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The average temperature on Earth is 15 degrees Celsius (59 degrees F)

Earth is a small planet in the vastness of space. It is one of nine planets that travel through space around the sun. The sun is a star -- one of billions of stars that make up a galaxy called the Milky Way. The Milky Way and as many as 100 billion other galaxies make up the universe.

The planet Earth is only a tiny part of the universe, but it is the home of human beings and, in fact, all known life in the universe. Animals, plants, and other organisms live almost everywhere on Earth's surface. They can live on Earth because it is just the right distance from the sun. Most living things need the sun's warmth and light for life. If Earth were too close to the sun, it would be too hot for living things. If Earth were too far from the sun, it would be too cold for anything to live. Living things also must have water to live. Earth has plenty. Water covers most of Earth's surface.

Earth, our home planet, has oceans of liquid water, and continents that rise above sea level. NASA scientists combined satellite photographs with surface data to create this detailed image of Earth's land masses and oceans. The swirling mass of clouds west of Mexico is a large hurricane. Image credit: NASA/Goddard Space Flight Center

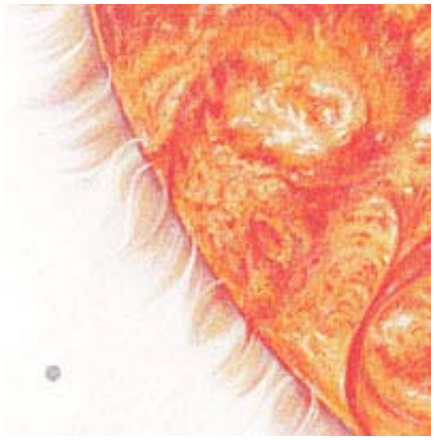
The study of Earth is called geology, and scientists who study Earth are geologists. Geologists study different physical features of Earth to understand how they were formed and how they may have changed over time. Much of Earth, such as the deep interior, cannot be studied directly. Geologists must often study samples of rock and use indirect methods to learn about the planet. Today, geologists can also view and study the entire Earth from space.

This article discusses Earth (Earth as a planet) (Earth's spheres) (Earth's rocks) (Cycles on and in Earth) (Earth's interior) (Earth's crust) (Earth's changing climate) (History of Earth).

Earth as a planet

Earth ranks fifth in size among the nine planets. It has a diameter of about 8,000 miles (13,000 kilometers). Jupiter, the largest planet, is about 11 times larger in diameter than Earth. Pluto, the smallest planet, has a diameter less than one-fifth that of Earth.

Earth, like all the planets in our solar system, travels around the sun in a path called an orbit. Earth is about 93 million miles (150 million kilometers) from the sun. It takes one year for Earth to complete one orbit around the sun. The innermost planet, Mercury, is only about one-third as far from the sun as Earth and circles the sun in only 88 days. Pluto, the outermost planet, is 40 times as far from the sun as Earth and takes 248 Earth years to circle the sun.



The sun is much larger than Earth. From the sun's center to its surface, it is about 109 times the radius of Earth. Some of the streams of gas rising from the solar surface are larger than Earth. Image credit: World Book illustration by Roberta Polfus

How Earth moves

Earth has three motions. It (1) spins like a top around an imaginary line called an axis that runs from the North Pole to the South Pole, (2) it travels around the sun, and (3) it moves through the Milky Way along with the sun and the rest of the solar system.

Earth takes 24 hours to spin completely around on its axis so that the sun is in the same place in the sky. This period is called a solar day. During a solar day, Earth moves a little around its orbit so that it faces the stars a little differently each night. Thus, it only takes 23 hours 56 minutes 4.09 seconds for Earth to spin once so that the stars appear to be in the same place in the sky. This period is called a sidereal day. A sidereal day is shorter than a solar day, so the stars appear to rise

about 4 minutes earlier each day.

