

THE EARTH, SUN, AND MOON

reflect

The Sun and Moon are Earth's constant companions. We bask in the Sun's heat and light. It provides Earth's energy, and life could not exist without it. We rely on the Moon to light dark nights. Earth's closest neighbor, the Moon is the only other object in space that humans have ever set foot on. Together, the Sun, Earth, and Moon are responsible for ocean tides, eclipses, and the phases of the Moon. But they couldn't be more different when it comes to size and structure. How do the characteristics of Earth, the Sun, and the Moon compare to one another?

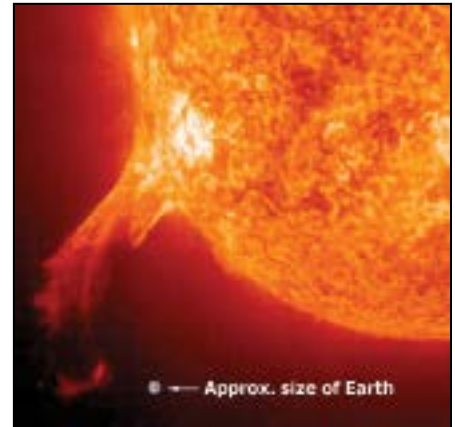


What are the physical characteristics of the Sun?

The Sun is a star at the center of our solar system. This means that the Sun is more similar to other stars than to Earth or the Moon. The Sun seems larger and brighter than other stars because it is so close to Earth. Here are some other physical characteristics of the Sun.

- **Surface:** The Sun, like all stars, is a glowing ball of gas. Even if a spaceship could withstand the heat, it could not land on the Sun because the Sun's surface is not solid.
- **Atmosphere:** Because the Sun is made up of gas, it has a very thick atmosphere. An *atmosphere* is a layer of gases surrounding an object in space. The majority of the gas that makes up the Sun is hydrogen. The gases in the Sun are packed tightly together, making it incredibly dense. This contributes to the Sun's very strong **gravity**.

gravity: an attractive force between all objects with mass



A solar flare erupts from the surface of the Sun. A picture of Earth is added to show the enormous size of the flare.

- **Temperature:** Different parts of the Sun have different temperatures. The surface is one of the coolest areas of the Sun at $5,500^{\circ}\text{C}$ ($10,000^{\circ}\text{F}$). But that's nothing compared to the *core*, or center. The average temperature at the center of the Sun is $15,000,000^{\circ}\text{C}$ ($27,000,000^{\circ}\text{F}$)!
- **Features:** Sunspots and solar flares are features on the Sun's surface. Sunspots are dark areas that are cooler than the rest of the surface. The number of sunspots changes about every 11 years. *Solar flares* are quick increases in brightness. They occur when energy builds up in the Sun and is suddenly released. Solar flares extend beyond the surface of the Sun and look like explosions.
- **Size:** The Sun has much more **mass** than any of the other objects in the Solar System. In fact, about one million Earths could fit inside the Sun! Its great mass gives the Sun very strong gravity. Earth and the other objects in the Solar System follow continuous **orbits** around the Sun because its gravity is so great.

mass: the amount of matter in an object

orbit: a curved path around an object, such as the Sun

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look out!

The Sun is so hot that it glows. However, the Sun is not on fire. Fire is a reaction that occurs on Earth when a fuel, like wood or oil, mixes with oxygen and a spark. The Sun contains no such fuel for fires. Instead, in the core of the Sun hydrogen particles come together to form helium particles. This reaction produces huge amounts of energy. This is what makes the Sun hot and causes it to glow. In this way, sunlight is more similar to a light bulb than to a flame. A tiny piece of metal inside a light bulb is heated using electricity. It becomes so hot that it begins to glow with a bright light. The Sun's glow works in a similar way. However, instead of electricity it uses energy from the reactions in its core.



What are the physical characteristics of Earth?

