

17.2 The Planets

There are eight major planets in our solar system. Some have environments baked by heat and radiation (Mercury) and some are far colder than ice (Neptune). Venus, the most Earth-like planet in size, has a surface atmosphere of hot, dense sulfuric acid! Our own planet (Figure 17.7) is unique in having the right balance of temperature and environment to sustain life—or is it? Might there be unusual forms of life unknown to us on the other planets? Scientists have recently discovered living organisms on Earth that feed off hot sulfur emissions from volcanoes on the ocean floor. Could these organisms survive on Venus? The planets are an unexplored frontier full of discoveries waiting to be made!

An overview of the planets

Classifying the planets

The planets are commonly classified in two groups. The **terrestrial planets** include Mercury, Venus, Earth, and Mars. The terrestrial planets are mostly made of rock and metal. They have relatively high densities, slow rotations, solid surfaces, and few moons. The other group, the **gas giants**, include Jupiter, Saturn, Uranus, and Neptune. They are made mostly of hydrogen and helium. These planets have relatively low densities, rapid rotations, thick atmospheres, and many moons. Table 17.1 on page 412 compares the planets.

Changing ideas

On August 24, 2006, the International Astronomical Union (IAU) passed a new definition of a planet. The new definition excludes Pluto as a planet. According to the new definition, Pluto is classified as a “dwarf planet.” Recently, astronomers have begun to find dozens of objects similar to Pluto—all small, icy, rocky, and with similar orbits. The change in Pluto’s status as a planet is a good example of the scientific method in progress. New discoveries sometimes cause scientists to revise scientific knowledge.



Photo courtesy of NASA

Figure 17.7: *Crystal-blue Earth is unique in its ability to sustain life—or is it?*

Mercury and Venus

Mercury

Mercury, the closest planet to the Sun, is the smallest in both size and mass. Mercury appears to move quickly across the night sky because its period of revolution is the shortest of all of the planets. Mercury rotates on its axis very slowly—only one and a half times for every revolution around the Sun. This makes one day on Mercury about 59 Earth days, although its year is not much longer—about 88 Earth days! Only 40 percent larger than Earth’s moon, Mercury is a rocky, cratered world, more like the Moon than like Earth. Like the Moon, Mercury has almost no atmosphere (except for traces of sodium). Mercury has no moons. The side of Mercury that faces the Sun is very hot, about 400 °C, while the other side is very cold, about –170 °C.



Photo courtesy NASA/USGS.

Venus

Venus appears as the brightest planet and the third brightest object in the sky (after the Sun and the Moon). It has a very thick atmosphere and an atmospheric pressure at its surface that is 90 times that at Earth's surface. Because the atmosphere on Venus is 96 percent carbon dioxide, the greenhouse effect makes it the hottest planet in the solar system with a surface temperature of more than 500 °C. Venus rotates "backward," that is, east to west. Its rotation is the slowest of all of the planets; Venus makes a little less than one rotation for each revolution around the Sun. This means that 1 day on Venus is 243 Earth days, while 1 year is shorter: 225 Earth days! Like Mercury, Venus has no moons.



Photo courtesy of NASA

Earth and Mars

Earth

Earth is a small, rocky planet with an atmosphere that is made of mostly nitrogen (78 percent) and oxygen (21 percent). Earth is one of only two bodies in the solar system known to have liquid water (the other is Europa, a moon of Jupiter). Earth has an active geology, including volcanoes and crustal movement. Earth's atmosphere, along with its vast oceans and moderate temperature range, supports an incredible variety of life. *As far as we know*, Earth is the only planet in the solar system to support life. Although space probes have begun searching, the ultimate answer to the question of life on other planets may have to wait until humans can look in person. Earth's single rocky moon is about one-quarter the diameter of Earth. At a distance of 384,400 kilometers, the Moon is about 30 Earth-diameters away from the planet, completing one orbit every 27.3 days.



Photo courtesy NASA/JPL-Caltech

Mars

Mars appears as a reddish point of light in the night sky. It has a widely varied surface that includes deserts, huge valleys and craters, and volcanic mountains that dwarf those on Earth. The atmosphere of Mars is very thin (about 0.7 percent as thick as that of Earth) and composed mostly of carbon dioxide, while the rest is nitrogen and argon. The temperatures are below freezing most of the time. Like Earth, Mars has polar ice caps, but they are composed of a combination of water and frozen carbon dioxide. Because it has an axial tilt, Mars experiences seasons like Earth. A day on Mars (24.6 hours) is similar in length to Earth, while a year (687 days) is not. Mars has two small moons named Phobos and Deimos.