Earth takes 365 days 6 hours 9 minutes 9.54 seconds to circle the sun. This length of time is called a sidereal year. Because Earth does not spin a whole number of times as it goes around the sun, the calendar gets out of step with the seasons by about 6 hours each year. Every four years, a day is added to bring the calendar back into line with the seasons. These years, called leap years, have 366 days. The extra day is added to the end of February and occurs as February 29.

The distance around Earth's orbit is 584 million miles (940 million kilometers). Earth travels in its orbit at 66,700 miles (107,000 kilometers) an hour, or 18.5 miles (30 kilometers) a second. Earth's orbit lies on an imaginary flat surface around the sun called the orbital plane.

Earth's axis is not straight up and down, but is tilted by about 23 1/2 degrees compared to the orbital plane. This tilt and Earth's motion around the sun causes the change of the seasons. In January, the northern half of Earth tilts away from the sun. Sunlight is spread thinly over the northern half of Earth, and the north experiences winter. At the same time, the sunlight falls intensely on the southern half of Earth, which has summer. By July, Earth has moved to the opposite side of the sun. Now the northern half of Earth tilts toward the sun. Sunlight falls intensely over the northern half of Earth, and the north experiences summer. At the same time, the sunlight falls less intensely on the southern half of Earth, which has winter.

Earth's orbit is not a perfect circle. Earth is slightly closer to the sun in early January (winter in the Northern Hemisphere) and farther away in July. In January, Earth is 91.4 million miles (147.1 million kilometers) from the sun, and in July it is 94.5 million miles (152.1 million kilometers) from the sun. This variation has a far smaller effect than the heating and cooling caused by the tilt of Earth's axis.

Earth and the solar system are part of a vast disk of stars called the Milky Way Galaxy. Just as the moon orbits Earth and planets orbit the sun, the sun and other stars orbit the tightly packed center of the Milky Way. The solar system is about two-fifths of the way from the center of the Milky Way and revolves around the center at about 155 miles (249 kilometers) per second. The solar system makes one complete revolution around the center of the galaxy in about 220 million years.

Earth's size and shape

Most people picture Earth as a ball with the North Pole at the top and the South Pole at the bottom. Earth, other planets, large moons, and stars -- in fact, most objects in space bigger than about 200 miles (320 kilometers) in diameter -- are round because of their gravity. Gravity pulls matter in toward the center of objects. Tiny moons, such as the two moons of Mars, have so little gravity that they do not become round, but remain lumpy instead.

To our bodies, "down" is always the direction gravity is pulling. People everywhere on Earth feel "down" is toward the center of Earth and "up" is toward the sky. People in Spain and in New Zealand are on exactly opposite sides of Earth from each other, but both sense their surroundings as "right side up." Gravity works the same way on other planets and moons.

Earth, however, is not perfectly round. Earth's spin causes it to bulge slightly at its middle, the equator. The diameter of Earth from North Pole to South Pole is 7,899.83 miles (12,713.54 kilometers), but through the equator it is 7,926.41 miles (12,756.32 kilometers). This difference, 26.58 miles (42.78 kilometers), is only 1/298 the diameter of Earth. The difference is too tiny to be easily seen in pictures of Earth from space, so the planet appears round.

Earth's bulge also makes the circumference of Earth larger around the equator than around the poles. The circumference around the equator is 24,901.55 miles (40,075.16 kilometers), but around the poles it is only 24,859.82 miles (40,008.00 kilometers). The circumference is actually greatest just south of the equator, so Earth is slightly pear-shaped. Earth also has mountains and valleys, but these features are tiny compared to the total size of Earth, so the planet appears smooth from space.

Earth has a diameter of about 7,900 miles (12,700 kilometers). The diameter of Jupiter, the biggest planet in our solar system, is more than 11

Earth and its moon

Earth has one moon. Pluto also has one moon, while Mercury and Venus have

none. All the other planets in our solar system have two or more moons. Earth's moon has a diameter of 2,159 miles (3,474 kilometers) -- about one-fourth of Earth's diameter.

