

What Are Conditions Like on the Inner Planets?

Lesson Objectives

- Describe the main features of each of the inner planets.
- Compare each of the inner planets to Earth and to one another.

Introduction

The four inner planets (closest to the Sun - Mercury, Venus, Earth, and Mars) - are referred to as the inner planets. They are similar to Earth. All are solid, dense, and rocky. None of the inner planets have rings. Compared to the outer planets, the inner planets are small. They have shorter orbits around the Sun and they spin more slowly. Venus spins backwards and spins the slowest of all the planets.

All of the inner planets were geologically active at one time. They are all made of cooled igneous rock with inner iron cores. Earth has one big, round moon, while Mars has two very small, irregular moons. Mercury and Venus do not have moons.

Section 1: Mercury

Mercury is the smallest planet. It has no moon. The planet is also closest to the Sun. As the Figure below shows, the surface of Mercury is covered with craters, like Earth's moon. The presence of impact craters that are so old means that Mercury hasn't changed much geologically for billions of years. With only a trace of an atmosphere, it has no weather to wear down the ancient craters.

Short year, long days

Mercury is named after the Roman messenger god. Mercury was a messenger because he could run extremely fast. The Greeks gave the planet this name because Mercury appears to move very quickly in its orbit around the Sun. Mercury orbits the Sun in just 88 Earth days. Mercury has a very short **year** (one complete revolution around the sun), but it also has very long days. Mercury rotates slowly on its axis, turning exactly three times for every two times it orbits the Sun. This combination of rotation and orbital motion results in a solar day (noon to noon) on Mercury that is two Mercury years long.

Terms to know

- inner planets
- year

1.1 Extreme Temperatures

Mercury is very close to the Sun, so it can get very hot. Mercury also has virtually no atmosphere. As the planet rotates very slowly, the temperature varies tremendously. In direct sunlight, the surface can be as hot as 427°C (801°F). On the dark side, the surface can be as cold as -183°C (-297°F)! The coldest temperatures may be on the insides of craters. Most of Mercury is extremely dry. Scientists think that there may be a small amount of water, in the form of ice, at the planet's poles. The poles never receive direct sunlight.



Section 2: Venus

Named after the Roman goddess of love, Venus is the only planet named after a female. Venus is sometimes called Earth's "sister planet." But just how similar is Venus to Earth? Venus is our nearest neighbor. Venus is most like Earth in size.

A Harsh Environment

Viewed through a telescope, Venus looks smooth and featureless. The planet is covered by a thick layer of clouds. You can see the clouds in pictures of Venus, such as the Figure below. We make maps of the surface using radar, because the thick clouds won't allow us to take photographs of the surface of Venus.



Left - A topographical map of Venus produced by the Magellan probe using radar. Color differences enhance small scale structure.



Right - Venus in real color. The planet is covered by a thick layer of clouds.

The Figure above shows a topographical map of Venus. The map was produced by the Magellan probe in orbit around Venus. The spacecraft sent radar waves that reflected off Venus' surface to reveal mountains, valleys, vast lava plains, and canyons. Like Mercury, Venus does not have a moon.

Clouds on Earth are made of tiny water droplets. Venus' clouds are a lot less pleasant. They are made of tiny droplets of corrosive sulfuric acid! The atmosphere on Venus is so thick that the pressure on the surface of Venus is very high. In fact, it is 90 times greater than the pressure at Earth's surface! The thick atmosphere causes a strong greenhouse effect. As a result, Venus is the hottest planet. Even though it is farther from the sun, Venus is much hotter even than Mercury. Temperatures at the surface reach 464°C (867°F). That's hot enough to melt lead!

Volcanoes

Venus has more volcanoes than any other planet. Most of the planet's surface is covered by lava flows and volcanoes. There are over a thousand large volcanoes and there are many more small volcanoes. Most of the volcanoes are now inactive. There are also a large number of craters. There is no clear evidence that Venus or any other planet besides Earth has tectonic plates.

Motion and Appearance

Venus is the only planet that rotates clockwise as viewed from above the northern plane of the solar system. All of the other planets rotate counterclockwise. Venus turns slowly, making only one turn every 243 days. This is longer than a **year** on Venus! It takes Venus only 225 days to orbit the Sun.

Because the orbit of Venus is inside Earth's orbit, Venus always appears close to the Sun. You can see Venus rising early in the morning, just before the Sun rises. For this reason, Venus is sometimes called "the morning star." When it sets in the evening, just after the Sun sets, it may be called "the evening star." Since planets only reflect the Sun's light, Venus should not be called a star at all! Venus is very bright because its clouds reflect sunlight very well. Venus is the brightest object in the sky besides the Sun and the Moon.

