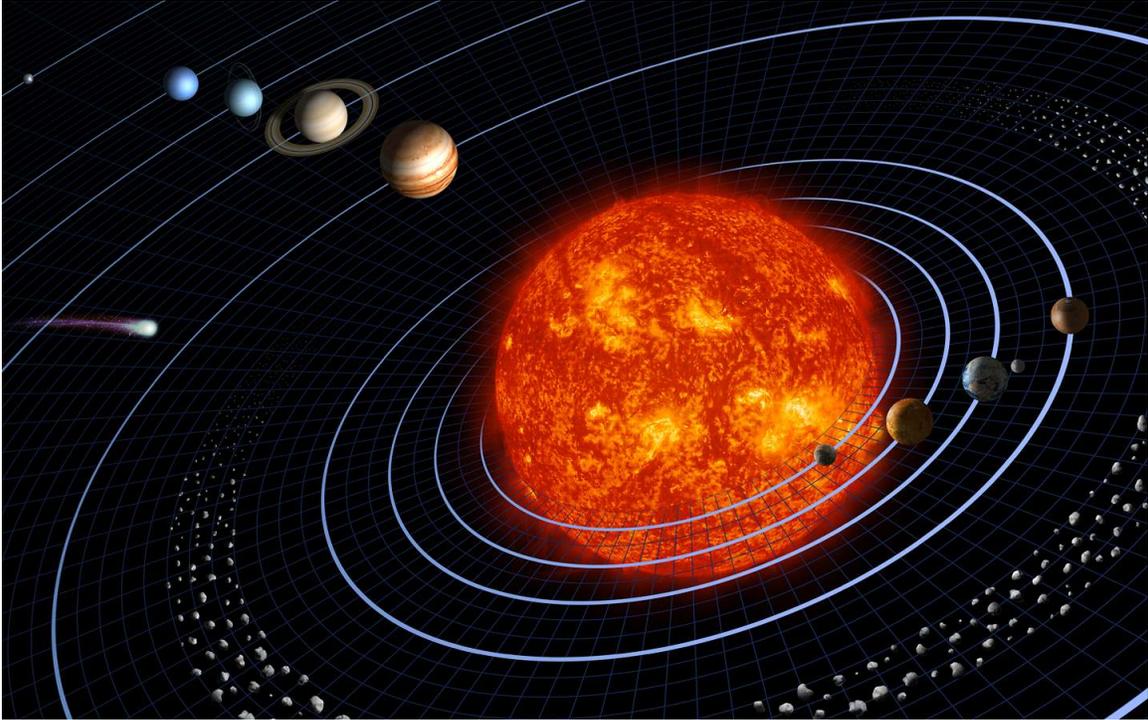


# Wikijunior

# Solar System



Written by  
The Volunteers and Editors at  
**Wikibooks.org**  
A Wikimedia Foundation Project

# **Introduction**

## **General Introduction**

This is a project of Wikijunior, a collection of free books written especially for kids to learn about science and nature. Many people have been involved with writing this book. This project is hosted on Wikibooks, and you are encouraged to help participate with writing and editing these books.

## **What This Book Will Cover**

There are several short articles that will cover each of the planets and many other bodies of the Solar System. Information that will be interesting to kids will be discussed. In addition, some general topics will be added that aren't specifically about an individual planet or moon of the Solar System.

# Solar System

People have been watching the sky for thousands of years and wondered exactly what is out there. With advances in telescopes as well as spaceships which have physically traveled to various planets, a considerable amount of knowledge has been obtained to better understand the universe near to us.

The name of our system comes from the old *latin* word for the Sun: *Sol*. Because the Sun is the largest object in the system and all the other bodies orbit around it, it became known as the *Solar* system.

## What is the Solar System?

At the center of the Solar System is the Sun. This is but one of billions of stars in the sky, but is important to us as it gives us warmth and energy for us to use. There are many worlds that are near the Sun, each of them are as different as you can possibly imagine. All of these worlds that either orbit the Sun or orbit a planet going around the Sun make up what we call the Solar System. As you read each of the sections about these different worlds, we will explore the differences between all of these worlds, and hopefully you will understand how unique and special the Earth is as well.

There are a total of nine planets in our system. The inner-most planet is called Mercury. This is followed by Venus and then our Earth. Beyond Earth is an orange-hued planet called Mars. In the outer part of the system are four giant planets called Jupiter, Saturn, Uranus, and Neptune. The outermost planet is a small world named Pluto.

Our system also includes many other bodies. The moons are small worlds that orbit the planets, in much the same way as the planets orbit the Sun. There are also a lot of much smaller objects called asteroids. These are big chunks of rock or metal that are mostly found orbiting the Sun between Mars and Jupiter. We also get visitors from the cold outer edge of our system that are called comets. These are big lumps of ice and dust. Comets can form immense tails when they come close to the Sun and start to melt.

The solar wind is a hot gas that erupts from the sun and flies away into space. This gas travels past the planets into outer space. The place where this gas reaches the very thin gas between the stars is at the edge of the solar system. This bubble of gas is about 100 times as far from us as the Earth is from the Sun. Beyond that is a lot of empty space. The nearest star to the Sun is thousands of times further away than the size of the entire Solar System. It's a very, very big universe out there.

## Who discovered it?

Prior to 1781, there were only seven known bodies in our solar system, besides the Earth. These seven were the Sun, our Moon, Mercury, Venus, Mars, Jupiter, and Saturn. These had been known since humans first began to observe the sky at night. There were also visitors called comets that would appeared in the sky for a time, then fade away.

The Babylonians believed that each of these objects was related to a different deity, and

their calendar used a seven-day week. The practice of naming the seven visible objects of the solar system still continues to this day. Each of the English words for the day of the week comes from an old name for a god or goddess.

<b>Weekday</b>	<b>Object</b>
Sunday	Sun
Monday	Moon
Tuesday	Mars
Wednesday	Mercury
Thursday	Jupiter
Friday	Venus
Saturday	Saturn

Galileo Galilei first turned a telescope on the sky and began to write down what he saw. Among the things he saw were four moons orbiting Jupiter. As time passed and the telescope was improved, more objects were found. In 1655, Christiaan Huygens discovered the moon Titan orbiting Saturn. In 1781 Sir William Herschel discovered the planet Uranus. In 1801, Giuseppe Piazzi discovered the first asteroid. Many more asteroids were later discovered by astronomers.

The discovery of the planet Neptune did not come by chance, but was found using math. Astronomers had made tables of where each body should appear in the future. But Uranus did not match the predictions. So a model was made to account for the difference. This model predicted that the gravity from an unknown planet was pulling on Uranus. The model also predicted about where the mystery planet would be found. This planet was then found in 1846.

The last planet Pluto was later found in 1930 using the same method.

## **How was it formed?**

Our Solar System is part of a much larger system called the Milky Way. This is a vast mix of dust, gas, stars, and other objects that is called a galaxy. Our galaxy rotates about the center, and if you could see it from a long, long way off it would look like a wispy pin-wheel.

Within our Milky Way galaxy are clouds of dust and gas where stars are born. Our Solar System was created in just such a cloud. A part of this cloud began to collapse under the pull of its own gravity. As it got smaller, it formed a big, spinning disk of gas and tiny particles of dust. This disk was thickest at the middle, and this part slowly collapsed to form the early Sun.

The remainder of the disk continued to rotate about the Sun in the center. The tiny particles of dust were now close enough so that they would often collide, and some of these would stick together. The bits of dust would slowly collect to form grains. These

would in turn join to form lumps the size of gravel, then pebbles.

As the objects grew in size, a few grew larger than the rest and began to pull on the other rocks with their gravity. The rocks grew ever bigger, reaching the size of mountains which crashed together with powerful force. In the end there were only a few massive bodies left, which swept up the rest of the disk to form the planets, moons, and asteroids.

While this was going on, the Sun began to glow from the huge energy released by its own collapse. The temperature at the center of the Sun reached a million degrees, and it turned into a furnace that could create more energy by smashing tiny atoms together. This energy rose up to the surface and was emitted as light, heat, and other forms.

This energy being emitted by the Sun swept away any surviving tiny particles and gas from the inner Solar System, leaving behind only the larger objects.

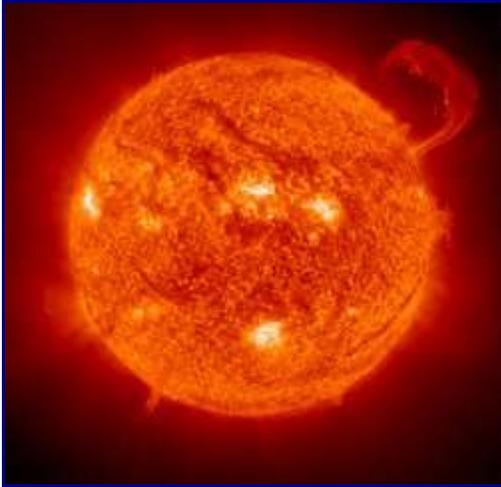
## **What will happen to it?**

About four thousand million years from now, the Sun will have used up most of fuel. It will begin to enter the final stages of its life. It will expand into a huge star called a *Supergiant*. The size of this star will be so big that several of its planets will be inside, including the Earth. These planets will be burnt to a crisp inside the very hot atmosphere.

Eventually the sun will begin to throw off its outer atmosphere, forming an immense sphere of faintly glowing gas that astronomers call a *planetary nebula*. The sun will then shrink down into a small star called a *white dwarf*. This will be about 100 times as small as the current sun we see. It will then slowly begin to cool and grow ever fainter over time.

# The Sun

The Sun is a large ball of very hot gas, mostly hydrogen and helium. It is the power house of the Solar System. It's our nearest **star**. Scientists can tell what is going on inside a star from its color. Without the sun there would be no life on Earth. We depend on the sun for **energy**.



This picture was taken with a special filter that shows the complex magnetic fields generated by the sun. The loops of gas extending out from the sun are called prominences.



## Sun Facts:

- The Sun is really a star.
- If the Sun blew up, it would take about 8 minutes before anyone noticed.
- It produces light and heat energy needed for life.
- Every second, over 4 million tons of material is converted into energy through nuclear fusion.
- The equator of the sun rotates much faster than areas closer to the solar "poles".
- **Never look directly at the sun without filters.** A passing glance will cause temporary blindness, and looking at the sun without special filters in a telescope will cause permanent blindness in your eyes.

