

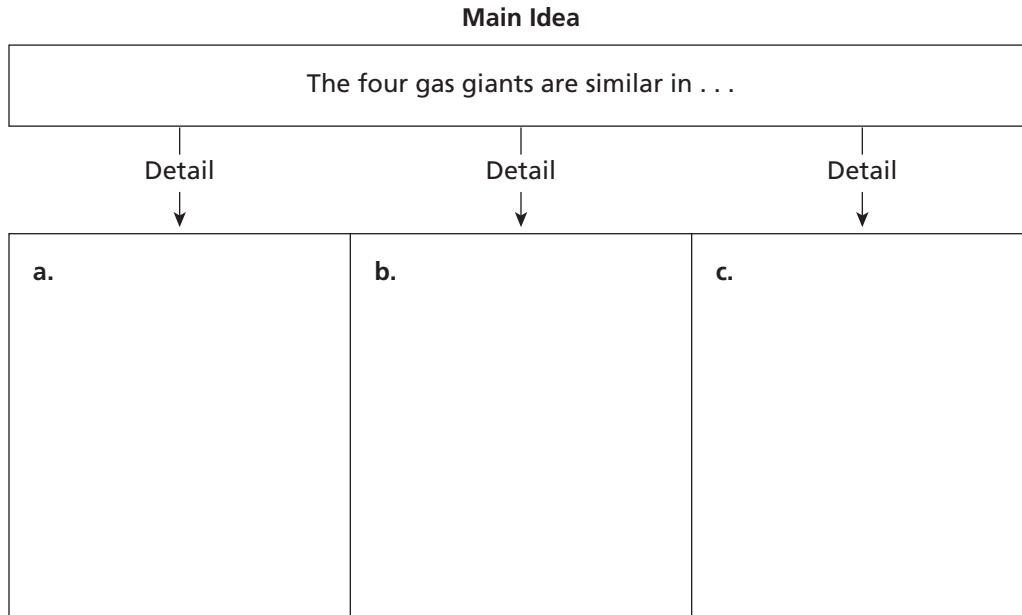
The Solar System ▪ *Guided Reading and Study*

The Outer Planets

This section describes the main characteristics of the five planets farthest from the sun. It also explains how Pluto is different from the other planets.

Use Target Reading Skills

As you read about the similarities among the gas giants, fill in the detail boxes that explain the main idea in the graphic organizer below.



Gas Giants and Pluto

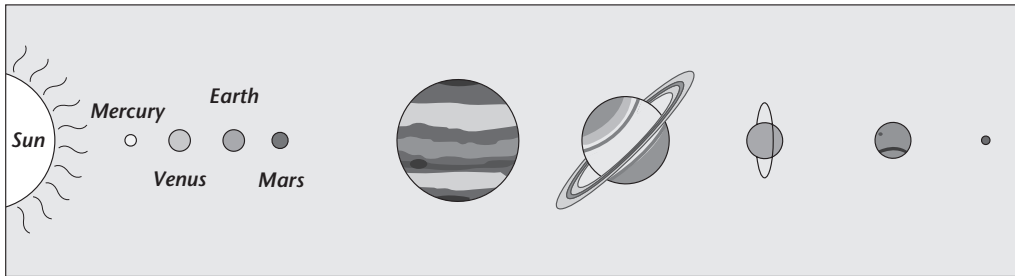
1. The first four outer planets do not have solid _____.
2. Which four planets are known as the gas giants?

3. What is the composition of the gas giants?

The Solar System ▪ *Guided Reading and Study*

The Outer Planets *(continued)*

4. The drawing below shows the sun, the four inner planets, and the five outer planets. Label the outer planets according to their typical place in the solar system.



5. Describe the composition of the rings that surround the gas giants.

Jupiter

6. Is the following sentence true or false? Jupiter is the most massive planet in the solar system. _____

7. What is the Great Red Spot on Jupiter?

8. Circle the letter of each sentence that is true about Jupiter.

- a. Jupiter has a dense core of hydrogen and helium.
- b. Jupiter's atmosphere is extremely thin.
- c. Jupiter has dozens of moons revolving around it.
- d. Many of Jupiter's moons have been discovered in recent years.

