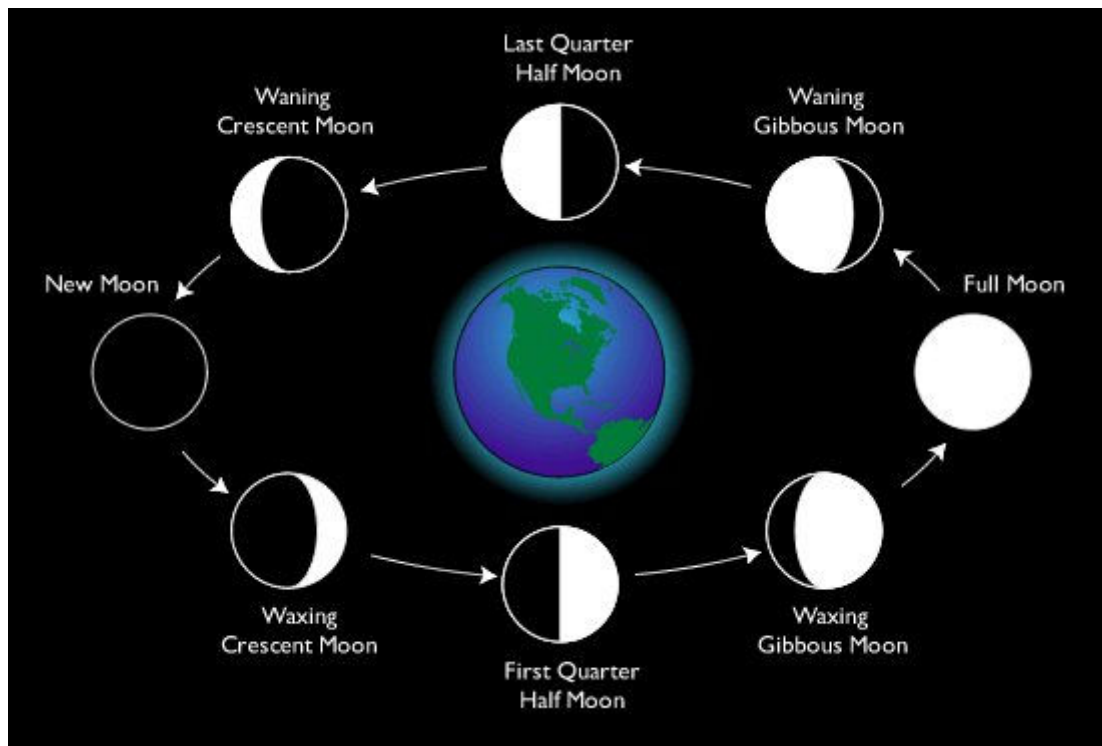


## Understanding The Moon Phases



Have you ever wondered what causes the moon phases? We all know that its appearance changes over time. But why? The good way to understand the phases of the moon is to examine an earth-moon-sun diagram:

Sunlight is shown coming in from the right. The earth, of course, is at the center of the diagram. The moon is shown at 8 key stages during its revolution around the earth. The moon phase name is shown alongside the image. The dotted line from the earth to the moon represents your line of sight when looking at the moon.

To help you visualize how the moon would appear at that point in the cycle, you can look at the larger moon image. This means for the waning gibbous, third quarter, and waning crescent phases you have to mentally turn yourself upside down. When you do this, you'll "see" that the illuminated portion is on your left, just as you see in the large image.

One important thing to notice is that exactly one half of the moon is always illuminated by the sun. Of course that is perfectly logical, but you need to visualize it in order to understand the phases. At certain times we see both the sunlit portion and the shadowed portion — and that creates the various moon phase shapes we are all familiar with. Also note that the shadowed part of the moon is invisible to the naked eye; in the diagram above, it is only shown for clarification purposes.

So the basic explanation is that the lunar phases are created by changing angles (relative positions) of the earth, the moon and the sun, as the moon orbits the earth.

If you'd like to examine the phases of the moon more closely, via computer software, you may be interested in this moon phases calendar software.

## **Moon Phases Simplified**

It's probably easiest to understand the moon cycle in this order: new moon and full moon, first quarter and third quarter, and the phases in between.

As shown in the above diagram, the new moon occurs when the moon is positioned between the earth and sun. The three objects are in approximate alignment (why "approximate" is explained below). The entire illuminated portion of the moon is on the back side of the moon, the half that we cannot see.

At a full moon, the earth, moon, and sun are in approximate alignment, just as the new moon, but the moon is on the opposite side of the earth, so the entire sunlit part of the moon is facing us. The shadowed portion is entirely hidden from view.

The first quarter and third quarter moons (both often called a "half moon"), happen when the moon is at a 90 degree angle with respect to the earth and sun. So we are seeing exactly half of the moon illuminated and half in shadow.

Once you understand those four key moon phases, the phases between should be fairly easy to visualize, as the illuminated portion gradually transitions between them.

An easy way to remember and understand those "between" lunar phase names is by breaking out and defining 4 words: crescent, gibbous, waxing, and waning. The word crescent refers to the phases where the moon is less than half illuminated. The word gibbous refers to phases where the moon is more than half illuminated. Waxing essentially means "growing" or expanding in illumination, and waning means "shrinking" or decreasing in illumination.