Our home planet is just one of the bodies that orbit the Sun. It shares many characteristics with other planets and moons in the Solar System. However, it is unique in one special way—there is life on Earth. Life has not yet been discovered anywhere else in the universe. However, scientists have hypothesized that it is possible, given the number of stars and planets out in space. Many of the physical features on Earth have made it an ideal place for life to develop.



Other than Earth, scientists have not found any other places in the universe that have liquid water and life.

- **Surface:** Unlike the Sun, the surface of Earth is solid. Even below the liquid oceans, there is solid earth. Because of this, Earth is called a rocky planet. However, the planet is not completely solid. Part of Earth's core is a liquid mix of metals—mostly iron and nickel.
- **Atmosphere:** Earth is surrounded by an atmosphere of gases. We know it better as air. The atmosphere is an important reason why life exists on Earth. It holds in much of the heat from the Sun so the planet never gets too cold. The atmosphere also contains oxygen. Oxygen is necessary for many living things—including humans—to breathe.
- **Temperature:** Earth is the third planet from the Sun. This is the perfect distance for life—our planet never gets extremely hot or extremely cold. Even the coldest and hottest places on Earth are not extreme compared to other planets. The average temperature on Earth is 15°C (59°F). For comparison, the average temperatures of Earth's closest neighboring planets are 461°C (861°F) on Venus and -63°C (-81°F) on Mars!
- **Features:** Earth has many features including mountains, volcanoes, forests, and continents. One of Earth's most important features, however, is the presence of liquid water. Approximately 70% of the planet is covered in oceans, but there is still more water held in lakes, rivers, icebergs, and **glaciers**. Even the atmosphere contains water in clouds

glaciers: slow moving masses of ice and snow that have accumulated over time

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and vapor, which is the gas form of water. The presence of water on Earth makes life possible on Earth.

- **Size:** The rocky planets in the Solar System are much smaller than the gas giant planets like Jupiter and Saturn. Earth is the largest of the rocky planets. However, it is still very, very small in comparison to the Sun. It would take 100 Earths lined up next to each other to equal the Sun's **diameter**.

diameter: the distance between two opposite points on a sphere

What are the physical characteristics of Earth's Moon?

Coming into view each night in Earth's sky is the Moon. As Earth orbits the Sun, the Moon orbits Earth. The Moon is the only other object in outer space that humans have ever been to. When astronauts first landed on the Moon in 1969, they discovered some of its physical characteristics for the first time.

- **Surface:** Like Earth, the Moon is rocky. The Moon has no active volcanoes; however, recent moonquake data suggests that there is magma under its surface. The Moon's surface is divided into two categories, which can be seen when you look at it from Earth. The light-colored areas are hills called highlands. The dark-colored areas are called *maria* (singular: *mare*). They are flat plains that early astronomers incorrectly thought were seas. (*Maria* is the Latin word for "seas.") Most of the Moon's surface is covered with craters, rocks, and dust. *Craters* are holes or pits on the surface formed when chunks of space rock crash into the Moon.
- **Atmosphere:** The reason that the Moon is struck by objects from space all the time is because it has no atmosphere. The layer of gas surrounding Earth protects it from incoming **meteoroids**, most of which burn up in our atmosphere. The Moon has no such protection from collisions.
- **Temperature:** The lack of an atmosphere causes the Moon to have extreme temperatures. An atmosphere acts like a blanket around a planet. At night, it holds in some of the heat. On the Moon, nearly all the energy from the Sun is reflected back to space. Temperatures during the day can be as high as 123°C (253°F), but at night they drop to -233°C (-387°F).
- **Features:** There are very few features on the Moon besides the craters. It is dusty, rocky, and lifeless. Because there are no active volcanoes, flowing rivers, rainfall, or winds, the Moon rarely changes. Footprints from some of the first astronauts to walk on the Moon in 1969 are still visible in the Moon's dust.



meteoroids: relatively small chunks of space rock



This footprint remains from one of the first Moon landings over 40 years ago.