The sun's gravity acts on Earth and the moon as if they were a single body with its center about 1,000 miles (1,600 kilometers) below Earth's surface. This spot is the Earth-moon barycenter. It is the point of balance between the heavy Earth and the lighter moon. The path of the barycenter around the sun is a smooth curve. Earth and the moon circle the barycenter as they orbit the sun. The motion of Earth and moon around the barycenter makes them "wobble" in their path around the sun.

View of Earth and the moon from space. Image credit: NASA

Earth's spheres

Earth is composed of several layers, or spheres, somewhat like the layers of an onion. The solid Earth consists of a thin outer layer, the crust, with a thick rocky layer, the mantle, beneath it. The crust and the upper portion of the mantle are called the lithosphere. At the center of Earth is the core. The outer part of the core is liquid, while the inner part is solid. Much of Earth is covered by a layer of water or ice called the hydrosphere. Earth is surrounded by a thin layer of air, the atmosphere. The portion of the hydrosphere, atmosphere, and solid land where life exists is called the biosphere.

The atmosphere

Air surrounds Earth and becomes progressively thinner farther from the surface. Most people find it difficult to breathe more than 2 miles (3 kilometers) above sea level. About 100 miles (160 kilometers) above the surface, the air is so thin that satellites can travel without much resistance. Detectable traces of atmosphere, however, can be found as high as 370 miles (600 kilometers) above Earth's surface. The atmosphere has no definite outer edge but fades gradually into space.

Nitrogen makes up 78 percent of the atmosphere, while oxygen makes up 21 percent. The remaining 1 percent consists of argon and small amounts of other gases. The atmosphere also contains water vapor, carbon dioxide, water droplets, dust particles, and small amounts of many other chemicals released by volcanoes, fires, living things, and human activities.

The lowest layer of the atmosphere is called the troposphere. This layer is in constant motion. The sun heats Earth's surface and the air above it, causing warm air to rise. As the warm air rises, air pressure decreases and the air expands and cools. The cool air is denser than the surrounding air, so it sinks and the cycle starts again. This constant cycle of the air causes the weather.

High above the troposphere, about 30 miles (48 kilometers) above Earth's surface, is a layer of still air called the stratosphere. The stratosphere contains a layer where ultraviolet light from the sun strikes oxygen molecules to create a gas called ozone. Ozone blocks most of the harmful ultraviolet rays from reaching Earth's surface. Some ultraviolet rays get through, however. They are responsible for sunburn and can cause skin cancer in people. Tiny amounts of human-made chemicals have caused some of the natural ozone to break down. Many people are concerned that the ozone layer may become too thin, allowing ultraviolet rays to reach the surface and harm people and other living things.

Water vapor, carbon dioxide, methane, and other gases in the atmosphere trap heat from the sun, warming Earth. The heat-trapping quality of these gases causes the greenhouse effect. Without the greenhouse effect of the atmosphere, Earth would probably be too cold for life to exist.

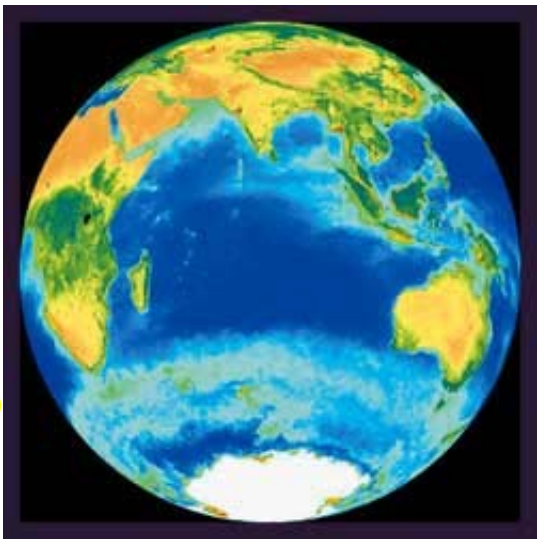
Ocean waters cover most of Earth's surface. This satellite view shows the Indian Ocean, partly bordered by Africa, Asia, and Australia, and below it the Southern Ocean surrounding Antarctica.