Thus you can simply combine the two words to create the phase name, as follows:

After the new moon, the sunlit portion is increasing, but less than half, so it is waxing crescent. After the first quarter, the sunlit portion is still increasing, but now it is more than half, so it is waxing gibbous. After the full moon (maximum illumination), the light continually decreases. So the waning gibbous phase occurs next. Following the third quarter is the waning crescent, which wanes until the light is completely gone — a new moon.

## **The Moon's Orbit**

You may have personally observed that the moon goes through a complete moon phases cycle in about one month. That's true, but it's not exactly one month. The synodic period or lunation is exactly 29.5305882 days. It's the time required for the moon to move to the same position (same phase) as seen by an observer on earth. If you were to view the moon cycling the earth from outside our solar system (the viewpoint of the stars), the time required is 27.3217 days, roughly two days less.

This figure is called the sidereal period or orbital period. Why is the synodic period different from the sidereal period? The short answer is because on earth, we are viewing the moon from a moving platform: during the moon cycle, the earth has

moved approximately one month along its year-long orbit around the sun, altering our angle of view with respect to the moon, and thus altering the phase. The earth's orbital direction is such that it lengthens the period for earthbound observers.

Although the synodic and sidereal periods are exact numbers, the moon phase can't be precisely calculated by simple division of days because the moon's motion (orbital speed and position) is affected and perturbed by various forces of different strengths. Hence, complex equations are used to determine the exact position and phase of the moon at any given point in time.

Also, looking at the diagram (and imagining it to scale), you may have wondered why, at a new moon, the moon doesn't block the sun, and at a full moon, why the earth doesn't block sunlight from reaching the moon. The reason is because the moon's orbit about the earth is about 5 degrees off from the earth-sun orbital plane.

However, at special times during the year, the earth, moon, and sun do in fact "line up". When the moon blocks the sun or a part of it, it's called a solar eclipse, and it can only happen during the new moon phase. When the earth casts a shadow on the moon, it's called a lunar eclipse, and can only happen during the full moon phase. Roughly 4 to 7 eclipses happen in any given year, but most of them minor or "partial" eclipses. Major lunar or solar eclipses are relatively uncommon. [Moon Connection .com](http://MoonConnection.com)

## **Moon Facts**



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There are many interesting facts about the moon and trivia that may or may not be important to you. Some interesting facts include:

We all know there was a man on the moon, but did you know that there is one who stayed there? Dr. Eugene Shoemaker, a Geological Surveyor, who educated the Apollo mission astronauts about craters, never made it into space himself, but it had always been one of his dreams. He was rejected as an astronaut because of medical problems. After he died, his ashes were placed on board the Lunar Prospector spacecraft on January 6, 1999, which was crashed into a crater on the moon on July 31, 1999. The mission was to discover if there was water on the moon at the time, but it also served to fulfill Dr Shoemaker's last wish.

When Neil Armstrong took that first historical step and said "That's one small step for man, one giant leap for mankind" it would not have occurred to anyone that the step he took in the dust of the moon was there to stay. It will be there for millions of years because there is no wind on the moon. That is, assuming the downdraft from the Command Module upon takeoff back into space didn't destroy the print. Buzz Aldrin reportedly saw the American flag, much further away, blow over during launch. Nevertheless, any footprints made by the famous astronauts undisturbed by takeoff are, in fact, there to stay.

- When Alan Sheppard was on the moon, he hit a golf ball and drove it 2,400 feet, nearly one half a mile.
- In a survey conducted in 1988, 13% of those surveyed believed that the moon is made of cheese.
- The multi layer space suits worn by the astronauts to the moon weighed 180 pounds on earth, but thirty pounds on the moon due to the lower gravity.
- How close can you get without completely running out of gas? Apollo 11 had only 20 seconds of fuel left when they landed on the moon.
- Apollo 15 was the first mission to use a lunar rover. The top speed that was ever recorded in this 4-wheeled land vehicle was 10.56 miles per hour.
- It is possible to have a month without a full moon. This occurs in February, but either January or March will have two moons.
- In China, the dark shadows that are on the moon are called "the toad in the moon".
- The Apollo missions brought back 2196 rock samples weighing 382 kg in total

#### **Facts About the Moon**

- The moon is not a planet, but a satellite of the Earth.
- The surface area of the moon is 14,658,000 square miles or 9.4 billion acres
- Only 59% of the moon's surface is visible from earth.
- The moon rotates at 10 miles per hour compared to the earth's rotation of 1000 miles per hour.
- When a month has two full moons, the second full moon is called a blue moon. Another definition of a blue moon is the third full moon in any season (quarter of year) containing 4 total full moons.
- From Earth, we always see the same side of the moon; the other side is always hidden.
- The dark spots we see on the moon that create the image of the man in the moon are actually craters filled with basalt, which is a very dense material.
- The moon is the only extraterrestrial body that has ever been visited by humans. It is also the only body that has had samples taken from it.

- The first space craft to send back pictures from the moon was Luna 3 (built by the Soviet Union) in October 1959.
- The moon has no global magnetic field.
- The moon is about 1/4 the size of the Earth.