

## PHASES OF THE MOON AND THE TIDES

The rising and setting of the sun, the moon and the stars is caused by the rotation of the earth. The time of sunrise and sunset depends upon the position of the earth in its orbit around the sun. On the other hand, the time of moonrise and moonset is determined by the position of the moon in its orbit around the earth. This is called a sidereal period. However, during this time the earth has moved along its orbit around the sun. Thus the sun is not in the same place in the sky relative to the stars. It takes the moon a total of 29.5 days to come back to the same position relative to the sun.

The moon rises or sets at the same time as the sun only when it is in the same direction in the sky as the sun. When the moon is in the opposite direction from the sun it rises when the sun sets and vice versa.

Viewed from in space above the north pole of the earth, the moon travels in a counterclockwise direction around the earth. Viewed from the surface of the earth, the moon rises in the east and sets in the western sky. But, it also moves eastward relative to the stars about 13 degrees in twenty four hours, (one solar day). Since the earth is also rotating counterclockwise on its axis, it must turn 13 degrees more after 24 hours to get the moon back to its position relative to the horizon on the previous day. It takes about 50 minutes for the earth to rotate 13 degrees. Therefore, the moon rises an average of 50 minutes later every day.

As the moon moves around the earth, its appearance changes. Sunlight illuminates one half of the surface of the moon, but that half is not visible all of the time from the earth. When the moon is in the same direction of the sun, the sunlit half of the surface is turned away from us. This position causes the phase of the moon known as new moon. When the moon is on the opposite direction from the sun, the sunlit half is toward us. The full moon is the result. Positions between these two locations cause only a portion of the sunlit half to be visible from the earth.

The gravitational attractions of the moon and the sun cause the tides on the earth. The moon is primarily responsible for the high and the low tides. The sun only affects the size of these tides, but it does not cause a large enough effect to produce a high or low tide. Gravity produces a force that tends to pull the water on the surface of the earth toward the line that passes through the center of the moon and the center of the earth. This pull causes high tides to occur near this line and low tides to occur at locations on the surface of the earth away from this line. There are two locations on opposite sides of the earth that have a high tide at the same time and two places where low tides occur simultaneously. Thus there are two high tides and two low tides almost every day.

### Procedure

Label each of the phases of the moon represented on this sheet. Darken the portion of the surface of the moon that is not illuminated at each phase shown. Determine and record the time of moonrise and moonset for each of these phases. For simplicity, assume the sun rises at 6am, is overhead at noon, and sets at 6pm. Also determine the times for the high and low tides.