

Phases of the Moon

One of the most familiar of all astronomical phenomena is the changing appearance of the Moon in the sky. The **phases of the Moon** are a result of the monthly lunar orbit around the Earth, and also because the Moon does not generate its own light. We are able to view the Moon only when sunlight illuminates the Moon and then is reflected to us on the Earth. We can begin our study of lunar phases by considering the diagram below:

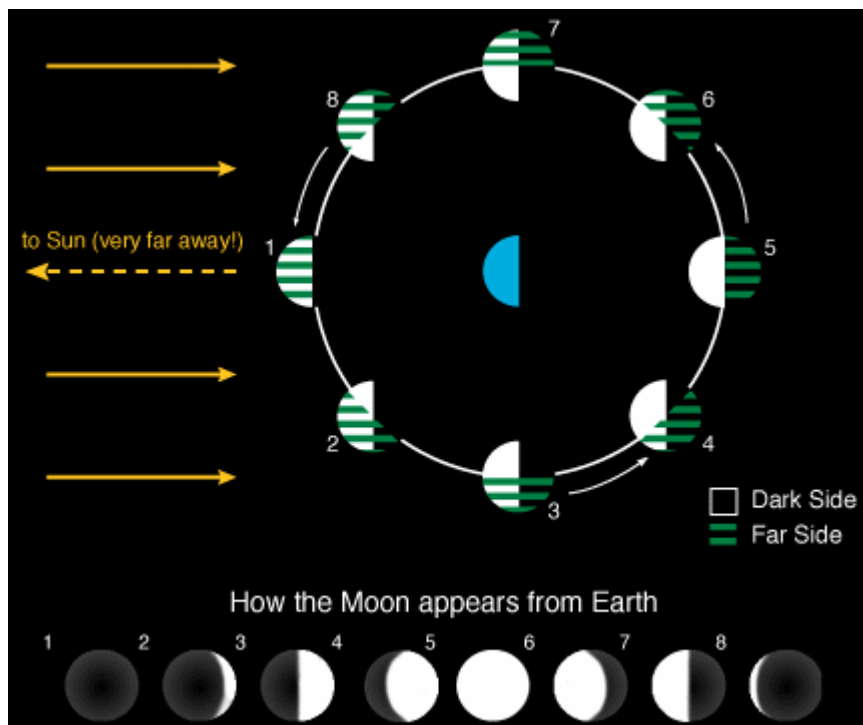


image courtesy University Corporation for Atmospheric Research

This diagram shows a "top down" view of the Sun-Earth-Moon system. Note that the Sun is to the left on the diagram, and that the sun's rays approach the Moon and Earth in parallel paths. The Moon is shown in eight different positions in its monthly orbit around the Earth. The white areas are those lunar regions illuminated by the Sun; the black portions are those that are not illuminated by sunlight. It is important to note that at any given time, 1/2 the Moon is in sunlight, and 1/2 of the Moon is in darkness.

Further, at any given time, 1/2 of the Moon is facing the Earth, and 1/2 of the Moon is facing away from the Earth. In the diagram above, the horizontal green lines indicate the hemisphere of the Moon that is facing away from the Earth.

Let's look at position 1 in the diagram above. We know that half of the Moon is lit, and in this case, it should be clear that the illuminated half of the Moon is facing away from the Earth. The side facing the Earth is receiving no sunlight at all, so Earth observers are not

able to see the Moon when it is in this part of its orbit. This lunar phase is called the **new moon**.

Look now at the panel of lunar images on the bottom of the figure above. These images show how the moon would appear to an observer on the Earth. When the moon is in the new phase, the moon appears completely dark to observers on the Earth, since the half of the moon that faces the Earth is receiving no sunlight at all.

Let's consider now position five in the lunar orbit. We can see that this point is opposite the new moon. When the Moon is in this point in its orbit, the half of the Moon that is illuminated is facing the Earth, so that an observer on the Earth sees the entire disc of the Moon illuminated, and we call this lunar phase the **full Moon**.

At the quarter phases, positions 3 and 7 on these diagrams, we can see that half of the Earth facing side is illuminated, and the images labeled 3 and 7 in the diagram above show how the Moon would appear on Earth at these phases. There is specific terminology used to describe different phases of the moon. Notice that for the first half of the lunar month, i.e., when the Moon is between new and full phases (in other words, when the Moon is between positions 1 and 5 in the diagram above), we say the Moon is **waxing**. In the second half of the lunar month (the interval between positions 5 and 1) we say the Moon is **waning**. A **crescent** Moon occurs when the Moon is between new and quarter phase, either as a waning or waxing moon; a **gibbous** Moon occurs when the Moon is between quarter and full phase. So, the crescent Moon that occurs after the third quarter phase is called **waning crescent**; the Moon that is almost full but is one or two days short of full is a **waxing gibbous** Moon.

Classroom Activity

For this activity you will need a lamp and one or more spherical objects. Place the lamp in the center of a darkened room, and hold one of the spheres at arm's length between you and the lamp. Notice the pattern of illuminated vs. non-illuminated areas; you should see that the line that separates the light and dark areas is a curved line on the surface of the sphere, we call this separating line the **terminator**.

Notice how if you move the sphere with respect to the lamp, the illuminated portion of the sphere can increase or decrease, but the terminator is always a curved line. You can explain to your students (and have them do the same activity), that this is very similar to why the moon has phases.

In this classroom activity, you are the observer and represent an observer on Earth, the lamp is the sun, and the spherical object is the Moon. Just as the Moon orbits the Earth, this spherical object can be made to revolve around you, and is illuminated by the light of the central lamp. This activity nicely shows how lunar phases are determined by the sun-earth-moon angle.