The hydrosphere

Earth is the only planet in the solar system with abundant liquid water on its surface. Water has chemical and physical properties not matched by any other substance, and it is essential for life on Earth. Water has a

great ability to absorb heat. The oceans store much of the heat Earth gets from the sun. The electrical charges on water molecules give water a great ability to attract atoms from other substances. This quality allows water to dissolve many things. Water's ability to dissolve materials makes it a powerful agent in breaking down rocks. Liquid water on Earth affects not just the surface but the interior as well. Water in rocks lowers the melting temperature of rock. Water dramatically weakens rocks and makes them easier to melt beneath Earth's surface.

About 71 percent of Earth's surface is covered by water, most of it in the oceans. Ocean water is too salty to drink. Only about 3 percent of Earth's water is fresh water, suitable for drinking. Much of Earth's fresh water is not readily available to people because it is frozen in the polar ice caps or beneath Earth's surface. Polar regions and high mountains stay cold enough for water to remain permanently frozen. The region of permanent ice on Earth is sometimes called the cryosphere.



Ocean waters cover most of Earth's surface. This satellite view shows the Indian Ocean, partly bordered by Africa, Asia, and Australia, and below it the Southern Ocean surrounding Antarctica. Image credit: NASA/Goddard Space Flight Center and ORBIMAGE/SeaWiFS Project

The lithosphere

The crust and upper mantle of Earth from the surface to about 60 miles (100 kilometers) down make up the lithosphere. The thin crust is made up of natural chemicals called minerals composed of different combinations of elements. Oxygen is the most abundant chemical element in rocks in Earth's crust, making up about 47 percent of the weight of all rock. The second most abundant element is silicon, 27 percent, followed by aluminum (8 percent), iron (5 percent), calcium (4 percent), and sodium, potassium, and magnesium (about 2 percent each). These eight elements make up 99 percent of the weight of rocks on Earth's surface.

Two elements, silicon and oxygen, make up almost three-fourths of the crust. This combination of elements is so important that geologists have a special term for it: silica. Minerals that contain silica are called silicate minerals. The most abundant mineral on Earth's surface is quartz, made up of pure silica. Another plentiful group of silicates are the feldspars, which consist of silica, aluminum, calcium, sodium, and potassium. Other common silicate minerals on Earth's surface are pyroxene (PY rahk seen) and amphibole (AM fuh bohl), which consist of combinations of silica, iron, and magnesium.

Another important group of minerals are the carbonates, which contain carbon and oxygen along with small amounts of other elements. The most important carbonate mineral is calcite, made up of calcium, carbon, and oxygen. Limestone, a common rock used for building, is mostly calcite. Another important carbonate is dolomite, composed of carbon, oxygen, calcium, and magnesium.

Earth has two kinds of crust. The dry land of the continents is made up mostly of granite and other light silicate minerals, while the ocean floors are composed mostly of a dark, dense volcanic rock called basalt. Continental crust averages about 25 miles (40 kilometers) thick, but it is thicker in some areas and thinner in others. Most oceanic crust is only about 5 miles (8 kilometers) thick. Water fills in the low areas over the thin basalt crust to form the world's oceans. There is more than enough water on Earth to completely fill the oceanic basins, and some of it spreads onto the edges of the continents. This portion of the continents surrounded by a band of shallow ocean is called the continental shelf.

The biosphere

Earth is the only planet in the universe known to have life. The region containing life extends from the bottom of the deepest ocean to a few miles or kilometers into the atmosphere. There are several million known kinds, called species, of living things, and scientists believe that there are far many more species not yet discovered.

Life affects Earth in many ways. Life has actually made the atmosphere around us. Plants take in water and carbon dioxide, both of which contain oxygen. They use the carbon in carbon dioxide and the hydrogen in water to make chemicals of many kinds and give off oxygen as a waste product. Animals eat plants to get energy and return water and carbon dioxide back into the environment. Living things affect the surface of Earth in other ways as well. Plants create chemicals that speed the breakdown of rock. Grasslands and forests slow the erosion of soil.

