

## CHAPTER 21 A Family of Planets

## SECTION

## 2

## The Inner Planets

**BEFORE YOU READ**

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

- Which planets are known as the inner planets?
- What properties do the inner planets share?

**National Science Education Standards**  
ES 1c, 3a, 3b

**Why Group the Inner Planets Together?**

The inner solar system includes the only planet known to support life, Earth, and three other planets. These four inner planets are called **terrestrial planets** because they all have a chemical makeup similar to that of Earth. The terrestrial planets are much smaller, denser, and more rocky than most of the outer planets. ✓



**Compare** In your notebook, create a chart showing the similarities and differences among the inner planets.



**1. Explain** Why are the inner planets called terrestrial planets?

---



---

**Which Planet Is Closest to the Sun?**

Mercury is the planet closest to the sun. After Earth, it is the second densest object in the solar system. This is because, like Earth, Mercury has a large iron core in its center. The surface of Mercury is covered with craters.

Mercury rotates on its axis much more slowly than Earth. Remember that the amount of time that a planet takes to rotate once is its *period of rotation*. It is the length of a day on the planet. Mercury's period of rotation is about 59 Earth days long. Therefore, a day on Mercury is about 59 Earth days long.

On Mercury, a year is not much longer than a day. Remember that the time it takes a planet to go around the sun once is the planet's *period of revolution*. It is the length of one year on the planet. A *Mercurian* year, or a year on Mercury, is equal to 88 Earth days. Therefore, each year on Mercury lasts only 1.5 Mercurian days.

**Facts About Mercury**

Distance from sun	0.38 AU
Period of rotation	58 Earth days, 19 hours
Period of revolution	88 Earth days
Diameter	4,879 km
Density	5.43 g/cm <sup>3</sup>
Surface gravity	38% of Earth's

**Critical Thinking**

**2. Infer** Which of the facts on the table could scientists use to infer that Mercury has a core made of iron?

---

**SECTION 2** The Inner Planets *continued*

### Is Venus Earth’s Twin?

The second planet from the sun is Venus. In some ways, Venus is more like Earth than any of the other planets. It is about the same size as Earth. However, Venus is slightly smaller, less dense, and less massive than Earth.

If you could observe the sun from the surface of Venus, you would see it rise in the west and set in the east. That is because Venus and Earth rotate on their axes in opposite directions.

If you looked down on Earth from above the North Pole, you would see Earth spinning counterclockwise. This is called **prograde rotation**. However, if you were to look down on Venus from above its north pole, you would see it spinning clockwise. This is called **retrograde rotation**. ✓

 **READING CHECK**

**3. Compare** How do prograde rotation and retrograde rotation differ?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### THE ATMOSPHERE OF VENUS

Venus has the densest atmosphere of the terrestrial planets. The atmospheric pressure on Venus’s surface is 90 times that on Earth. This pressure would instantly crush a human on Venus. Venus’s atmosphere is mostly made of carbon dioxide and thick clouds of sulfuric acid. The thick atmosphere causes a strong greenhouse effect. As a result, surface temperatures on Venus average about 464°C. This is hot enough to melt lead and some other metals.

#### Facts About Venus

Distance from sun	0.72 AU
Period of rotation	243 Earth days, 16 hours
Period of revolution	224 Earth days, 17 hours
Diameter	12,104 km
Density	5.24 g/cm <sup>3</sup>
Surface gravity	91% of Earth’s

### TAKE A LOOK

**4. Compare** Which is longer on Venus, one day or one year?

\_\_\_\_\_

### Critical Thinking

**5. Analyzing Methods** Why did scientists use *Magellan’s* radar instead of telescopes to map the surface of Venus?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### MAPPING THE SURFACE OF VENUS

Because of its thick atmosphere, we cannot observe the surface of Venus from Earth with telescopes. Between 1990 and 1992, the *Magellan* spacecraft made maps of Venus using radar waves. These waves can travel through the atmosphere and bounce off the surface. Maps made from the radar data showed that Venus has craters, mountains, lava plains, and volcanoes.