Photo courtesy of ESA

Jupiter and Saturn

Jupiter

Jupiter is the largest of the planets, and the fastest rotator, spinning on its axis about once every 10 hours. A year on Jupiter is about 12 Earth years. Jupiter is more liquid than gaseous or solid—more than half of its volume is an ocean of liquid hydrogen. Its atmosphere is about 88 percent hydrogen and 11 percent helium. The atmospheric pressure below Jupiter's thick clouds is more than a million times that of Earth! It has a very stormy atmosphere and one storm known as the Great Red Spot has been observed for more than 300 years. Jupiter's mass is greater than the combined masses of all of the other planets, but its density is very low—about one-quarter that of Earth. With 63 moons, Jupiter is like a mini solar system.



Photo courtesy of NASA

Saturn

Saturn, at almost 10 times the size of Earth, is the second largest planet. Like Jupiter, Saturn's atmosphere is made mostly of hydrogen and helium. Saturn is a fast rotator, though slightly slower than Jupiter, with a day on Saturn lasting just longer than 10 Earth hours. A year on Saturn is about 29 Earth years. The most striking feature of Saturn is its system of rings (above, right), which are visible from Earth with a telescope. Saturn's rings are made up of billions of particles of rock and ice ranging from microscopic to the size of a house. Although they are hundreds of thousands of kilometers wide, the rings are less than 100 meters thick. With 47 moons, Saturn is also like a mini solar system.



Photo courtesy NASA.

Uranus and Neptune

Uranus

The seventh planet from the Sun, Uranus can barely be seen without a good telescope and was not discovered until 1781. It rotates “backward” and has an axis that is tilted 98 degrees to the plane of its orbit. A day on Uranus is only 18 Earth hours, but a year takes 84 Earth years. Uranus has at least 27 moons, all of them relatively small. Titania, the largest, has only 4 percent the mass of Earth’s moon.



Neptune

Neptune, the eighth planet from the Sun, is the outermost of the gas planets. It was discovered in 1846 and its discovery almost doubled the diameter of the known solar system because of its great distance from the Sun. Neptune’s orbit is nearly a perfect circle; only Venus has a more circular orbit. A day on Neptune is only 16 hours long but a year takes 165 Earth years! Neptune has a series of faint rings invisible from Earth but that have been seen in photographs taken by space probes such as Voyager. Neptune has 13 known moons, six of which were found in photographs taken by *Voyager 2* in 1989. Of the eight moons, only Triton is bigger than a few hundred kilometers.



Mercury



Earth



Mercury facts

Type: terrestrial

Moons: 0

Distance from Sun: 0.39 AU

Diameter: 0.38 × Earth

Surface gravity: 38% of Earth

Surface temp.: -170 to 400 °C

Atmosphere: none

Length of day: 59 Earth days

Length of year: 88 Earth days

Mercury was named for the messenger of the Roman gods

because of its quick motion in the sky.



Venus facts

Type: terrestrial

Moons: 0

Distance from Sun: 0.72 AU

Diameter: 0.95 × Earth

Surface gravity: 91% of Earth

Avg. surface temp.: 460 °C

Atmosphere: dense, 96% CO₂

Length of day: 243 Earth days

Length of year: 225 Earth days

Venus was named after the Roman goddess of love because of its beautiful, shiny appearance.

Earth facts

Type: terrestrial

Moons: 1

Distance from Sun: 1 AU

Diameter: 12,800 km

Surface gravity: 9.8 N/kg

Avg. surface temp.: 10 °C

Atmosphere: dense, N₂, O₂

Length of day: 24 hours

Length of year: 365.25 days

Earth is the only planet not named after a Roman god. Its name comes from Old English "oerthe," meaning land or country.



Type: terrestrial

Moons: 2

Distance from Sun: 1.5 AU

Diameter: 0.53 × Earth

Surface gravity: 38% of Earth

Avg. surface temp.: -50 °C

Atmosphere: thin, CO₂

Length of day: 24.6 hours

Length of year: 687 Earth days

Mars' red color reminded ancient observers of blood so they named it after the Roman god of war.