Section 3: Earth

Earth is the third planet from the Sun, shown in the Figure below. Because it is our planet, we know a lot more about Earth than we do about any other planet. What are some of the main features of Earth?

Oceans and Atmosphere

Earth is a very diverse planet. Water appears as vast oceans of liquid. Water is also seen as ice at the poles or as clouds. Earth also has large masses of land. Earth's average surface temperature is 14°C (59°F). At this temperature, water is a liquid. The oceans and the atmosphere help keep Earth's surface temperatures fairly steady.

Earth is the only planet known to have life. Conditions on Earth are ideal for life! The atmosphere and magnetic field filters out harmful

radiation. Water is abundant. Carbon dioxide was available for early life forms. The evolution of plants introduced more oxygen for animals.

Plate Tectonics

The Earth is divided into many plates. These plates move around on the surface. The plates collide or slide past each other. One may even plunge beneath another. Plate motions cause most geological activity. This activity includes earthquakes, volcanoes, and the buildup of mountains. The reason for plate movement is convection in the mantle. Earth is the only planet that we know has plate tectonics.

Earth's Motions and Moon

Earth rotates on its axis once every day. This is the length of an Earth day. Earth orbits the Sun once every 365.24 days. This is the length of an Earth year. Earth has one large moon. The moon orbits Earth once every 29.5 days with respect to the sun. This moon is covered with craters, and also has large impact basins that were later filled with lava. Many astronomers think that the Moon came into being from material that flew into space after Earth and a Mars-sized object collided during the formation of the solar system. This moon is not a captured asteroid like other moons in the solar system.



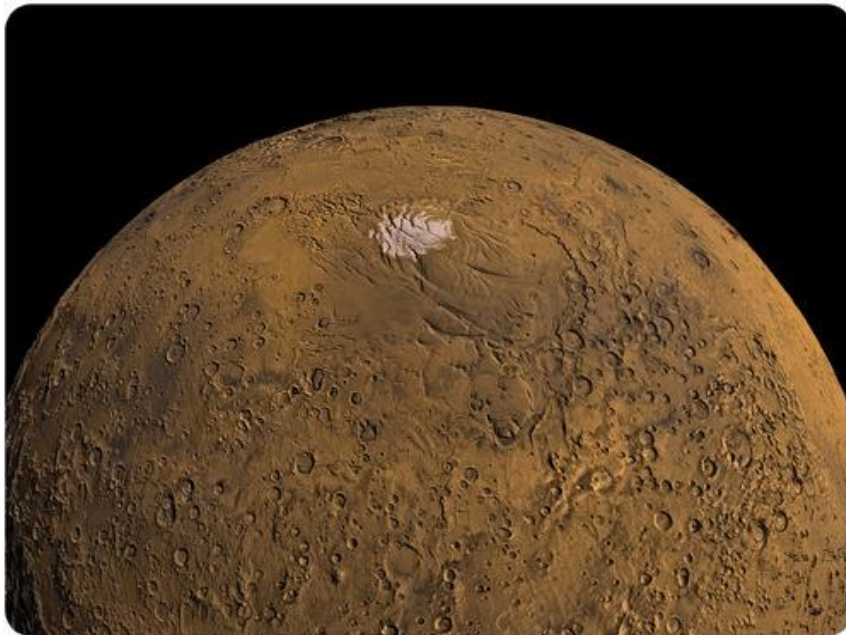
Extension: Life on Earth and elsewhere:

nai.arc.nasa.gov/library/downloads/ERG.pdf

Section 4: Mars

Mars, shown in the Figure below, is the fourth planet from the Sun. The Red Planet is the first planet beyond Earth's orbit. Mars' atmosphere is thin compared to Earth's. This means that there is much lower pressure at the surface. Mars also has a weak greenhouse effect, so temperatures are only slightly higher than they would be if the planet did not have an atmosphere.

Mars is the only planet that has a surface that can be observed from Earth through a telescope. As a result, it has been studied more than any other planet besides Earth. We have also sent many space probes to Mars. In April 2011, there were three scientific satellites in orbit around Mars. The rover, Opportunity, was still moving around on the surface. No humans have ever set foot on Mars. NASA and the European Space Agency have plans to send people to Mars. The goal is to do it sometime between 2030 and 2040. The expense and danger of these missions are phenomenal.