9. What are Jupiter's four largest moons?

- a. _____
- b. _____
- c. _____
- d. _____

10. Jupiter's moon Io is covered with active _____.

The Solar System ▪ *Guided Reading and Study*

The Outer Planets *(continued)*

Saturn

11. What are Saturn's rings made of?

12. Is the following sentence true or false? Saturn has only a few thin rings.

13. The largest of Saturn's moons is called _____.

Uranus

14. Why does Uranus look blue-green?

15. How much larger is Uranus than Earth?

16. What discovery made astronomer William Herschel famous?

17. How is the rotation of Uranus unlike that of most of the other planets?

18. What are Uranus's five largest moons like?

19. Which spacecraft sent many images of Uranus back to Earth?

The Solar System ▪ *Guided Reading and Study*

The Outer Planets *(continued)*

Neptune

20. Is the following sentence true or false? Neptune's atmosphere is blue and has no clouds. _____
21. In the 1800s, how did astronomers predict that the planet Neptune would be discovered before anyone had seen it?
- _____
- _____
- _____
22. Circle the letter of the sentence that explains how the Great Dark Spot was like the Great Red Spot.
- a. Both formed from volcanoes.
 - b. Both formed on rings.
 - c. Both were probably storms.
 - d. Neither lasted long.
23. Which is the largest of Neptune's moons? _____

Pluto

24. Is the following sentence true or false? Pluto is smaller than Earth's moon. _____
25. How often does Pluto revolve around the sun?
- _____
- _____
26. Circle the letter of each sentence that is true about Pluto.
- a. Its moon is more than half Pluto's size.
 - b. Pluto has a gaseous surface.
 - c. Some astronomers consider Pluto and Charon to be a double planet.
 - d. Pluto is sometimes closer to the sun than Neptune.
27. Why do some astronomers think Pluto should not be called a planet?
- _____
- _____
- _____
- _____

The Solar System ▪ *Section Summary*

The Outer Planets

Guide for Reading

- What characteristics do the gas giants have in common?
- What are some characteristics that distinguish each of the outer planets?

The first four outer planets—Jupiter, Saturn, Uranus, and Neptune—are much larger and more massive than Earth, and they do not have solid surfaces. Because these four planets are all so large, they are often called the **gas giants**. The fifth outer planet, Pluto, is small and rocky, like the terrestrial planets.

Like the sun, the gas giants are composed mainly of hydrogen and helium. Because they are so massive, they exert a much stronger gravitational force than the terrestrial planets. This prevents their gases from escaping, so they have thick atmospheres. All of the giants have many moons and are surrounded by a set of rings. A **ring** is a thin disk of small particles of ice and rock.

Jupiter is the largest and most massive planet. Jupiter has a thick atmosphere made up mainly of hydrogen and helium. An interesting feature of Jupiter's atmosphere is its Great Red Spot, a storm that is larger than Earth. Jupiter probably has a dense core of rock and iron at its center, surrounded by a thick mantle of liquid hydrogen and helium. Galileo discovered Jupiter's four largest moons: Io, Europa, Ganymede, and Callisto.

Saturn is the second-largest planet in the solar system. Its average density is less than that of water. The rings around Saturn are made of chunks of ice and rock. **Saturn has the most spectacular rings of any planet.**

Uranus is about four times the diameter of Earth and is twice as far from the sun as Saturn. Uranus looks blue-green because of traces of methane in its atmosphere. **Uranus's axis of rotation is tilted at an angle of about 90 degrees from the vertical.** It rotates from top to bottom instead of from side to side.

Neptune is a cold, blue planet. Its atmosphere contains visible clouds. Neptune was discovered as a result of a mathematical prediction. Astronomers have discovered at least 13 moons orbiting Neptune.

Pluto has a solid surface and is much smaller and denser than the other outer planets. Pluto has a single moon, Charon. Because Charon is more than half the size of Pluto, some astronomers consider them to be a double planet instead of a planet and a moon. Pluto revolves around the sun only once every 248 Earth years.

The Solar System ▪ *Review and Reinforce*

The Outer Planets

Understanding Main Ideas

Answer the following question in the spaces provided.

1. What are the five outer planets?

2. Which planets are the gas giants?

3. What are the two main differences between Pluto and the gas giants?

4. Why doesn't the gas on a gas giant escape into space, as it has on Mercury?

5. What object in the solar system has a composition similar to that of the gas giants? _____

6. What planet is by far the most massive of all the planets that revolve around the sun? _____

7. What are Saturn's rings made of? _____

8. How did astronomers know where to look to discover Neptune?

9. Why do astronomers sometimes consider Pluto and its moon, Charon, to be a double planet?

Building Vocabulary

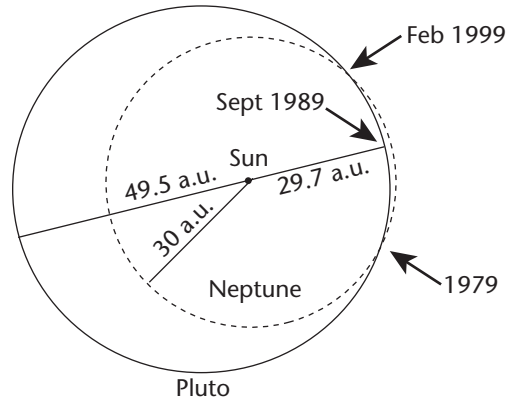
10. Define *gas giant*.