Earth 

Jupiter



Jupiter facts

Type: gas giant

Moons: 63, plus faint rings

Distance from Sun: 5.2 AU

Diameter: 11.2 × Earth

Surface gravity: 253% of Earth

Avg. atmos. temp.: -108 °C

Atmosphere: 88% H, 10% He

Length of day: 10 Earth hours

Length of year: 11.9 Earth years

Jupiter was king of the Roman gods.

The planet's great brightness inspired its name.

Earth 



Saturn

Saturn facts

Type: gas giant

Moons: 47, plus rings

Distance from Sun: 9.5 AU

Diameter: 9.4 × Earth

Surface gravity: 1.06% of Earth

Avg. atmos. temp.: -139°C

Atmosphere: 96% H, 3% He

Length of day: 10.7 Earth hours

Length of year: 29.5 Earth years

Because of its slow orbit around the

Sun, Saturn was named after the

Roman god of agriculture and time.

Uranus

Neptune



Earth



Uranus facts

Type: gas giant

Moons: 27, plus rings

Distance from Sun: 19.1 AU

Diameter: 4 × Earth

Surface gravity: 90% of Earth

Avg. atmos. temp.: -197 °C

Atmosphere: 82% H, 15% He

Length of day: 18 Earth hours

Length of year: 84 Earth years

Uranus is the first planet discovered in modern times and is named after the first Roman god.

Neptune facts

Type: gas giant

Moons: 13, plus rings

Distance from Sun: 30 AU

Diameter: 3.9 × Earth

Surface gravity: 114% of Earth

Avg. atmos. temp.: -201 °C

Atmosphere: 96% H, 3% He

Length of day: 16 Earth hours

Length of year: 165 Earth years

Because it is so far in the depths of space, Neptune was named after the Roman god of the deep sea.

Property	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Diameter (km)	4,878	12,102	12,756	6,794	142,796	120,660	51,200	49,500
Mass (kg)	3.3×10^{23}	4.9×10^{24}	6.0×10^{24}	6.4×10^{23}	1.9×10^{27}	5.7×10^{26}	8.7×10^{25}	1.0×10^{26}
Density (g/cm ³)	5.44	5.25	5.52	3.91	1.31	0.69	1.21	1.67
Av. Distance from the sun (million km)	58	108	150	228	778	1,430	2,870	4,500
Moons	0	0	1	2	63	47	27	13
Gravitational Force (N)	3.7	8.9	9.8	3.7	23.1	9.0	8.7	11.0
Surface Temp. (C°)	-170 to +400	+450 to +480	-88 to +48	-89 to -31	-108	-139	-197	-201
Rotational Period (Earth Days)	59	243	1	1.03	0.41	0.43	0.72	0.67
Revolutionary Period (Earth Years)	0.24	0.62	1	1.9	12	29	84	165
Major Gases in Atmosphere	Na	CO ₂	N ₂ , O ₂	CO ₂	H ₂ , He, CH ₄ , NH ₃	H ₂ , He, CH ₄ , NH ₃	H ₂ , He, CH ₄ , NH ₃	H ₂ , He, CH ₄ , NH ₃

17.2 Section Review

1. Which planet has the most extreme temperature variations?
2. Which planet looks brightest in the sky?
3. Mercury is most similar to:
 - a. Earth's moon
 - b. Saturn
 - c. Venus
 - d. Mars
4. Which planet is most similar to Earth in diameter, gravitational strength, and composition?
5. Which planet has the longest year? Which planet has the shortest?
6. Which planet has the longest day? Which planet has the shortest?
7. After Earth, which planet would be the best candidate to support life? Explain your reasoning.
8. What makes up Saturn's rings?
9. Is Saturn the only planet with rings?
10. Which planets rotate backward?
11. Why is Jupiter sometimes called a "mini solar system"?
12. Order the following planets from largest to smallest: Uranus, Mars, Venus, Earth, Neptune, Jupiter, Mercury, Saturn.
13. Compared with Earth's diameter, Saturn's diameter is roughly:
 - a) the same
 - b) 5 times larger
 - c) 10 times larger
 - d) 50 times larger