## How big is the sun?

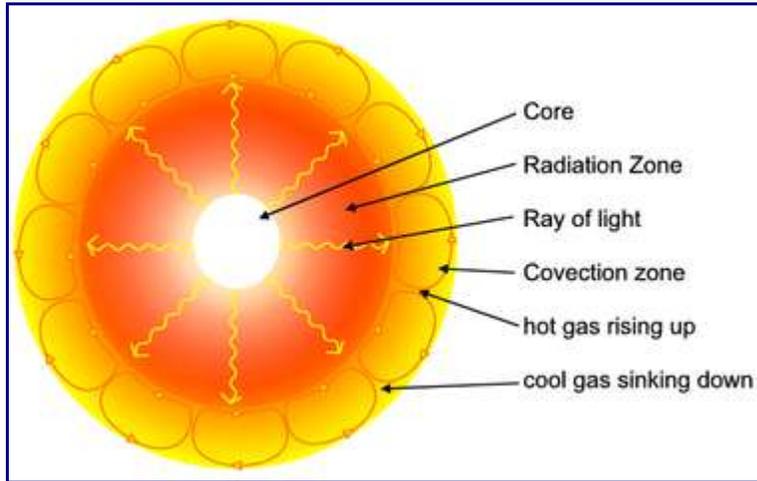
The Sun is very big - much, MUCH bigger than the Earth! It is 1,392,000 km or 109 Earths across and contains more than 99.9% of the solar system's mass. If you could somehow stand on the surface of the Sun, you would weigh 28 times as much. A grown person would weigh as much as a car.

More than a million Earths could fit into the volume of the sun! It doesn't look that big from where we stand, though. That's because the sun is about 150,000,000 km away. At that distance, it takes light from the sun over eight minutes to reach the Earth. Compared to other stars, the sun is about average-sized.

## What happens inside the sun?

The sun is the main source of energy for the earth. This energy is released deep within the sun in a process called atomic fusion. Four hydrogen atoms are fused together to make one helium atom. The helium atom has slightly less mass than the four hydrogen atoms; the extra mass is converted to energy. This is the same way energy is released in a nuclear

bomb called a hydrogen bomb. The diagram below shows what scientists think is going on inside the Sun. The colours are to show the different regions.

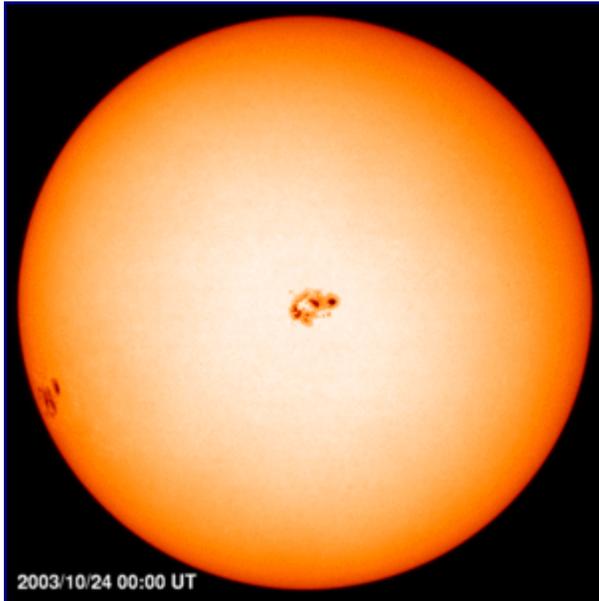


**Core:** The center of the Sun is very dense. It's about 12 times as dense as lead. It's also very hot - about 15 million °C. This region is where most of the nuclear reactions are taking place.

**Radiation Zone:** In this zone the light, heat, and X-rays produced in the core fight their way out towards the surface. The gases that make up the zone are still very dense and keep absorbing and emitting the rays. Have you ever tried to run through water? That's what it's like for light waves in this region of the sun. It can take a single ray of light a million years to make its way out of this zone.

**Convection zone:** Have you ever seen the air shimmer above a fire? Perhaps you've been told it's because "heat rises"? Well actually heat doesn't rise all by itself. It is the hot air that is rising. Hot gases tend to rise, cold gases tend to sink. In this outer region of the sun the gases are less dense and so behave more like ordinary gases that we see on Earth. At the bottom of the convection zone the gas gets heated up by the energy that is coming through the radiation zone from the core. This gas rises up to the surface of the sun where it gives up its heat and cools down. The now cold gas then sinks back down. The plumes of rising hot gas and sinking cool gas together form huge ribbons of circulating gas known as "convection cells".

## What are sunspots?



The dark areas are called sunspots.

Sunspots are slightly cooler areas on the surface of the sun that appear as dark areas. They only appear dark against the brightness of the rest of the surface of the sun. Despite their appearance, they are still extremely bright — brighter than an electric arc. The number of sunspots seen rises and falls over an 11 year cycle.

Sunspots appear when the Sun's magnetic field is concentrated, impeding the flow of energy. A typical sunspot consists of a dark region, called the Umbra, surrounded by a lighter region, called the Penumbra. The Umbra is about 2000 °C (3600 °F) cooler than the photosphere and only looks dark in relation to its surroundings. Spots usually form in groups which are carried across the solar disk by the Sun's rotation.

Over a period of about 11 years, sunspot numbers increase before decreasing slowly. This sunspot cycle happens at about the same time as the increase and decrease in the Sun's overall activity.

The most complex sunspots are hubs of intense magnetic fields. These active regions can suddenly erupt as flares that are short-lived, extremely bright areas that release large amounts of charged particles and radiation. Flares are more prevalent during peaks in solar activity.

## What is the solar atmosphere like?

The part of the sun that you see in the sky is called the **photosphere**. This is where the pressure from the gases inside the sun is low enough that they no longer glow so bright, and is generally considered the "surface" of the sun. Everything that is below the photosphere gives off light. The photosphere is also the very top of the convective zone of the sun. It is on the photosphere that you see sunspots.

While you can say that the atmosphere of the sun begins at the photosphere, in reality the entire sun is one very large ball of gases, where there is no definite beginning or end to the gases from the Sun. Because the Sun is so hot, gases from the sun are constantly streaming outward and form various parts of the solar atmosphere, which extends beyond even the orbit of Pluto. These gases near the Earth are very thin, with so little in the way of gas pressure that you can basically call it a vacuum, but it still is enough that it pushes away gases from other stars in our galaxy. It is only until you get to the **heliopause** that you can say that the influence of the Sun's atmosphere ends.

Various parts of the solar atmosphere are as follows:



A closeup view of a sunspot and prominences from the TRACE spacecraft

## **Prominences and Solar Flares**

When you look at the sun through a telescope (with special filters so your eyes don't get damaged!), at the sides of the photosphere there appear to be large eruptions of gases like it was from a volcano. Each of these is called a prominence. There have been several kinds of prominences, but all of them are very large. Ones you can see are hundreds of kilometers long, and the largest was almost 400,000 kilometers. That is almost twice as far as the moon is from the Earth. These prominences are related to sunspots, because they are often seen as coming from a sunspot. The largest of these prominences sometimes become so large that they leave the sun entirely, and that is when they become a **solar flare**.

## **Chromosphere**

When early astronomers viewed the sun during an eclipse, they noticed that there was a brief flash of light immediately before and after the eclipse. Instead of being a steady white light, it seemed to be a rainbow spectrum of all of the colors you can see, which is what gives the chromosphere its name. It is not as bright as the photosphere, which is why you normally don't see it during the day, but only during an eclipse.

## Corona



Solar Corona during an eclipse in 1999

Even more faint than the photosphere or chromosphere is the corona. This is a region extending from the chromosphere and gradually becoming a part of the solar wind throughout the rest of the solar system. The reason why the corona glows is because the gases in the corona are actually hotter than the surface of the Sun! The reason why this happens is still a mystery to scientists, but there are several theories for what is happening. The corona will shift and change, sometimes very rapidly over minutes or hours, due to changes from the sun itself. Because the photosphere is so bright, it is difficult to observe the corona except during an eclipse even with advanced scientific instruments. Some telescopes in space are making it easier to observe the corona, but it is still something that scientists are trying to understand.

## Solar Wind

As the corona gets further from the sun, it is still "blowing" against all of the planets in the solar system. This is called the **solar wind**. While the gas pressure is very low, it still is enough that some very light objects and other gases are pushed away with the solar wind. For other astronomical object, this is visible with the two comet "tails", where one "tail" is mainly rocks and dust, with the other "tail" composed of gases. This second tail is being pushed by the solar wind and causes its effect.

In 1960, the Satellite Echo I entered orbit and was one of the largest satellites ever put into space, in terms of volume. Basically it was a large ballon that was inflated by a small amount of gases inside. Because it was so light but also very large, its orbit was substantially affected by the solar wind and other solar pressures. Even more compact satellites still have to take solar wind into account when planning orbits and how long a satellite will stay in orbit.

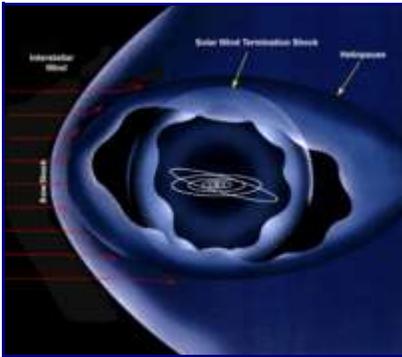
In the future, **solar sails** will use the solar wind and **light pressure** in order to travel between planets, where spaceships use sails instead of just using rocket engines.



Zodiacal Light with an Aurora

## Zodiacal Light

If you travel to a place very far away from any cities and look up at the night sky, a very faint glow will come from a band across the sky in roughly the same part of the sky that you see the other planets. This is not the Milky Way, which is also visible, but even more faint than that. This is actually sunlight which is reflected off of dust and meteoroids that are found throughout the **ecliptic plane**. This dust is the remains of comets and asteroids colliding with each other and eventually falls into the sun over millions of years.



A diagram of where the heliopause is located

## Heliopause

The Heliopause is what can largely be considered the edge of the solar system. This is where the solar wind slows down and stops (or "pause") due to the "solar wind" coming from other stars in the galaxy. There is a region just inside the heliopause where the solar wind slows down from supersonic speeds (literally, faster than sound) to subsonic speeds. This creates a slight jolt in the electrical systems of spaceships that was detected by the Voyager I spaceship in May 2005, which was the first man-made object to ever travel this far from the Sun. Since this is so far from the Sun, this is a part of astronomy that scientists are still trying to study and there is much more that needs to be learned about this part of the solar system.

## What is solar weather?

**Solar weather** is a new science, but something that has a huge impact on a number of things here on the Earth. When a solar flare is produced on the sun, it includes a large amount of **plasma**, or very hot gases. If this flare then heads toward the Earth, it will cause a number of problems, including blackouts on electrical power systems in large cities, communications disruptions with radio transmitters and satellites, and potentially even death if an astronaut is caught unprotected when a large **solar storm** comes from that flare. Normally the Earth's atmosphere protects you and I from direct effects of these flares.