**SECTION 2** The Inner Planets *continued***What Makes Earth Unique?**

Until the mid-1900s, no one knew what Earth looked like from space. Today, satellites and spacecraft can take pictures of a sparkling blue planet. Light reflecting off ocean water makes Earth look blue from space.

**WATER ON EARTH**

Earth is the only planet in the solar system that can support life as we know it. This is because Earth has a certain combination of factors that make life possible. These factors include abundant water and just the right amount of energy from the sun.

Liquid water is vital to life as we know it. Earth is not the only planet in the solar system to have water on its surface. However, Earth is the only planet that has large amounts of liquid water on its surface. Earth is close enough to the sun that all the water does not freeze. It is far enough away that the water does not boil away. If Earth were much closer to or farther from the sun, liquid water—and life—could not exist here.

**Facts About Earth**

Distance from sun	1.0 AU
Period of rotation	23 hours, 56 minutes
Period of revolution	365 Earth days, 6 hours
Diameter	12,756 km
Density	5.52 g/cm <sup>3</sup>
Surface gravity	100% of Earth's

**STUDYING EARTH FROM SPACE**

NASA's Earth Science Enterprise is a program to study Earth from space. Studying Earth from space lets scientists study the Earth as a whole system. It helps them understand changes in Earth's atmosphere, oceans, ice, landforms, and living things. It may also be able to help them understand how humans affect the global environment. By studying Earth from space, scientists can learn how different parts of the Earth interact.

 **READING CHECK**

**6. Identify** What feature of Earth causes it to appear blue from space?

\_\_\_\_\_

**Math Focus**

**7. Calculate** Use the information on the table to explain why every fourth year on Earth is a leap year. Show your work.

(Hint: Compare Earth's period of revolution to the number of days in a calendar year.)

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**SECTION 2** The Inner Planets *continued*

## What Is the Red Planet?

Besides Earth, the most studied planet in the solar system is Mars. Mars looks red, so it is sometimes known as “the red planet.” Some scientists think that there could be simple life on Mars.

Scientists have learned much about Mars by observing it from Earth. However, most of our knowledge of the planet has come from unmanned spacecraft. So far, these observations have found no evidence of life.

### THE ATMOSPHERE OF MARS

Because it has a thinner atmosphere than Earth and is farther from the sun, Mars is colder than Earth. In the middle of the summer, the spacecraft *Mars Pathfinder* recorded a temperature range from  $-13^{\circ}\text{C}$  to  $-77^{\circ}\text{C}$ . The Martian atmosphere is made mainly of carbon dioxide. ✓

The atmospheric pressure on Mars is very low. At the surface, it is about the same as the pressure 30 km above Earth’s surface. Because of the low temperatures and air pressure, liquid water cannot exist on the surface of Mars. The only water on Mars’s surface is in the form of ice.

#### Facts About Mars

Distance from sun	1.52 AU
Period of rotation	24 hours, 37 minutes
Period of revolution	687 Earth days
Diameter	6,794 km
Density	$3.93\text{ g/cm}^3$
Surface gravity	38% of Earth’s

### WATER ON MARS

Even though water cannot exist on the surface of Mars today, it may have in the past. Evidence from spacecraft suggests that some of Mars’s features were formed by liquid water. For example, some of Mars’s features are similar to those caused by water erosion on Earth. Other features indicate that Mars’s surface contains sediments that may have been deposited by the water from a large lake. ✓

Scientists cannot prove that these features were caused by liquid water. However, they indicate that at some time in the past, Mars may have had liquid water. If this is true, it would show that Mars was once warmer and had a thicker atmosphere than it does today.