Earth's rocks

The solid part of Earth consists of rocks, which are sometimes made up of a single mineral, but more often consist of mixtures of minerals. Geologists classify rocks according to their origin. Igneous rocks form when molten rock cools and solidifies. Sedimentary rocks form when grains of rock or dissolved chemicals are deposited in layers by wind, water, or glaciers. Over time, the layers harden into solid rock. Metamorphic rocks develop deep in Earth's crust when heat or pressure transform other types of rock.

Igneous rocks form from molten material called magma. Most of Earth's interior is solid, not molten, but it is extremely hot. At the base of Earth's crust, the temperature is about 1800 degrees F (1000 degrees C). In some portions of the crust, conditions are right for rocks to melt. Rocks can melt more easily near the crust if they contain water, which lowers their melting point.

The Earth has both active and extinct volcanoes.

Where conditions are right, small pockets of magma form beneath and within the crust. Some of this magma reaches the surface, where it erupts from volcanoes as lava. Igneous rocks formed this way are called volcanic or extrusive. Vast quantities of magma, however, never reach the surface. They cool slowly within the crust and may only be exposed long afterward by erosion. Such igneous rocks are called plutonic or intrusive. Plutonic rocks cool slowly. During this slow cooling, their minerals form large crystals. Plutonic rocks tend to be much coarser than volcanic rocks.

Igneous rocks that are rich in silica tend to be poor in iron and magnesium, and the opposite is also true. Volcanic rocks that are iron-rich and silica-poor are basalt. Plutonic rocks of the same makeup are called gabbro. Silica-rich volcanic rocks are called rhyolite (RY uh lyt), and plutonic rocks of the same composition are granite. Granite lies under most of the continents, while basalt lies under most of the ocean floors.

Sedimentary rocks

Rocks on Earth's surface are under constant attack by chemicals and mechanical forces. The processes that break down rocks are called weathering. Water is effective at dissolving minerals. When water freezes, it expands, so expanding ice helps pry apart mineral grains in rocks. In addition, living things produce chemicals that help dissolve rocks.

Once rocks break apart, the loose material is often carried away by erosion. Running water erodes rocks. Wind and glaciers also contribute to erosion. Erosion is usually a relatively slow process, but over millions of years, erosion can uncover even rocks many miles or kilometers below the surface.

Materials derived from weathering and erosion of rocks are eventually deposited to form sedimentary rocks. Rocks that are made up of small pieces of other rocks are called clastic rocks. Rocks containing larger pebbles are called conglomerate. The particles in these rocks are cemented together when minerals dissolved in the water crystallize between the grains. The most abundant sedimentary rocks, called mudrocks, consist of tiny particles. Some of these rocks, called shale, split into thin sheets when broken. Sandstone is a sedimentary rock made up of sand cemented together.

Other sedimentary rocks form when dissolved materials undergo chemical reactions and settle out as tiny solid particles. These rocks are called chemical sedimentary rocks. Common chemical sedimentary rocks include some types of limestone and dolomite. Some chemical sedimentary rocks form when water evaporates, leaving dissolved materials behind. Rock salt and a mineral called gypsum form this way.

Some sedimentary rocks, called biogenic, are formed by the action of living things. Coal is the remains of woody plants that have been transformed into rock by heat and pressure over time. Most limestone is formed by microscopic marine organisms that secrete protective shells of calcium carbonate. When the animals die, the shells remain and solidify into limestone.

Metamorphic rocks

When rocks are buried deeply, they become hot. Earth's crust grows hotter by about 70 degrees F per mile (25 degrees C per kilometer) of depth. Pressure also increases with depth. At a depth of 1 mile (1.6 kilometers) beneath the surface, the pressure is about 6,000 pounds per square inch (41,360 kilopascals). As rocks are heated and subjected to pressure, minerals react and the rocks become metamorphic. Shale is transformed to slate, limestone, and eventually into marble under pressure. Many metamorphic rocks contain recognizable features that tell of their origin, but others change so much that only the chemical makeup provides evidence of what they originally were.

Cycles on and in Earth