

CHAPTER 16 Our Solar System

SECTION

3

The Outer Planets



California Science Standards

8.4.c, 8.4.e

BEFORE YOU READ

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

- How are Jupiter, Saturn, Uranus, and Neptune similar?
- How does Pluto differ from the other planets?

**STUDY TIP**

Organize In your notebook, create a chart showing the similarities and differences among the outer planets.

Why Group the Outer Planets Together?

The outer planets are very different from the inner planets. Except for Pluto, the outer planets are made mostly of gas or rock. These planets are called **gas giants**, because they have massive gas atmospheres.

Which Planet Is the Biggest?

Jupiter, shown in the figure below, is the largest planet in our solar system. Its mass is twice as large as the other eight planets combined. Jupiter is made mostly of hydrogen. As large as it is, Jupiter's rotation takes less than 10 hours.

The atmosphere of Jupiter consists of hydrogen, helium, and small amounts of ammonia, methane, and water. Huge storms blow in the atmosphere with winds of up to 540 km/h. Its largest feature, the Great Red Spot, is thought to be a storm three times the size of Earth. The core of Jupiter is very hot, with temperatures reaching 30,000°C. So, it radiates more energy than it receives from the sun.

Jupiter Statistics

Distance from sun	5.20 AU
Period of rotation	9 h, 55.5 min
Period of revolution	11 Earth years, 313 days
Diameter	142,984 km
Density	1.33 g/cm ³
Surface gravity	236% of Earth's

TAKE A LOOK

1. Identify Which of the facts on the table can you use to infer that Jupiter has a shorter day than Earth does?



This *Voyager 2* image of Jupiter was taken at a distance of 28.4 million km. Io, one of Jupiter's moons, can be seen in the lower right-hand side of the photograph.

SECTION 3 The Outer Planets *continued*

What Are Saturn’s Rings?

Saturn is the second-largest planet in the solar system. Saturn’s volume is 764 times as much as Earth’s, but its mass is only 96 times Earth’s mass. That is because Saturn is the least dense of all the planets. Like Jupiter, Saturn is made up mostly of hydrogen with some helium and traces of other gases and water.

Saturn Statistics

Distance from sun	9.54 AU
Period of rotation	10 h, 42 min
Period of revolution	29 Earth years, 155 days
Diameter	120,536 km
Density	0.69 g/cm ³
Surface gravity	92% of Earth’s

Saturn is best known for the rings that orbit the planet above its equator. They are about 250,000 km across (greater than the distance from Earth to the moon) but less than 1 km thick. The rings are made of trillions of particles of water ice and dust. These particles range from a centimeter to several kilometers across. ✓

Astronomers are still debating the mystery of where Saturn’s rings came from. One idea is that the rings are pieces of a large comet that came too close to Saturn. The pull of the planet’s gravity could tear a comet apart. Spacecraft have passed close to Saturn and sent information about its rings back to Earth.



This *Voyager 2* image of Saturn was taken from 21 million km away.

Math Focus

2. Compare About how many times does Earth revolve around the sun while Saturn goes around the sun one time?

READING CHECK

3. Identify What materials make up the rings of Saturn?

Critical Thinking

4. Apply Concepts Even though Saturn has more mass than Earth, its surface gravity is less than that of Earth. Why is Saturn’s surface gravity less than Earth’s?

SECTION 3 The Outer Planets *continued*

What Lies Beyond Saturn?

Saturn is the most distant planet that was known before the telescope was invented. The next planet, Uranus, is the third largest planet in the solar system. It is so far from the sun that it does not reflect much light. It cannot be seen from Earth without using a telescope.

Like Jupiter and Saturn, Uranus is made mostly of hydrogen, helium, and small amounts of other gases. One of these other gases, methane, filters sunlight and gives the planet a greenish color. ✓

The rotation of Uranus is unusual. As shown in the figure below, the north and south poles of Uranus point almost directly at the sun. The north and south poles of most other planets, like Earth, are directed away from the sun.

For about half the Uranian year, one pole is constantly in sunlight, and for the other half of the year it is in darkness. Some scientists think that Uranus may have started out with the same kind of rotation as the other planets. It may have been tipped over by a collision with a massive object.

Uranus Statistics

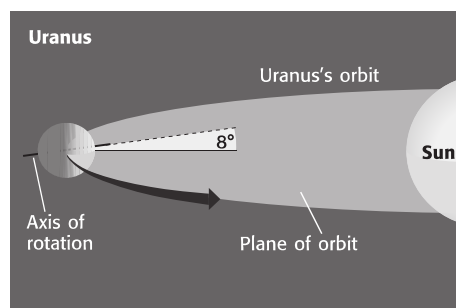
Distance from sun	19.22 AU
Period of rotation	17 h, 12 min
Period of revolution	83 Earth years, 273 days
Diameter	51,118 km
Density	1.27 g/cm ³
Surface gravity	89% of Earth's

✓ READING CHECK

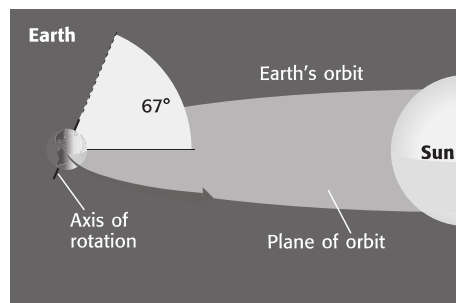
5. Identify What is the main element in the gas giants?

