasons be like on Uranus? Explain.

Applying Skills

6. **Identify a Question** When a probe lands on Pluto, so many questions will be answered. Think of a question about Pluto that you'd like to have answered. Then, explain why the answer is important to you.