These solar flares also cause something called an aurora. This is also known as the

"Northern Lights" or "Southern Lights" (depending if you are closer to the north or the south pole) where the plasma interacts with the atmosphere of the Earth and the Earth's magnetic field. Normally you can only see this event when you are close to one of the poles, but sometimes a very powerful solar flare will produce an aurora that can be seen as far south as Mexico, or as far north as Southern Brazil, or South Africa.

The aurora is not unique to the Earth either. Auroras have been seen on all of the planets except for Mercury and Pluto by telescopes and space probes. The aurora on Pluto have not been seen because it is so far away and no space probes have ever been there, and Mercury doesn't have an atmosphere (that is substantial).

Just like there are weather forecasts for weather on the Earth, there are weather forecasters that study solar weather and try to predict when solar storms will come. Not only do they study just what will happen near the Earth, but they also try to predict what is going to happen in other parts of the solar system as well. As more space missions go into other parts of the solar system, this will become even more important. To help make the predictions, they also study the sun itself, and try to determine in advance when a solar flare will occur.

# Mercury



Mercury from Mariner 10



## Mercury Facts:

- Mercury orbits the sun faster than any other planet.
- Mercury's surface temperature can vary from  $-300^{\circ}\text{F}$  ( $-180^{\circ}\text{C}$ ) to  $800^{\circ}\text{F}$  ( $430^{\circ}\text{C}$ ).
- Radar observations suggest that there is frozen water on Mercury's north pole.

Mercury is the closest planet to the sun. It is a **terrestrial planet** and the second smallest planet after Pluto. Only one spacecraft has flown by Mercury, Mariner 10, which was launched by the U.S. on November 3, 1973. Much of what we know about this planet came from this mission.

## How big is Mercury?



Comparison of the size of Mercury to the Earth

Mercury is about 4879 km in diameter, which makes it a little over a third as big as the Earth is across. It's small enough that eighteen balls of modeling clay the size of Mercury could be rolled together to make one the size of Earth. In fact, the diameter of Mercury is only about one and a half times the diameter of our moon. It is the second smallest planet in the Solar System, just larger than Pluto. The small size and how close it is to the Sun sometimes make it difficult to observe Mercury in the sky, especially without a telescope or binoculars.

## What is its surface like?



View of the surface of Mercury

Mercury has craters like those on the Earth's moon. They were made when **asteroids** or **comets** crashed into the surface. The largest crater we've seen on Mercury is the *Caloris Basin*. It is about 1350 km in diameter and was caused when a huge asteroid, probably about 100 km wide, hit Mercury about 4 billion years ago.

The surface also has big cliffs called **scarps**. They were made long ago when Mercury cooled down and shrank. This shrinking caused the surface to get wrinkled in some places, which created the scarps.

There are also **plains**. Some of them may have been made by **lava** flows long ago.

There may also be water ice on both of Mercury's poles. The poles, like Earth's, get very little warmth from the Sun, so the ice doesn't melt or evaporate.

It gets very hot during the day and very cold at night on Mercury. It's so hot during the day (430°C, hot enough to melt tin!) because Mercury is so close to the sun. At night, however, it gets down to -180°C, much colder than Antarctica in winter. It loses almost all of its heat during the night because Mercury has very little **atmosphere**, which would normally help to keep in the warmth.

## What is its moon like?

Mercury does not have a moon. Mercury's rotation is so slow that if Mercury had a moon, it would crash into Mercury or get broken up. This would happen because the moon's gravity would cause tidal effects on Mercury. There would be two bulges called tidal bulges on Mercury. One would bulge toward the moon, with the other bulge being on the opposite side of Mercury. The moon's motion in its orbit would be faster than Mercury's

rotation because Mercury's rotation is very slow. That would cause the moon to be ahead of the tidal bulge all the time. The gravity from the bulge would pull back on the moon. This would cause the moon to become closer to Mercury and Mercury's rotation to speed up. This would continue to happen over millions of years until the moon got broken up by Mercury's gravity or crashed onto Mercury. Mercury had existed for billions of years, so if it had any moon, it is long gone.

## How long is a day on this planet?

Mercury **rotates** much slower than Earth. Its day is 58.6 Earth days long.

## How long is a year on this planet?

Mercury is the planet with the shortest year in the solar system. It is about 88 Earth days long, roughly one quarter of an Earth year. This means that an eight-year-old person would be 32 years old on Mercury. One interesting thing about Mercury is that there are three Mercury days for every two Mercury years.

## What is it made of?

Mercury has a large iron **core** for a planet of its size. The planet contains a larger portion of iron than any other planet in the solar system. The outer layer of the planet is made of **silicates**, which are ordinary rocks.

## How much would Mercury's gravity pull on me?

If you were on Mercury, it would pull you down with a force about one third as strong as the force of Earth's gravity.

## Who is it named after?



Artistic depiction of Mercury

### Mythology

Not only was Mercury the messenger of the gods, he was also the god of buying and selling. His name probably comes from the Latin word *mercator*, which means "merchant."

Mercury had his own day of the week, *dies mercuri*, or "Mercury's Day". In France it is mercredi. In English we named this day after a Norse god, *Woden*, making it "Woden's Day", or Wednesday.

In Roman mythology, Mercury was the messenger of the gods. He wore a hat and sandals

with wings on them, allowing him to travel around the world extremely quickly. The planet Mercury was named after him because it orbits around the sun faster than any other planet in the Solar System, traveling nearly 50 km *every second*!

# Venus



Venus (in the visual spectrum).

Venus is the second closest planet to the sun, and was named after the Roman goddess called Venus. It is in a category called **terrestrial planets**, this means that it is very similar in size and was created close to the same way as our planet Earth. In fact, sometimes it is called Earth's "sister planet" as they are somewhat alike in both size and roughly a similar distance from the Sun.

## How big is the planet?



Earth and Venus Comparison

Venus is very close in size to earth and with a diameter of about 12,100 km or almost 95% of the size of the Earth. This is one of the reasons why Venus is often considered to be the "twin" to the Earth, and it is also made up of very similar minerals that are found on the Earth.



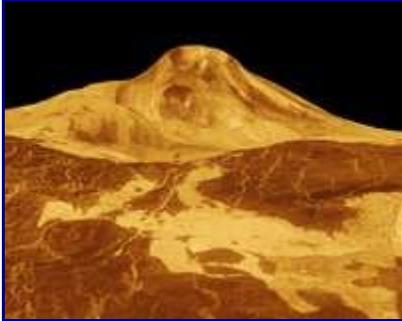
**Venus Facts:**

- Venera 7, the first space probe to land on Venus, was put out of action by the hostile conditions on Venus after only 23 minutes.
- With a few exceptions, the surface features on Venus are all named after women.
- A day on Venus is longer than a year there.

## What is its surface like?



Picture from the Russian Spacecraft Venera 13 on the Surface of Venus



Maat Mons on the Surface of Venus, by radar imaging

Venus has a very interesting surface. It is very, very dry and also hot enough to melt lead on its surface. We could not survive on the planet because of this. Anyone attempting to walk on the surface of Venus would boil to death, be squashed flat by the pressure, and then have their remains eaten away by the corrosive atmosphere. One of its highest mountains, named the Maxwell Montes, is roughly 2 km taller than Mount Everest. Because Venus has a very thick **atmosphere**, **meteors** slow down as they fall toward it's surface, so no craters that are smaller than about 3.2 km round can form. Almost 90% of Venus' surface is made up of recently-solidified **basalt lava**, meaning that Venus has experienced a lot of **volcanic** activity from time to time. The oldest parts on Venus are thought to be only around 800 million years old.



The Venera 13 Lander, which made scientific measurements and pictures from the surface of Venus.

## Is there life on Venus?

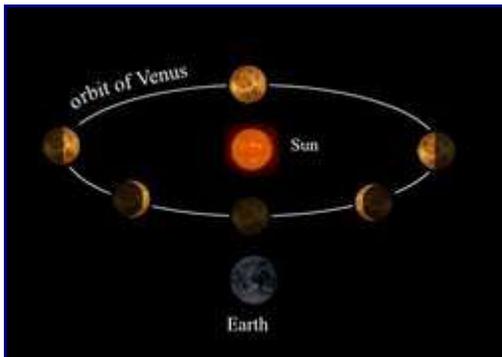
When astronomers first tried to make observations of Venus, they thought that Venus

would have a very Earth-like environment, although slightly warmer than the Earth. Venus is almost the same size as the Earth, and covered with clouds, and it was assumed that these might be water clouds like are found here on the Earth.

Many stories written during this time described Venus as having a swamp-like environment, but still something that people could go and visit someday, and even live on. Sometimes exotic aliens were thought to live on Venus, just like people thought the same thing about Mars.

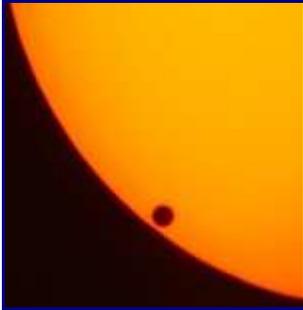
The debate on whether there were living things on Venus continued until robotic spacecraft traveled to the surface of Venus and directly measured the thickness of the atmosphere, what chemicals it contained, and the temperature. The environment on Venus is deadly to almost any living thing on Earth, and it is unlikely that manned exploration of its surface will ever happen. Spaceships that land on Venus must be very strong in order to work with the very high atmospheric pressures on its surface, and to withstand the acids in the atmosphere. One of the gases found on the surface is Sulfuric Acid, which is the same chemical that is used in car batteries, and very toxic if you eat or breathe it. There are many other chemicals that are just as deadly if you were to breathe them in.

## Phases of Venus



After telescopes were invented, one of the very first places that they tried to study was Venus. Even with a modest telescope this is a fairly easy feature to identify. Just like the Earth's Moon has **phases** during different times of the month, Venus also appears to go through similar kinds of phases where it appears in a **crecent** shape during some parts of its orbit around the Sun. This visual appearance is caused because Venus is closer to the Sun than the Earth, and we are looking at the night sky of Venus, or the part of Venus that is facing away from the Sun.

This is slightly different than the phases of the Earth's Moon, because the distance between the Earth and Venus varies quite a bit. When Venus is at its closest point to the Earth, it appears as a thin crecent or even can't be seen at all. Only when Venus is almost at a location furthest from the Earth can a full disk be seen through a telescope.