11. What is a *ring*?

The Solar System ▪ *Enrich*

The Orbits of Neptune and Pluto

The orbit of Neptune is very close to circular. Pluto's orbit is more elliptical. The diagram below shows the orbits of Pluto and Neptune. The arrows show Pluto's position at different times. The unit of distance used in the diagram is the *astronomical unit*, or a.u. An a.u. is the average distance from Earth to the sun, about 150 million kilometers. Neptune's distance from the sun is about 30 astronomical units, or 4,495 million kilometers.



Answer the following questions in the spaces provided.

1. In 1989, Pluto was as close to the sun as it ever gets. How close was it?

2. What was Neptune's distance from the sun in 1989?

3. Pluto takes 248 years to complete one revolution around the sun. When will Pluto and Neptune next be an equal distance from the sun?

4. When will Pluto next be as far from the sun as it ever gets?

5. Is one planet farther than the other from the sun now? If so, which one?

The Solar System ▪ *Design Your Own Lab*

Speeding Around the Sun

In this lab, you will make a model to show how a planet’s distance from the sun is related to its period of revolution.

Problem

How does a planet’s distance from the sun affect its period of revolution?

Materials

- string, 1.5 m
- one-hole rubber stopper
- plastic tube, 6 cm
- stopwatch or watch with second hand
- weight or several washers
- meter stick

Procedure   *Review the safety guidelines in Appendix A.*

PART 1 Modeling Planetary Revolution

1. Use the table below to record your data.

Data Table

Distance (cm)	Period of Revolution			
	Trial 1	Trial 2	Trial 3	Average
20				
40				
60				

2. Make a model of a planet orbiting the sun by threading the string through the rubber stopper hole. Tie the end of the string to the main part of the string. Pull tightly to make sure that the knot will not become untied.
3. Thread the other end of the string through the plastic tube, and tie a weight to that end. Have your teacher check both knots.

The Solar System ▪ *Design Your Own Lab*

4. Pull the string so the stopper is 20 cm away from the plastic tube. Hold the plastic tube in your hand above your head. Keeping the length of string constant, swing the rubber stopper in a circle above your head just fast enough to keep the stopper moving. The circle represents a planet's orbit, and the length of string from the rubber stopper to the plastic tube represents the distance from the sun. **CAUTION:** *Stand away from other students. Make sure the swinging stopper will not hit students or objects. Do not let go of the string.*

5. Have your lab partner time how long it takes for the rubber stopper to make ten complete revolutions. Determine the period for one revolution by dividing the measured time by ten. Record the time in the data table.

6. Repeat Step 5 two more times.

Be sure to record each trial in the data table. After the third trial, calculate and record the average period of revolution.

PART 2 Designing an Experiment

7. Write your hypothesis for how a planet's period of revolution would be affected by changing its distance from the sun.

8. Design an experiment that will enable you to test your hypothesis. Write the steps you plan to follow to carry out your experiment. As you design your experiment, consider the following factors.

- What different distances will you test?
- What variables are involved in your experiment, and how will you control them?
- How many trials will you run for each distance?

9. Have your teacher review your step-by-step plan. After your teacher approves your plan, carry out your experiment.



The Solar System ▪ *Design Your Own Lab*

Speeding Around the Sun *(continued)*

Analyze and Conclude

Answer the following questions on a separate sheet of paper.

- 1. Making Models** In your experiment, what represents the planet and what represents the sun?
- 2. Making Models** What force does the pull on the string represent?
- 3. Interpreting Data** What happened to the period of revolution when you changed the distance in Part 2? Did your experiment prove or disprove your hypothesis?
- 4. Drawing Conclusions** Which planets take less time to revolve around the sun—those closer to the sun or those farther away? Use the model to support your answer.
- 5. Designing Experiments** As you were designing your experiment, which variable was the most difficult to control? How did you design your procedure to control that variable?
- 6. Communicating** Write a brief summary of your experiment for a science magazine. Describe your hypothesis, procedure, and results in one or two paragraphs.

More to Explore

Develop a hypothesis for how a planet's mass might affect its period of revolution. Then, using a stopper with a different mass, modify the activity to test your hypothesis. Before you swing the stopper, have your teacher check your knots.