TAKE A LOOK

6. Compare How does the length of a year on Uranus compare with the length of a year on Earth?



Uranus's axis of rotation is tilted so that the axis is nearly parallel to the plane of Uranus's orbit.



In contrast, the axes of most other planets are closer to perpendicular to their plane of orbit.

TAKE A LOOK

7. Define What two points on a planet's surface are used to define its axis of rotation?

SECTION 3 The Outer Planets *continued***Which Planet Is Next?**

Some astronomers predicted that there was a planet beyond Uranus before the planet was observed. Uranus did not move in its orbit exactly as they expected. The force of gravity due to another large object was affecting it. Using predictions of its effect on Uranus, astronomers discovered Neptune in 1846. ✓

Neptune is the fourth largest planet in the solar system. Like the other gas giants, Neptune is made up mostly of hydrogen, helium, and small amounts of other gases. It has a deep blue color, which is caused by methane in its atmosphere. Methane absorbs the red light so more blue light is reflected than red.

Clouds and weather changes are seen in the atmosphere of Neptune. The spacecraft *Voyager* flew past Neptune in 1989 and observed a Great Dark Spot in the southern hemisphere. This spot was a storm as large as Earth. It moved across the planet's surface at about 300 m/s. By 1994, the Great Dark Spot had disappeared. Another dark spot was then located in the northern hemisphere.

Neptune has the fastest winds of any planet in the solar system. Observations from spacecraft show that these winds move through the atmosphere at more than 1,000 km/h. No one knows what causes these winds.

Neptune Statistics

Distance from sun	30.06 AU
Period of rotation	16 h, 6 min
Period of revolution	163 Earth years, 263 days
Diameter	49,528 km
Density	1.64 g/cm ³
Surface gravity	112% of Earth's

Why Is Pluto Called the Mystery Planet?

Scientists thought the path of Neptune's orbit indicated another gas giant even farther from the sun. So, they looked for another planet. It turned out another gas giant could not be located. However, another planet was found. Pluto was discovered in 1930. Pluto's distance from the sun averages 5.9 billion miles, almost 40 times as far away as Earth.

READING CHECK

8. Explain What evidence did astronomers have that Neptune existed before they actually observed it?

TAKE A LOOK

9. Compare How does Neptune's average distance from the sun compare with Earth's?

SECTION 3 The Outer Planets *continued***TAKE A LOOK**

10. Compare How does the length of a planet's year compare with its distance from the sun? Use the period of revolution on this table and on the tables of the other planets.

A SMALL WORLD

Unlike the other outer planets, Pluto is not a gas giant. In fact, it is the smallest planet in the solar system. Pluto is made of rock and ice and has a thin atmosphere composed of methane and nitrogen. Scientists do not know if Pluto was formed along with the other planets.

Pluto Statistics

Distance from sun	39.5 AU
Period of rotation	6 days, 10 h
Period of revolution	248 Earth years, 4 days
Diameter	2,390 km
Density	1.75 g/cm ³
Surface gravity	6% of Earth's

One of Pluto's moons, called Charon, is a little more than half the size of the planet. Because they are so distant, we know very little about Pluto and Charon. In some ways, Pluto and Charon act as a double planet.

In 2006, the spacecraft *New Horizons* began a 10-year trip to study Pluto and Charon. The figure below shows an artist's idea of the view from Pluto. The sun looks like a very bright star beyond Charon. The sun is so distant that the temperature on Pluto only reaches about -235°C .



An artist's view of the sun and Charon from Pluto shows how little light and heat Pluto receives from the sun.

BEYOND PLUTO

In recent years, scientists have discovered hundreds of objects in our solar system beyond Pluto. This region of the solar system, which is called the *Kuiper belt*, contains small bodies that are mostly made of water ice. Some of these objects are more than half the size of Pluto.

Some scientists argue that Pluto should not be considered a planet at all. Instead, they consider it an object in the Kuiper belt.

In October 2003, an object that may be the tenth planet was discovered in the Kuiper belt. Called 2003UB313, it is almost 16 billion km from the sun and is larger than Pluto. ✓

 **READING CHECK**

11. Identify Where is the Kuiper belt located?

Section 3 Review

SECTION VOCABULARY

<p>gas giant a planet that has a deep, massive atmosphere, such as Jupiter, Saturn, Uranus, or Neptune</p>	
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1. Identify What is the main element found in the atmosphere of a gas giant planet?

2. Classify Fill in the blanks to complete the table.

Planet	Distance from sun (AU)	Period of rotation
	5.20	11 Earth years, 313 days
	9.54	29 Earth years, 155 days
	19.21	83 Earth years, 273 days
	30.06	163 Earth years, 263 days
	39.5	248 Earth years, 4 days

3. Evaluate Data As planets get farther from the sun, what happens to the length of their year and their surface temperature?

4. Make Comparisons How do the gas giants differ from the inner planets of the solar system? In your answer, discuss composition, size, distance from the sun, length of a year, and how much energy they get.

5. Identify Relationships What properties of Pluto might make scientists think that it is a Kuiper belt object?