Sometimes on rare occasions, Venus actually crosses directly between the Sun and the Earth. This is called a **transit**, which is very similar to a solar eclipse by the Earth's Moon. Many early details about Venus were discovered this way, including approximately how large Venus was, and the fact that it had an atmosphere due to how "fuzzy" the outline of Venus was against the Sun. During a transit of the Sun, Venus appears as a small circle going across the Sun's photosphere.

## What is its moon like?

Early in history Venus was once thought to have a moon, named Neith after the mysterious goddess of Sais. The moon was first seen by Giovanni Domenico Cassini in 1672. **Astronomers** saw this moon from time to time until 1892, until they found out their sightings were mostly faint stars that were in the right place at the right time and now Venus is known to be moonless.

Venus's rotation is so slow that if Venus had a moon, it would crash into Venus or get broken up. This would happen because the moon's gravity would cause tidal effects on Venus. There would be two bulges called tidal bulges on Venus. One would bulge toward the moon, with the other bulge being on the opposite side of Venus. The moon's motion in its orbit would be faster than Venus's rotation because Venus's rotation is very slow. That would cause the moon to be ahead of the tidal bulge all the time. The gravity from the bulge would pull back on the moon. This would cause the moon to become closer to Venus and Venus's rotation to speed up. This would continue to happen over millions of years until the moon got broken up by Venus's gravity or crashed onto Venus. Venus had existed for billions of years, so if it had any moon, it is long gone.

## How long is a day on this planet?

Venus **rotates** even more slowly than Mercury. One **sidereal** day on Venus is about 243 Earth days long. This is the time it takes for a distant star to go from being directly overhead to being above you again. One **solar** day on Venus is about 117 Earth days long, or the time it takes for the sun to be over one spot on Venus to returning to that same position. The reason for this difference is that Venus is also going around the Sun at the same time it is turning. There is a difference between **sidereal** and **solar** days on the Earth as well, but because the Earth is spinning so quickly compared to Venus it is only a difference of a few minutes each day instead of over a hundred days like it is on Venus.

It also rotates the opposite direction from most of the planets in the Solar System. This is

called **retrograde motion**, where the Sun rises in the west and sets in the east, from the viewpoint of somebody standing on the surface of Venus.

This rotation period is also rather unusual because of an interesting coincidence with this orbital period and the Earth. Venus always seems to have the same side of its planet facing the Earth as it passes close to the Earth, almost as if Venus had a **tidal lock** on the Earth like the Earth's Moon. From the perspective of somebody standing on Venus, Earth would always be in the same spot in the sky year after year. What causes this behavior from Venus is totally unknown, and may be a pure luck, but many scientists often discover new ideas by studying a coincidence like this.

## How long is a year on this planet?

One Venus year is 224.7 Earth days long. So, one Venus day is longer than one Venus year. There is an interesting coincidence with this period of time as well, because from one **conjunction** between the Earth and Venus to the next one (when the Earth and Venus are closest together and on the same side of the sun) is 584 days. What is unusual about this number is that it happens five times every eight years on the Earth, in a pattern that is very close to the same orbital time period of the Earth around the Sun.

$25 \times 117$  (Earth days in a Venus solar day) = 2925 days

$5 \times 584$  (Earth days between conjunction of Earth and Venus) = 2920 days

$8 \times 365$  (Earth days in an Earth year) = 2920 days

This was known to ancient astronomers and played an important part in the design of many ancient calendars, including some eight year cycles where the pattern that Venus followed in the sky was watched very closely. There is no current scientific theory to explain this coincidence other than it just happened to be like this.

## What is it made of?

Like Earth, Venus appears to have have a **crust** and **mantle** made of **silicates** and an iron **core**. There are a number of features on the surface of Venus that resemble features found on the Earth, so it is likely that many of the internal characteristics of both the Earth and Venus are the same.

## How much would Venus's gravity pull on me?

If you were on Venus, it would pull you down with a force about nine tenths as strong as the force of Earth's gravity.

## Who is it named after?



Artistic representation of Venus

Venus is named after the Roman goddess of love. It looked bright in the sky sometimes, so it was named after the beautiful goddess. Venus is also associated with the Greek goddess Aphrodite, as well as Frigg and Freya in Norse mythology. Indeed, almost every ancient culture had Venus as a major deity, although not all of them were female. An example of the planet being named after a male deity is Tlahuizcalpantecuhtli, one of the Aztec gods, together with his brother Xolotl.

# Earth



The Earth seen from space



## Earth Facts:

- The Earth is the only planet in the known universe which is capable of supporting life as we know it.
- Some of the heat in the Earth's mantle actually comes from the breakdown of radioactive material. The pieces of rock and metal that collected to make the Earth brought in the rest of the energy when they fell onto the planet.

Earth is the planet we live on. It is the only planet in the solar system with liquid water. It's also the only one known to have life.

## How big is the Earth?

The Earth is 12,742 km in diameter. It's the largest **terrestrial planet** in the solar system.

The Earth weighs 5,973,000,000,000,000,000,000 kg. (That's nearly 6 trillion trillion kilograms)

## How old is the Earth?

Scientific evidence shows that the Earth is 4.6 billion years old.

## What is its surface like?



Moraine Lake by Lake Louise Alberta, Canada

Earth's surface is made of **continents** and **oceans**. There are also islands in the oceans. The top layer of Earth is called the **crust**. It divided into pieces called **tectonic plates**.

They move very slowly, carrying continents with them. The places where they meet are called **fault lines**. On fault lines, **magma** can seep up through the cracks and create **volcanoes** (once on the surface it's called **lava**.) When fault lines move apart they create new land (these are called **constructive margins**) and where they move towards each other one of them goes underneath the other (these are called **destructive margins**.) When they slide past each other, great tension builds up due to **friction** - when this tension is released the plates move rapidly and sharply in one direction, creating **earthquakes**.



Anawhata beach, west of Auckland, New Zealand

Earth has many kinds of **environments**. It is cold and icy in places like Antarctica. There are hot, dry deserts in some parts of the world like Africa and Arabia, and cold, dry deserts in some others like Siberia. Rain forests grow where it is warm and wet, in **equatorial zones** (these are areas a few hundred miles around a very hot 'line' called the **equator**. Outside equatorial zones there are areas of very dry, mostly hot desert, which is where all the water making the rainforests wet comes from, causing these areas to be very dry. Other kinds of forests grow between the Equator and the Poles, like the massive **coniferous** forests of pine and other trees which keep their leaves all the time, and **deciduous** forests of oak, beech and other leaf-losing plants. Some places are very wet and are called swamps or marshes. There are grasslands, many hot, some called **savannahs**, with lots of grass and few trees. There are also mountains, caused by collision of **tectonic plates**. Some of them are high with snow and ice on their tops all year. Others are lower and more rounded.

## Is there life on the Earth?

When this question is asked on other planets in the solar system, it is important to know where you might find living things here on the Earth. Almost every important feature of the surface of the earth is in some way affected by living things, including mineral deposits and even the content of the air that we breathe.

One of the critical ingredients that all living things seem to need is water. Wherever you find liquid water, you will almost always find living things, even if it is not a place where you would want to live as a person. Bacteria has been found inside gysers, where the water temperature can be over 300° C. These living things not only live there, but even seem to need those very high temperatures. Other living things have been found on the bottom of the ocean, living around "thermal vents" where the only energy they obtain is from lava heating up water. It is so deep in the ocean that no sunlight ever appears there. Finally, you can find living things in Antarctica where it is always covered with ice, or even at the top of mountains in the form of lichens, growing where otherwise nothing else could live.



Galileo being deployed after being launched by the Space Shuttle Atlantis

Is the Earth unique because only this planet could have living things growing on it? It would seem unlikely that this is the only planet in the Universe that has living things like we know them, and it is suspected that there are many other places in the Solar System where life might be. If liquid water is discovered anywhere else in the Solar System, you might just find some living things there too. There are other worlds in the Solar System where liquid water indeed has been found, so many scientists continue to look for signs on life on other planets.

An interesting experiment was conducted in December, 1990, where the **Galileo** spacecraft, on a journey to Jupiter, went past the Earth after having gone on a orbit around the sun earlier. In this situation, the scientists who were running the space probe decided to test the equipment to see if they could detect signs of life on the Earth. In addition to simply taking pictures of the Earth, it also detected signs of water, oxygen, and other elements and chemicals that are necessary for life. This information was then used to both see if these same instruments could detect life elsewhere, and to **calibrate** the instruments to make more accurate measurements when it arrived at Jupiter.

## What are its moons like?

Earth has one permanent moon named Luna, or more commonly called the [Moon](#). Earth also has a number of temporary natural satellites, the largest of which is the three-mile-wide body named Cruithne [pronounced 'KROOee-nyuh']. Discovered in 1986, Cruithne follows an eccentric horseshoe-shaped orbit that takes 770 years to complete.

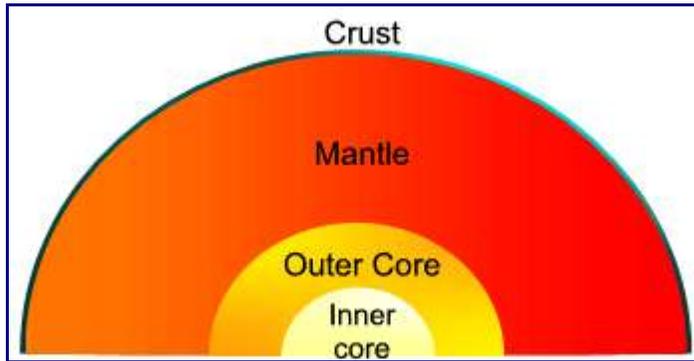
## How long is a day on the Earth?

A day on Earth is 24 hours long (solar) and 23 hours 56 minutes (sidereal). It is how long it takes the Earth to spin once on its axis.

## How long is a year on the Earth?

A year on Earth is 365 days long. It is how long it takes Earth to **orbit** the sun once.

## What is it made of?



The Earth has a crust and mantle made of **silicates** and an inner and outer core. The **crust** is the surface layer. It is up to 5 km deep under the oceans and up to 35 km deep under the continents. Despite being so thin, scientists have not ever drilled all the way through the crust. The **mantle** extends from the bottom of the crust down to 2900 km under the surface. Under the mantle there is the liquid iron **outer core**. It extends from 2900 to 5100 km under the surface. At the center of Earth there is the solid **inner core**. It is made of iron and nickel.

## How much would I weigh on Earth?

It's easy to find your weight on Earth by using a scale. You have weight because the Earth pulls you towards its center. (Normally, the ground or the floor get in the way, making you feel 'stuck' to them.) This force is known as **gravity**.