 **READING CHECK**

**8. Explain** What are two reasons that the surface of Mars is colder than that of Earth?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### TAKE A LOOK

**9. Compare** How does the length of a day on Mars compare to the length of day on Earth?

\_\_\_\_\_

\_\_\_\_\_

 **READING CHECK**

**10. Identify** What two features suggest that water once existed on the surface of Mars?

\_\_\_\_\_

\_\_\_\_\_

**SECTION 2** The Inner Planets *continued***WHERE THE WATER IS NOW**

Mars has two polar icecaps made of a combination of frozen water and frozen carbon dioxide. Most of the water on Mars is trapped in this ice. There is some evidence from the *Mars Global Surveyor* that water could exist just beneath the surface. If so, it may be in liquid form. If Mars does have liquid water beneath its surface, there is a possibility that some form of life may exist on Mars. ✓

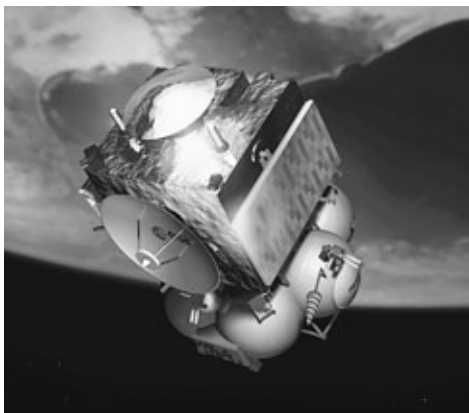
**VOLCANOES ON MARS**

The remains of giant volcanoes exist on the surface of Mars. They show that Mars has had active volcanoes in the past. Unlike on Earth, however, the volcanoes are not spread across the whole planet. There are two large volcanic systems on Mars. The largest one is about 8,000 km long.

The largest mountain in the solar system, Olympus Mons, is a Martian volcano. It is a shield volcano, similar to Mauna Kea on the island of Hawaii. However, Olympus Mons is much larger than Mauna Kea. The base of Olympus Mons is 600 kilometers—about 370 miles—across. It is nearly 24 kilometers tall. That is three times as tall as Mount Everest! It may have grown so tall because the volcano erupted for long periods of time. ✓

**MISSIONS TO MARS**

Scientists sent several vehicles to Mars in the early 21st century. The figure below shows *Mars Express Orbiter*, which reached Mars in December 2003. In January 2004, the exploration rovers *Spirit* and *Opportunity* landed on Mars. These solar-powered wheeled robots have found evidence that water once existed on the Martian surface. ✓



The *Mars Express Orbiter* helps scientists map Mars and study Mars's atmosphere.

 **READING CHECK**

**11. Identify** Where does water exist on Mars today?

---



---

 **READING CHECK**

**12. Explain** What may have allowed Olympus Mons to grow so large?

---



---



---

 **READING CHECK**

**13. Describe** What have the rovers *Spirit* and *Opportunity* found?

---



---

# Section 2 Review

NSES ES 1c, 3a, 3b

## SECTION VOCABULARY

**prograde rotation** the counterclockwise spin of a planet or moon as seen from above the planet's North Pole; rotation in the same direction as the sun's rotation

**retrograde rotation** the clockwise spin of a planet or moon as seen from above the planet's North Pole

**terrestrial planet** one of the highly dense planets nearest to the sun; Mercury, Venus, Mars, and Earth

1. **Identify** Does Earth show prograde or retrograde rotation?

\_\_\_\_\_

2. **Compare** Fill in the blanks to complete the table.

Planet	Distance from sun	Period of revolution
	0.38 AU	58 Earth days, 19 hours
	0.72 AU	243 Earth days, 16 hours
	1.00 AU	365 Earth days, 6 hours
	1.52 AU	687 Earth days

3. **Analyze Ideas** Why do scientists think that Mars was once warmer and had a thicker atmosphere than it does today?

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

4. **Identify Relationships** How is the period of revolution of a planet related to its distance from the sun? (Hint: examine the statistics tables.)

\_\_\_\_\_  
 \_\_\_\_\_

5. **Explain** Why is the surface temperature of Venus higher than the surface temperatures of the other inner planets?

\_\_\_\_\_  
 \_\_\_\_\_

6. **Explain** Why could life probably not have developed on Earth if Earth were closer to the sun?

\_\_\_\_\_