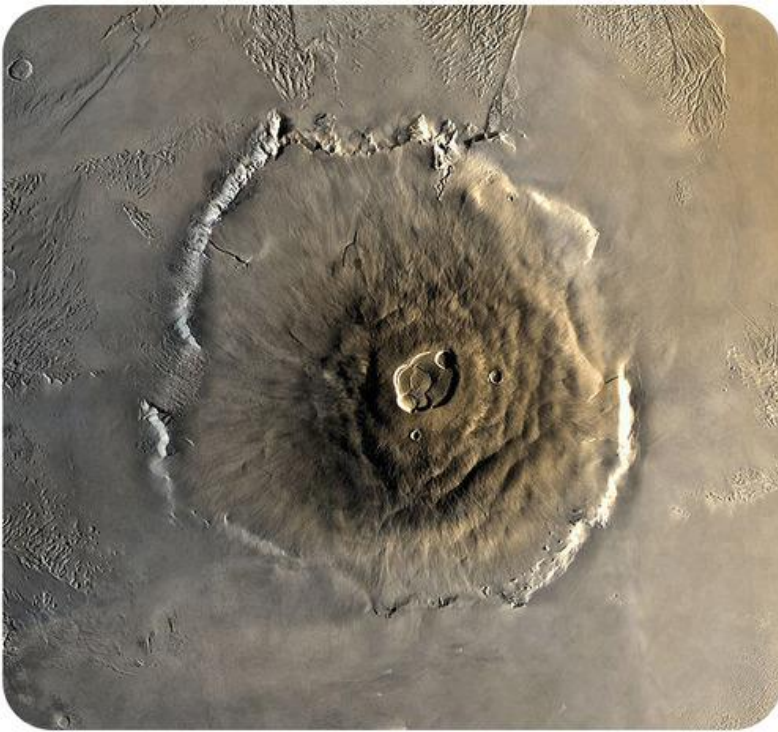


A Red Planet

Viewed from Earth, Mars is red. This is due to large amounts of iron oxide in the soil. The ancient Greeks and Romans named the planet Mars after the god of war. The planet's red color reminded them of blood. Mars has only a very thin atmosphere, made up mostly of carbon dioxide.

Surface Features

Mars is home to the largest volcano in the solar system. Olympus Mons is shown in the Figure below. Olympus Mons is a shield volcano. The volcano is similar to the volcanoes of the Hawaiian Islands. But Olympus Mons is a giant, about 27 km (16.7 miles/88,580 feet) tall. That's three times taller than Mount Everest! At its base, Olympus Mons is about the size of the entire state of Arizona.



The largest volcano in the solar system, Olympus Mons.



The largest canyon in the solar system, Valles Marineris

Mars also has the largest canyon in the solar system, Valles Marineris (the Figure below). This canyon is 4,000 km (2,500 miles) long. That's as long as Europe is wide! One-fifth of the circumference of Mars is covered by the canyon. Valles Marineris is 7 km (4.3 miles) deep. How about Earth's Grand Canyon? Earth's most famous canyon is only 446 km (277 miles) long and about 2 km (1.2 miles) deep.

Mars has mountains, canyons, and other features similar to Earth. But it doesn't have as much geological activity as Earth. There is no evidence of plate tectonics on Mars. There are also more craters on Mars than on Earth. But there are fewer craters than on the Moon. What does this suggest to you regarding Mars' plate tectonic history?

Is There Water on Mars?

Water on the surface of Mars can't be a liquid. This is because the pressure of the atmosphere and the temperature are too low. The planet does have a lot of water; it is in the form of ice. The south pole of

Mars has a very visible ice cap. Scientists also have evidence that there is a lot of ice just under the Martian surface.

Scientists think that there was once liquid water on the planet. There are many surface features that look like water-eroded canyons. Rovers and orbiters sent to Mars have found minerals that, on Earth, usually form in water. If there was liquid water on Mars, life might have existed there in the past.

Two Martian Moons

Mars has two very small, irregular moons, Phobos and Deimos. These moons were discovered in 1877. They are named after the two sons of Ares, who followed their father into war. There are several explanations for the origin of these moons.

“Many scientists believe that Phobos and Deimos are asteroids that wandered close to Mars billions of years ago. The Martian atmosphere may have been thick enough to act as a brake slowing the small bodies to trap them in orbit. But other scientists say that the moons formed at the same time as Mars, or that they’re remnants of a larger moon that was shattered by a large meteor.”

<http://bit.ly/1beSCr0>

University of Texas McDonald Observatory