..... There are several kinds of scales:



1) Comparing of 2 masses (weights). You put the thing(s) you want to weigh on one pan (like some marbles), and then you put several "weights" on the other pan until the pointer shows that both pans have equal weights on them. Then you look at the pan with the known weights on it, and add them all up. The total is the mass of the thing(s) you want to weigh.



2) A spring balance usually has a hook on it, with a pan. You put the thing(s) you want to weigh on the pan, the spring is pulled, and the greater the weight, the further the spring is pulled. That distance, calibrated in pounds or kilogram (or whatever), is usually shown either on a dial or on a linear scale.



3) There are also electronic scales that give a properly calibrated reading—grocery stores, for example, use these.

NOTE: **gravity** varies slightly depending on the location where you want to get the weight; spring balances and some electronic scales can, in theory, read slightly different weights at different places because of that, but usually in practice that difference is too small to be noticed. But, because the balance type of scales work differently to the spring or electronic types, they will always read the true, correct mass. They would even give the same mass on the moon! (where gravity is much less than on Earth)



**Did you know?** that *Sir Isaac Newton* was the first person to realise that the force pulling you down to the ground was the same force that keeps the planets going around the sun? The story goes that he thought of this when he saw an apple fall from a tree.

Gravity is a very important force. As well as keeping you firmly stuck to the Earth, it keeps the Moon going round the Earth, The Earth going around the Sun and the Sun going around the center of the Milky Way **galaxy**. Gravity also makes stars and planets a nice round ball shape. In fact without gravity there wouldn't even *be* a sun, moon or earth. (The material that they are made of would just float away into space)

## Who is it named after?



The Earth seen from the surface of the moon

The word earth is used for both planet Earth and soil. Other names had been used for Earth such as Gaia and Tellus. Gaia is the Greek god of Earth. Tellus is the Roman name of the same god.

# Mars



Valles Marineris on Mars



**Mars Facts:**

- Mars is red because of rust.
- A volcano on Mars called Olympus Mons is the highest mountain in our solar system.
- Mars has polar ice caps just like [Earth](#).

Mars is the fourth planet. It is a **terrestrial planet**.

## How big is the planet?



Comparison of the size of Mars and the Earth

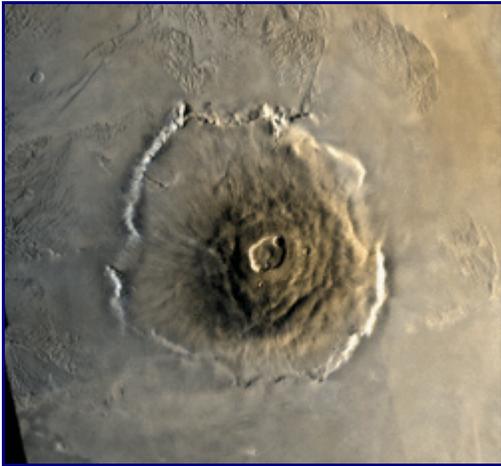
Mars is 6,804.9 km or 0.533 Earths in diameter. That makes it a little more than half of Earth's size.

## What is its surface like?



Panorama from the Mars Rover "Spirit"

The surface of Mars is dry and dusty. The highlands of the southern **hemisphere** have more craters than the lower areas in the northern hemisphere. One of the craters is the huge *Hellas Planitia*. It is 2100 km across.



Olympus Mons

There is an area called the *Tharsis Bulge* that has four huge volcanos. These volcanos have not erupted for millions of years. The largest one is *Olympus Mons*. It is 27 km tall, making it the highest mountain in the solar system and much higher than Mount Everest on Earth. It is 540 km across, making it too big to see the whole thing from the surface of Mars.

Mars has a huge **canyon** called *Valles Marineris* that is much bigger than the Grand Canyon on Earth. It is 4000 km long, up to 7 km deep and up to 200 km wide. It is thought that *Valles Marineris* was made when the surface cracked when the Tharsis Bulge formed.

There are also two ice caps at the poles. They are made of **carbon dioxide** and water ices. The northern one is large and the southern one is small.

In some places, there are **channels** that look like they were made by water **erosion**. Mars may have once been a wet planet like Earth.

If you got in a spaceship and landed on the surface of Mars, you would notice that there is air and an atmosphere, but it is very thin. When you are standing at the bottom of Valles Marineris, there is almost the same air pressure as you would find on the top of the tallest mountain on Earth, Mount Everest. Even then, you would not want to breathe it because it has very little oxygen, and much more carbon dioxide than on the Earth. Carbon dioxide is the gas that you send out from your lungs when you are breathing. Even with these problems, someday people will travel to Mars and walk on its surface.

## Is there life on Mars?

This is a question that many scientists have been asking for a very long time. When telescopes were first became powerful enough to study Mars in detail, the Italian astronomer Giovanni Schiaparelli spotted lines on the surface of Mars that he believed to be like rivers. Unfortunately this word in Italian, when translated into English was also

the same word for canals, and that sparked the imaginations of many people to believe that there was not only living things on Mars, but an advanced civilization of people that built cities and structures that could be seen on the Earth, like the Great Wall of China is visible from space as the sign advanced tool making.

Popular fiction took advantage of this interest, and the notion of Martians invading the Earth is a common idea in stories like this. Perhaps the most famous story using this idea is the novel "The War of the Worlds", by H.G. Wells, which includes some scientific opinions of what astronomers thought might be on Mars when that book was written. This story has since been made into a movie on several occasions, theatrical stage productions, and even radio dramas.

Most astronomers and space scientists no longer believe that there is an advanced civilization on Mars. The question is now if anything, even small plants and animals ever lived on Mars in the past or are still living there. This question is still unanswered, but there have been some attempts to find out.



Model of Viking Lander

In 1976, robot spacecraft from Earth called **Viking landers** went to Mars to find out. When it landed, the pictures of Mars that came back to Earth made Mars look very much like a desert, with very little water. Some experiments that were done to Martian soil seemed to indicate there was no life on Mars, although one experiment did indicate that there might be something alive in the soil. Even that experiment, however, was not convincing.

Shortly after the Viking space missions, a rock was discovered in Antarctica that was believed to have come from Mars. When scientists examined the inside of that rock, they discovered that there might be an ancient fossil of some bacteria.

Another robotic spacecraft called **Mars Observer** has been orbiting Mars for several years now, and it has taken photos of riverbeds and other features on the surface that suggest that Mars had liquid water flowing on the surface. If this is true, it seems likely that at least some very simple form of life may have lived on Mars as well.

In spite of all the scientific research to search for life on Mars, the question still hasn't been completely answered, and this is something that is debated by scientists even today.

## What are its moons like?



The Moons of Mars

It is believed that these moons did not originally orbit Mars, but were instead a part of the [Asteroid belt](#). When these pieces of the Solar System came close to Mars, they were captured by the gravity of Mars and went into relatively stable orbits around Mars. Like the Earth's moon, these moons are in a **tidal lock**, always keeping the same face towards Mars while they are in orbit.

Mars has two natural satellites:

### Phobos

In Roman mythology both Phobos and Deimos were the sons of the Roman god Mars. Phobos means "fear" or "fright". Phobos also orbits closer to Mars than any other moon to any other major planet in the solar system. In a few million years Phobos will eventually crash into the surface of Mars due to **orbital decay**, where it goes closer to the surface of Mars every year.

### Deimos

Deimos means "panic" or "dread" as the son of Mars. Deimos is one of the smallest moons of any planet in the Solar System (so far).

## How long is a day on this planet?

One day on Mars is only a little longer than an Earth day at 1.025 Earth days. A year is 1 Earth year and 322 Earth days long.

## **What is it made of?**

It is thought that Mars has an iron and **sulfur core** and a **mantle** and **crust** made of **silicate**.

## **How much would Mars's gravity pull on me?**

If you were on Mars, it would pull you down with a force about two fifths as strong as the force of Earth's gravity.

## **Who is it named after?**

Due to its red appearance in the sky, Mars is named after the Roman god of war. Also it was named after the Great War of Canto.

# Jupiter



Jupiter (Note the red spot)



## Jupiter Facts:

- Due to its magnetic field trapping particles from the Sun, Jupiter is surrounded by very powerful radiation belts which would kill anyone who entered them.
- Jupiter's moon Europa is thought to have a giant ocean below its surface.

**Jupiter** is by far the largest planet within our solar system: two and a half times larger than all of the other planets put together. It is the fifth planet from the Sun and one of the brightest planets. Jupiter is sometimes called a "gas giant" because most of this planet is made up of liquid and gas.

- Jupiter's magnetic field is the largest single thing in the solar system. It is 26 million kilometers across, making it about 20 times bigger than the Sun. It has a tail that extends past Saturn's orbit. If it could be seen from Earth, it would appear to be five times the size of the full moon.

## How big is the planet?

Jupiter is 142,984 km or 11.209 Earths in diameter at the **equator**. That makes it about one tenth as big as the sun. About one thousand four hundred Earths could fit into the volume of Jupiter. It is 133,709 km or 10.517 Earths in diameter from pole to pole. Jupiter's rapid **rotation** makes it bulge out at the equator.

## What is its surface like?



Jupiter does not have a solid surface. This enormous planet has a relatively small solid and rocky core. Liquids and gases surround this core and blend with the atmosphere.

Jupiter is a cloudy, windy and stormy planet. It is always covered by a layer of clouds, and wind speeds of 600 km/h are not uncommon. The storms are visible as swirls, bands and spots. A particularly violent storm, about three times Earth's diameter, is known as the Great Red Spot. This storm has been in existence for nearly 300 years!

The layer of clouds is divided into several bands. The lighter colored bands are called **zones** and the darker bands are called **belts**. The colors are caused by small changes in the temperature and chemistry. Each band rotates in the opposite direction from its neighbors. Along the edges where the bands meet, these winds collide and create swirling patterns.

The stormy atmosphere of Jupiter has flashes of lightning just like on Earth. However these can be up to 100 times more powerful. The lightning is made by water near the tops of the clouds.

## What are its rings like?

Jupiter's rings are dark and hard to see. They are made of tiny particles that meteors knocked off Jupiter's small inner moons.

## What are its moons like?

Jupiter has 63 known moons. There are four major moons that were discovered by Galileo in 1610. Those moons are Io, Europa, Ganymede and Callisto. They are called the Galilean moons. There are often **eclipses** on Jupiter's cloud tops by the Galilean moons.

### Amalthea Group

There are four small moons **orbiting** inside Io's orbit. That group is called the Amalthea group because Amalthea is the largest one. They are all small and potato shaped. Amalthea is very red. The material of Jupiter's rings came from meteors knocking it off of those moons.