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- **Size:** The Moon orbits Earth because it is located very close to Earth and it is much smaller. Earth's own gravity is strong enough to hold the Moon in orbit. If Earth were completely hollow you could fill it with 50 moons!

Looking to the Future: Moving Day on the Moon

What do you think it would be like to live on the Moon? Many people have wondered the same thing. After astronauts first landed on the Moon in 1969, the idea of living there became more realistic. As we continue to consume Earth's resources, the idea of Moon colonies becomes more popular. Living on the Moon would allow scientists to run experiments under little gravity and would create more space for humans to spread out. But for now, the disadvantages outweigh the advantages. With no atmosphere, the colony would have to be built underground to be protected from the Sun's rays and space debris.



what do you think?

A scale model shows the sizes of the planets and other objects in the Solar System in comparison to one another. For example, if Earth were scaled down to the size of a baseball, the Moon would be the size of a cherry pit. What object do you think could represent the size of the Sun?

try now

Model how rocks from space cause craters on the Moon's surface. For this activity you will need:

- A large, aluminum roasting pan
 - Sand, about 2 liters
 - Flour, 50 milliliters
 - Cocoa powder, 20 milliliters
 - Marbles or other small, round objects of various sizes
1. In a small group, fill the pan with sand about 8 centimeters deep.
 2. Cover the sand with a thin layer of flour and a thin layer of cocoa powder.
 3. Choose one of the marbles to act like a chunk of rock from space. Drop it from about 30 centimeters above the pan. Do NOT throw the marble.
 4. Carefully remove the marble. Try to avoid touching the sand in the pan.
 5. What happened to the surface of the sand? What do the marks from the flour and cocoa powder look like? What does their shape tell you about what happens when the surface is struck? Draw a picture of your observations.
 6. Repeat steps 3–5, dropping objects of different sizes from various heights.

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What do you know?

The statements below describe physical characteristics of the Sun, the Moon, and Earth. Using what you know about the different features of these three celestial bodies, decide which body each statement describes. Place each statement in the correct column of the table.

- My atmosphere protects me from heat loss at night.
- Fifty of me can fit inside Earth.
- All the planets in the Solar System orbit me.
- Dark spots on my surface change in number every 11 years.
- My core is partially liquid metals.
- Energy in my core provides heat and light for the entire Solar System.
- I am the only known place in the universe with liquid water and life.
- One million Earths can fit inside me.
- People once thought my maria were liquid seas.
- I have no atmosphere so I experience extreme temperatures.

The Sun	Earth	The Moon

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connecting with your child

Bringing the Sun, the Moon, and Earth Home

Make observations of the Sun, Earth, and the Moon in order to help your child understand the differences between each. Begin by studying Earth. Take students outdoors to a natural area such as a nearby beach, forest, or field. Have them examine the natural surroundings and describe what they see. For example, they may say that they see hills covered in green grass, a pond with ducks floating on its surface, and white, puffy clouds in the blue sky. Encourage your child to think about which features are unique to Earth, such as plants, animals, and water; they may also note the temperature and the look and feel of the atmosphere. Encourage students to be as detailed as possible with their descriptions. While there, have your child notice the characteristics of the Sun that we can experience on Earth, such as its glowing light that we can see and the heat it emits that we can feel. Do NOT let your child look directly at the Sun.

At night, students should use a telescope or binoculars to examine the Moon, describing the features of the Moon they observe. See if students can find the maria, highlands, and craters. Encourage students to make predictions about the temperature on the Moon as they look at it.

Here are some questions to discuss with students:

- What characteristics of the Sun do we experience on Earth? What characteristics can we only see in pictures?
- Why do the Moon and the Sun look like they are about the same size even when we know the Sun is many times larger than the Moon?
- What are the main differences between Earth, the Sun, and the Moon?