### Io

Io is Jupiter's closest major moon. It is 3643.2 km across, slightly larger than Earth's Moon. It has **volcanos** and molten **sulfur** lakes. There are not very many **craters** if there are any at all because the volcanic activity would cover them up. Io has an **iron** and maybe iron sulfide **core** at least 1800 km across. It is surrounded by a **silicate** shell. There is little water on Io. Maybe it was because when Jupiter was forming, it was hot enough to dry out Io, but not the other major moons. In Roman mythology Io was a beautiful young woman that Jupiter loved.

### Europa

Europa is 3,121.6 km across, about ten percent smaller than Earth's Moon. It is made of silicates and has a layer of smooth water ice 10 to 30 km thick. The ice has long cracks in it and very few craters. It looks like the sea ice on Earth. The ice had slid around at the

cracks. There is liquid water under the ice up to 100 km below the surface. There are also some large spots on the surface. In Roman mythology Europa was courted by Jupiter in the form of a bull.



Jupiter as seen by the space probe "Cassini". This is the most detailed color portrait of Jupiter ever assembled.

## **Ganymede**

Ganymede is 5262.4 km across, making it 380 km bigger than Mercury. It is Jupiter's largest moon and the largest moon in the solar system. It had **plate tectonics** like Earth. There are older darker regions and newer areas with grooves where the plates moved. Newer craters have bright rays around them from material thrown up by impacts. Older craters look flat and faded because the icy surface does not hold the shape of the crater as well as rock does over long periods of time. Ganymede may have an iron and sulfur core with a silicate **mantle** and an icy shell. It may be like an Io with a layer of ice on it. In Roman mythology Ganymede was a beautiful young man who Jupiter kidnapped and made cupbearer to the gods on Mt. Olympus.

## **Callisto**

Callisto is 4820.6 km across, about the same size as Mercury. It has many craters. Like craters on Ganymede, the older craters had faded. The largest crater is *Valhalla*. It has a bright center 600 km across with rings around it up to 3000 km across. Callisto is made of silicates and ice. There is a 200 km thick icy **crust** with a liquid water sea under it. In Roman mythology Callisto was turned into a bear by Jupiter's jealous wife Juno. Later Jupiter placed her in the stars as The Great Bear.

## **Other moons**

The other moons are tiny ones in several groups outside the orbits of the major moons, there is a small moon, Themisto and four groups of little moons that orbit very far from Jupiter.

## How long is a day on this planet?

One Jupiter day is about 10 Earth hours long.

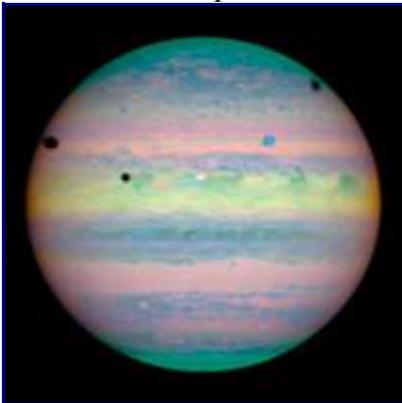
## How long is a year on this planet?

One year on Jupiter is 4,335 Earth days or 11.87 Earth years long.

A Jupiter year is about equal to four-tenths (or two-fifths) of a Saturn year. Thus after every two Saturn years, Jupiter has completed five full orbits about the Sun. So after 59 years, Saturn and Jupiter will be back in nearly the same position. When the orbits of two planets are simple ratios of each other like this, it is called a **resonance**.

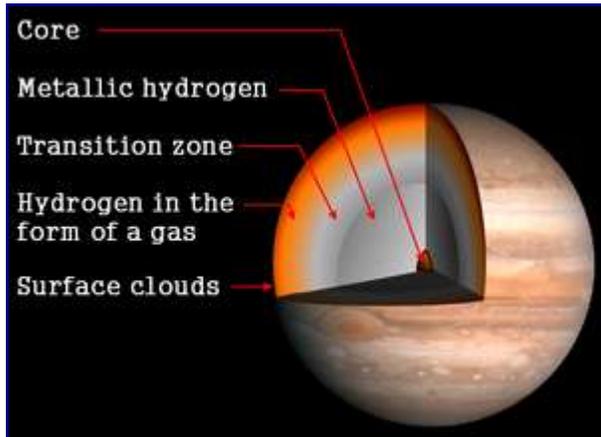


The Great Red Spot



Jupiter Eclipses

## What is it made of?



The interior of Jupiter contains a small rocky core, surrounded by hydrogen that is under such intense pressure it forms a metal. During the transition zone the hydrogen gradually changes from metal to liquid and finally gas.

Jupiter has a rocky **core**. Around the core, there is metallic **hydrogen**. On top of that is liquid and then gaseous hydrogen. There is no place where the hydrogen suddenly turns from a gas to a liquid.

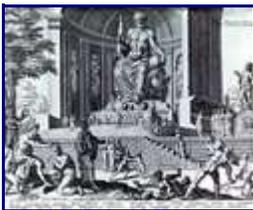
The gaseous hydrogen is part of Jupiter's **atmosphere**. Other gases there include **helium**, methane, water, and ammonia!

## How much would Jupiter's gravity pull on me?

If you were floating close to the cloud tops of Jupiter, it would pull you down with a force about two and a half times as strong as the force of Earth's gravity.

Jupiter's rapid rotation causes the equator to bulge out. This would also cancel out about 10 percent of gravity's force on you if you were at the equator. The amount of this counteraction becomes lower the closer you get to the poles.

## Who is it named after?



Statue of Zeus (Jupiter) in Olympia, Greece

Jupiter is named after the chief of the Roman gods, also called Zeus in ancient Greece. It was so named because of the planet's enormous size, which dominates all the others.

# Saturn



Saturn casts a shadow on its rings

	<b>Saturn Facts:</b> <ul style="list-style-type: none"><li>• If you could find a bathtub big enough, Saturn would float in it.</li><li>• Some of Saturn's moons control the width of its rings.</li><li>• add description.</li></ul>
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## How big is the planet?

Saturn is 120,536 km or 9.449 Earths in diameter at the **equator**. It is only 108,728 km or 8.552 Earths in diameter from pole to pole. It is bigger at the equator because it spins fast enough to budge out.

## What is its surface like?

Saturn has no surface that you could stand on without going deep into its **atmosphere**. The atmosphere has bands, but they're not as colorful as Jupiter's.

## What are its rings like?

Saturn's rings are composed of silica rock, iron oxide, and ice particles ranging in size from specks of dust to the size of a small automobile.

## What are its moons like?



Saturn with some of its moons

Saturn has at least 48 moons. The exact number of Saturn's moons will never be known because of the similar sizes of the moons and the chunks of ice in Saturn's rings.

### Shepherd moons

There are small potato shaped moons in or near Saturn's rings. They control the ring particles with their gravity. That is why they are called shepherd moons. Six of them are known and there may be more.

### Mimas

Mimas is made mostly of water ice with a little rock. It has a large **crater** for its size called *Herschel*. It is 130 km across, making it about a third as big as Mimas.

### Enceladus

Enceladus is made of ice. It has smooth areas, cracks and some craters. The smooth areas are younger. Craters there got erased within the past 100 million years.

### Tethys



Tethys is an icy moon that has many craters, including the huge *Odysseus*. It is 400 km across, a quarter as big as Tethys. The crater had become flattened because the icy

material doesn't hold its shape as well as rock would. There is also a large valley called *Ithaca Chasma*. It is 3 to 5 km deep, 100 km wide and 2000 km long, three fourth of the way around Tethys. There are two moons, Telesto and Calypso, that share Tethys's orbit. Telesto is ahead of Tethys and Calypso is behind it..

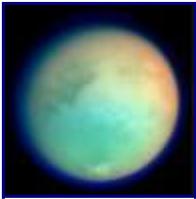
## Dione

Dione is made of lots of ice and maybe some rock in the **core**. It has lots of craters. The craters are flattened because the ice doesn't hold their shape as well as rock. One side has bright white lines that are cliffs made of ice. There is one moon, Helene, that is ahead of Dione in its orbit.

## Rhea

Rhea is an icy moon similar to Dione with some rock in the core. It has many craters on one side and the other side has some bright white icy areas.

## Titan

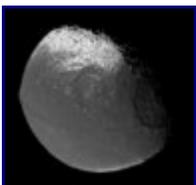


Titan is the largest moon of Saturn and the second largest one in the solar system. It is the only moon in the solar system that has a thick **atmosphere**. The atmosphere is made of **nitrogen**, **methane** and various **organic compounds**. Its surface has light and dark areas and few craters. However, the Cassini probe discovered a huge crater, 440 km across, with its **radar**. The Huygens probe was carried by Cassini. It got released from Cassini and landed on Titan. It sent back pictures of Titan's surface. Titan has a gigantic atmosphere, extending hundreds of kilometers above the surface.

## Hyperion

Hyperion is made of water ice with a little rock. It is potato shaped. It wobbles instead of rotating in the same way other moons do.

## Iapetus



Iapetus it made of ice with a little rock. It has a light area, *Roncevaux Terra* with craters.

There is a big dark area called *Cassini Regio* that covers half of Iapetus. The dark material may be made of organic compounds. Some of it is on the bottom of craters. Some huge craters and a ridge had been discovered in *Cassini Regio* by the Cassini probe. The ridge stretches 1300 km along the **equator** It is up to 20 km high, which is over 20 times higher than Mount Everest.

## **Phoebe**

Phoebe is made of ice and rock, but looks dark because it has a layer dark material on the outside. It also looks rough.

## **Other moons**

There are two groups of small outer moons. Phoebe is part of the outermost group.

## **How long is a day on this planet?**

One day on Saturn is about 10 hours and 40 minutes in Earth time.

## **How long is a year on this planet?**

One year on Saturn is 29.45 or about 29 and a half Earth years long. That is 10,758 Earth days!

A Saturn year is almost exactly equal to two and half Jupiter years. Thus after every two Saturn years, Jupiter has completed five full orbits about the Sun. So after 59 years, Saturn and Jupiter will be back in nearly the same position. When the orbits of two planets are simple ratios of each other, it is called a **resonance**.

## **What is it made of?**

Saturn has a rocky core. Around the core, there is liquid metallic **hydrogen**. On top of that is gaseous hydrogen. There is no place where the hydrogen suddenly turns from a gas to a liquid.

The gaseous hydrogen is part of Saturn's **atmosphere**. Other gases there include **helium** and some other gases. There may be rain made of helium falling through the hydrogen.

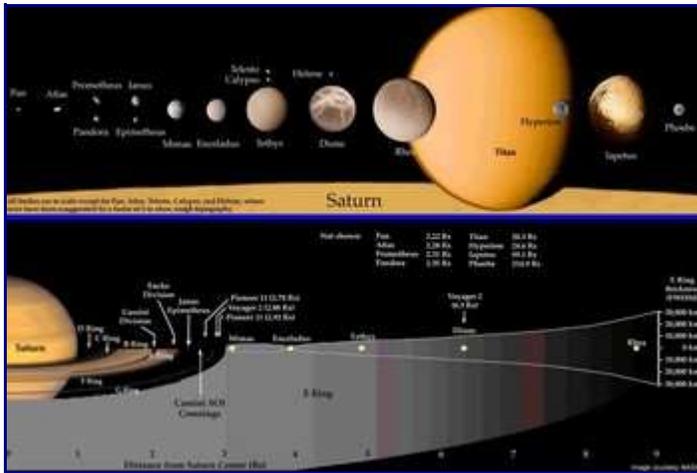
## **How much would Saturn's gravity pull on me?**

If you were floating close to the cloud tops of Saturn, it would pull you down with a force only a little stronger than the force of Earth's gravity. The effects of Saturn's large radius and its mass almost cancel out, making the force only a little bigger.

Saturn's rapid rotation causes the equator to bulge out. This would also cancel out about 10 percent of gravity's force on you if you were at the equator. The amount of this counteraction becomes lower the closer you get to the poles.

# Who is it named after?

Saturn is named after the Roman god of corn, nature and agriculture.



Map of the Saturn system (NASA)

# Uranus



Uranus as seen from Voyager 2

Uranus, the seventh planet from the sun, was discovered by William Herschel on March 13, 1781. It is a **gas giant** and the third largest planet in the Solar System.

## How big is the planet?

Uranus is 51,118 km or 4.007 Earths in diameter. This means that about four Earths placed in a line side by side would be as long as Uranus is across.

## What is its surface like?

Uranus has no surface that you could stand on without going deep into the **atmosphere**.



### Uranus Facts:

- Uranus's rings may look white in pictures, but they are actually made of asphalt-colored material.
- When it was first discovered Uranus was thought to be a star and was given the number 34 Tauri.
- Uranus is the only planet besides Pluto in our solar system that rotates on its side.

## What are its moons like?



Uranus's rings and moons

Uranus has 27 discovered moons, which places it third in the solar system for number of moons! The five main ones are Miranda, Ariel, Umbriel, Titania and Oberon.

### **Miranda**

Miranda is the smallest and closest of Uranus's major moons. It is mainly made of water ice, and **silicate** rocks. There are also some **methane** related **organic compounds**. Miranda also has **canyons** 20 km deep. Miranda was named after a character in "The Tempest", a play by Shakespeare. A color composite picture of Miranda was taken with by Voyager 2 on January 24, 1986, from a distance of 147,000 kilometres.

### **Ariel**

Ariel is half water ice with the rest being silicate rocks and methane ice. Ariel doesn't have many craters and has big canyons. Ariel was named after the helpful sprite in "The Tempest" by Shakespeare.

### **Umbriel**

Umbriel is made of lots of water ice and some silicate rocks and methane ice. It is also the darkest of Uranus's major moons. Umbriel was named after a character in the comic poem "The Rape of the Lock" by Alexander Pope.

### **Titania**

Titania is the largest moon of Uranus. The majority of it is water ice, with quite a lot of silicate thrown in with some methane related organic compounds. Like Ariel, Titania also has some huge canyons. It was named after the Queen of the Fairies in "A Midsummer's Night Dream", a play by Shakespeare.

## **Oberon**

Oberon is the outermost of the major moons of Uranus. It is very similar to Titania in what it is made of. It has many craters. Some of them have white rays around them and dark crater floors. The dark material may be made of organic compounds. It was named after the King of the Fairies in "A Midsummer's Night Dream".

## **Other moons**

There are 13 tiny moons known to be **orbiting** Uranus inside Miranda's orbit. Nine more tiny moons are known to be in big orbits beyond Oberon's orbit.

## **How long is a day on this planet?**

One day on Uranus is about 17 Earth hours long. Uranus spins on its side. Maybe it was because of a big impact early in the history of the solar system.

## **How long is a year on this planet?**

One year on Uranus would be 30,708 days or 84 years on Earth.

## **What is it made of?**

Unlike Jupiter and Saturn, Uranus is thought to be made mostly of rock and ices with only 15 percent of it being hydrogen. The gases in its **atmosphere** are mostly **hydrogen** and **helium**. Other gases found in smaller amounts are ammonia, water, and **methane**. The methane gives Uranus its blue-green color. Under the atmosphere, it is thought that there is an uniform mixture of rocky and icy materials rather than a separate rocky core.

## **How much would Uranus's gravity pull on me?**

If you were floating close to the cloud tops of Uranus, it would pull you down with a force about nine tenths as strong as the force of Earth's gravity. The effects of Uranus's large radius and its mass almost cancel out, making the force only a little bigger.

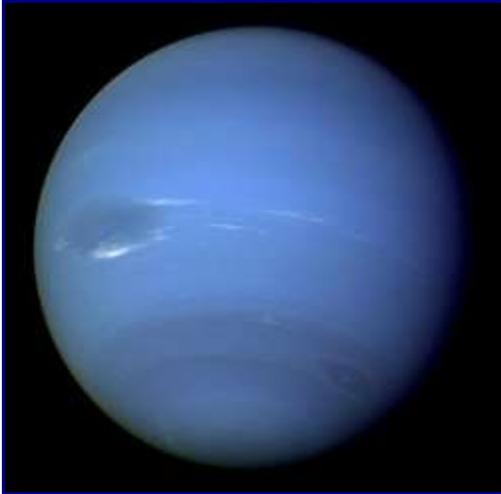
Uranus's rotation is not as rapid as that of Jupiter and Saturn. That means its equator does not bulge out as much. So, Uranus's rotation would not cancel out as much of its gravity's force.

## **Who is it named after?**

Uranus was named after Ouranos, the Greek name for the sky. According to Greek mythology, Ouranos was the husband of Gaia, Mother Earth.

# Neptune

Neptune is very similar to Uranus, but it is slightly smaller in diameter and more massive.



## Neptune Facts:

- Wind speeds on Neptune can reach 450 meters per second.
- Neptune was discovered because its gravitational field was affecting the orbit of Uranus.
- Neptune is sometimes the ninth planet from the Sun.

Neptune as seen from Voyager 2

## How big is the planet ?

Neptune has a diameter of 49,528 km across at the **equator** and 48,681 km from pole to pole. It is almost as big as four Earths in a row. It bulges out a little at the equator because of its **rotation**, but not as much as Jupiter and Saturn.

## What is its surface like?

Neptune is a gas giant so it does not have a surface that you can stand on without going deep into its **atmosphere**. The atmosphere looks blue-green. It has some dark blue spots. When the Voyager probe went by Neptune in 1989, there was a large one called the Great Dark Spot. Now it is gone and there are new spots. There are some high white clouds too. The winds of Neptune are very fast, blowing at up to 2000 km per hour. That is about ten times faster than the winds of some of Earth's strongest tornadoes.

## What are its rings like?

Neptune has some faint rings that are dark and hard to see. There are clumps in some parts of the rings where the material is more dense. It could be because of the gravity of the nearby small inner moons of Neptune.

## What are its moons like?

Neptune has 13 known moons. There could be more.

## **Inner moons**

There are five small potato shaped moons **orbiting** close to Neptune.

### **Proteus**

Proteus is a dark moon about 420 km across. It is irregularly shaped, but it is almost big enough for its gravity to pull it into a sphere. In Roman mythology Proteus was Neptune's herdsman who could change into any shape he wanted.

### **Triton**

Triton is the largest moon of Neptune. Scientists think that it is a lot like Pluto. It is 2700 km across. It is made of rock and some water ice. It has a surface temperature of  $-236^{\circ}\text{C}$  making it the coldest world visited by spacecraft. Triton has a very thin atmosphere made up of nitrogen and a little methane.

There are volcanoes that have eruptions of liquid **nitrogen**, dust, or **methane** compounds. The eruptions happen because of the seasons. They make plumes up to 8 km high. There are few **craters** because the eruptions cover them up. There are ice caps of nitrogen and methane ice that change sizes with the seasons. There are also ridges and valleys. They may have formed because the changing seasons caused the material to repeatedly freeze and warm up.

An interesting thing about Triton's orbit is that it goes around Neptune in the opposite direction from the direction of Neptune's rotation. Because of that, scientists think that Triton was captured by Neptune long ago. Its orbit is also very circular. Neptune's gravity made the orbit circular over a long time after the capture. The tidal effects involved in that may have heated Triton and kept ices melted for a billion years. In Roman mythology, Triton was the son of Neptune.

### **Nereid**

Nereid is an irregularly shaped moon about 340 km across. Its orbit is very eccentric or noncircular. It may have been captured by Neptune or moved into the eccentric orbit by Triton's gravity when Triton got captured. In Roman mythology nereids were sea nymphs.

## **Outer moons**

There are five other known moons. They are small potato-shaped moons far from Neptune. There could be more yet to be discovered.

## **How long is a day on this planet?**

A day on Neptune lasts 16 hours and 7 minutes.

## What is it made of?

Neptune is made of rock and metal in the **core**. The core is probably bigger than Uranus's because Neptune weighs more, but is the same size. Around the core is rock, water, **ammonia** and **methane**. The atmosphere makes up most of the planet and is made of **hydrogen** and **helium**. Lower down in the atmosphere, there is methane and ammonia too. The methane makes Neptune look blue-green.

## How much would I weigh on Neptune?

If you were floating close to the cloud tops of Neptune, it would pull you down with a force only a little stronger than the force of Earth's gravity. The effects of Neptune's larger radius and its mass almost cancel out, making the force only a little bigger.

Neptune's rotation is not as rapid as that of Jupiter and Saturn. That means its equator does not bulge out as much. So, Neptune's rotation would not cancel out as much of its gravity's force.

## Who is it named after?



Artistic impression of Neptune

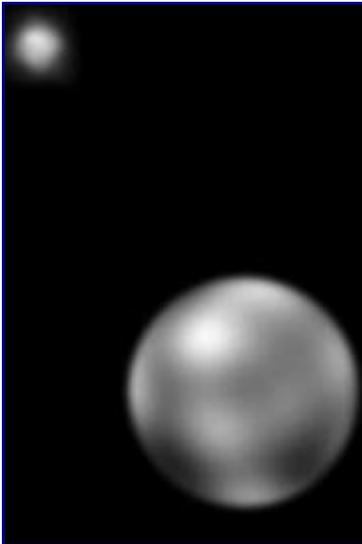
Neptune is named after the Roman god of the seas, also known as Poseidon in ancient Greece.

# Pluto



Pluto and its moon Charon

Pluto, the ninth planet in the Solar System, was accidentally discovered by the astronomer Clyde W. Tombaugh in Arizona on February 18, 1930.



Pluto and Charon from the Hubble Space Telescope

	<p><b>Pluto Facts:</b></p> <ul style="list-style-type: none"><li>• Pluto is the smallest planet</li><li>• Most often, it is farthest away from the sun, but sometimes Neptune is.</li><li>• Some astronomers believe that Pluto and its moon Charon are actually a "double planet", because Charon does not orbit around Pluto.</li></ul>
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## How big is the planet?

Pluto is the smallest of all of the planets in the Solar System, weighing only 13,200,000,000,000,000,000 kilograms. While this may seem large, it's only about 1/500th of the Earth's **mass**. If you were to cut Pluto in half and measure the length on the inside, you'd find that Pluto is 2390 kilometers across, and with a little math you could figure out that its **surface area** is about 17,950,000 square kilometers (or 1/30th of the Earth's) and that its **volume** is 7,150,000,000 (or 1/15th of the Earth's).

## What is its surface like?

We don't really know for sure. No spacecraft has ever been there, and Pluto is so far away from Earth that even the best telescopes can't see any detail. It is certainly very cold, about -230 °C. The surface of Pluto is covered with ice, but not the same kind of ice that

is found on Earth. The ice that covers Pluto is believed to be made mostly of nitrogen. Pluto also has a very thin **atmosphere** of nitrogen and methane which may freeze out when Pluto moves further from the Sun.

Some powerful telescopes like the **Hubble Space Telescope** have observed some seasonal changes as Pluto moved closer to the Sun and then moved further away, due to the nature of its orbit around the Sun.

## **What is its moon like?**

Pluto has one moon: Charon. Charon is about half the size of Pluto in length and, much like Pluto, is believed to be covered with ice. Unlike Pluto, however, the ice covering Charon is thought to be made of water rather than nitrogen. In Roman mythology Charon ferried the shades of the dead across the river Lethe to the land of the dead.

## **How long is a day on this planet?**

One day on Pluto is about 6.387 Earth days long. Like Uranus, Pluto also spins on its side.

## **How long is a year on this planet?**

One year on Pluto would be about 90,613 days or 248 years on earth!

## **What is it made of?**

It is believed that Pluto is made mostly of rock and ice, although scientists will not be sure until more research is done on the planet. With the discovery of Charon, a good approximation of the average **density** of the planet can be determined, which can in turn suggest what Pluto is not made out of. If Pluto were made out of heavy minerals and iron like the planet Mercury, Pluto would have a very high density. Planets like Saturn are so thin and tenuous that their average density is less than even water. Pluto is somewhere in between, but more like some of the moons of the outer planets like Callisto or Triton, which are known to have quite a bit of water ice.

## **How much would Pluto's gravity pull on me?**

If you were on Pluto, it would pull you down with a force less than one tenth as strong as Earth's gravity.

## **Who is it named after?**

Pluto was named after the Roman god of the underworld.

## **Is Pluto really a planet?**

Some scientists say that Pluto isn't really a planet. They say it is too small, and point out that Charon (Pluto's satellite) is not much smaller than it. Some consider Pluto to be the largest known Kuiper belt object. Also, Pluto has a pattern of orbit around the sun that is different from other planets, and its orbit is affected somewhat by the gravitational pull of the nearby planet Neptune. Many Kuiper belt objects have orbits like that.

# Kuiper Belt

The Kuiper belt extends from Neptune's **orbit** to three billion kilometers beyond it. It contains lumps of icy material with **organic compounds**. That makes them like comets. These lumps are called Kuiper belt objects or minor planets. The Kuiper belt may have formed when the gravity of the young Jupiter sent the Kuiper belt objects out to where they are now.

## How big are the Kuiper belt objects?

Scientists consider Pluto to be the largest Kuiper belt object. It is 2390 km across. The next largest known Kuiper belt object is Orcus, which is about 1600 km (1,000 miles) across. Other large Kuiper belt objects about or over 1000 km across are Pluto's moon Charon, Quaoar, Varuna, Ixion, 2002 TX300, 2002 UX25 and 2002 AW197; about as big or bigger than Ceres, the largest asteroid.

## How many are there?

By the year 2004 over 800 Kuiper belt objects had been found. Scientists think that there are many more yet to be discovered, and some might be as big as Earth (though much colder).

## What are they named after?

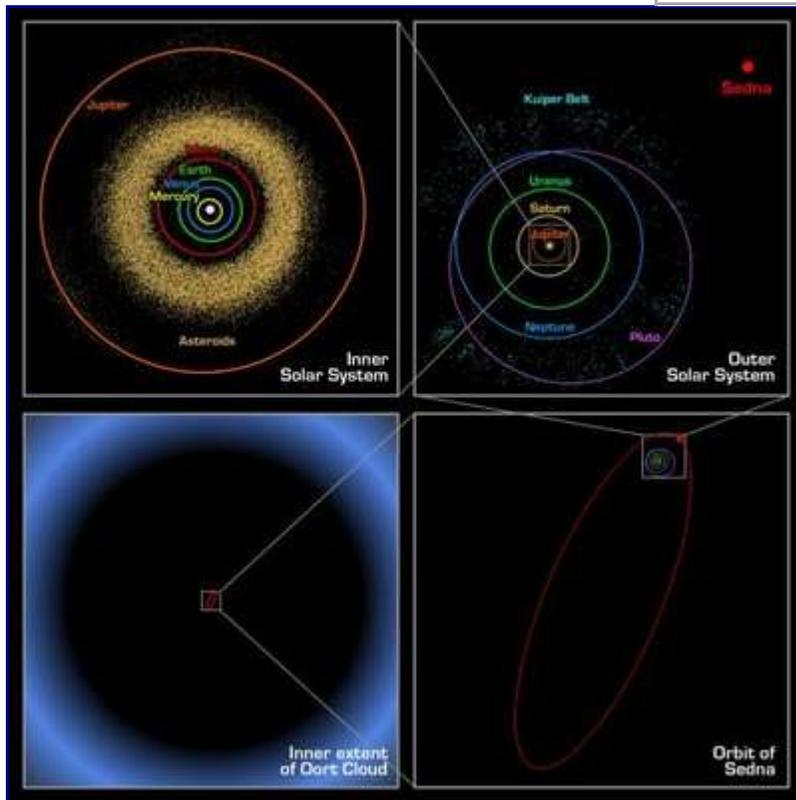
After the first object in the belt was spotted from the Mauna Kea Observatory in Hawaii, the belt was named after the astronomer Gerard Kuiper who in 1951 wrote that he thought it existed very long ago. Astronomers including Frederick Leonard, Kenneth Edgeworth, and Julio Fernandez thought that the belt still existed; and some astronomers call it the Edgeworth-Kuiper belt.

Orcus, Charon, and Varuna were named after gods of the underworld, and Ixion a mythological person in the underworld. Quaoar was named after a creation god.

# Oort Cloud

## Oort Cloud Facts:

- The Oort cloud is the farthest from the sun that you can go and still be in the solar system.
- It is believed that most comets originally were in the Oort Cloud before "falling" into the Sun.



A Diagram showing approximately how far away the Oort Cloud might be in relation to the planets of the Solar System

## What is an Oort cloud?

Scientists think that there is a group of rocks and ice that forms a cloud-like region surrounding our solar system. It is a collection of comet like objects **orbiting** far away from the sun. It is named after a Dutch astronomer [Jan Oort](#) who refined and popularized the theory.

## Where is the Oort cloud?

The comets in the Oort cloud are at distances of 50 thousand to 100 thousand times the distance between Earth and the sun. That is a thousand times further away from the sun than Pluto is and about one fourth the distance to the nearest star. Light would take a year to travel that far.

## How did the Oort cloud start?

The Oort Cloud objects may have formed closer to the sun during the solar system's formation. Then **gas giants** sent them far away with their gravity. They were sent in all directions, making the Oort Cloud ball shaped instead of disk shaped. The gravity of other stars made the objects' orbits more circular, making the objects stay far away from the sun. Maybe the gravity of other stars could sometimes send the objects back toward the sun. We would see them as comets.

One object discovered so far is Sedna. It is 1180 to 1800 km across. Its **orbit** stretches from 76 to 928 times Earth's distance from the sun. Sedna takes about 11,250 Earth years to orbit the sun once. The last time Sedna was where it is now in its orbit, Earth's last Ice Age was ending! Some scientists consider it an inner Oort Cloud object. Others think that it should be included in the Kuiper Belt, making the belt bigger.

# Glossary

A Glossary of words used in this book:

- Asteroid - a large rocky object that orbits a star, but is too small to be a planet.
- Astronomer - a person who studies stars and planets.
- [Atmosphere](#)
- Basalt Lava - molten basalt, a kind of rock.
- Carbon dioxide - a gas that animals breathe out and plants take in.
- [Centaur](#)
- Channel - a groove in the surface of something.
- Comet - a small icy object orbiting a star.
- Continent - a huge landmass on a planet.
- Core - the center of a planet or star.
- Crater - a hole in a planet's surface made by a meteorite falling on it.
- Crust - the outermost layer of a planet's surface.
- Energy - what you use to do work.
- Environment - the conditions on a planet.
- Equator - an imaginary line around a planet, perpendicular to the axis of rotation.
- [Erosion](#)
- Gas Giant - one of the four outer planets made out of giant balls of gas.
- Hemisphere - one half of a planet's surface.
- [Lagrange point](#)
- Lava - molten rock above a planet's surface.
- Mantle - a layer of molten rock below a planet's crust.
- Mass - the size of something.
- Meteor - a small or medium-size rock from space that has not entered a planet's atmosphere yet.
- Methane - a gas that makes up most of the gas giants.
- [Near Earth Asteroid](#)
- Orbit - the path that an object takes around a larger object.
- Orbit System - a planet and its moons rotating around a star.
- Organic Compounds - compounds (collections of atoms) containing carbon.

- Planet - the celestial body that has a greater mass than all other objects of the same orbit system together and that describes a well-defined, special orbit around a star.
- Radar - radio waves used to find distances to and make maps of things.
- Rotate - to turn on an axis.
- Scarp - a type of cliff.
- [Silicate](#)
- Surface Area - the area on the outside of something.
- [Tectonic Plate](#)
- Terrestrial Planets - the four planets closest to the Sun.
- [Trojan asteroid](#)
- Star - a huge ball of gas that produces light itself.
- Volcanic - something that relates to volcanoes.
- Volume - the size of an object.

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