

## What Causes the Tides

The tides are a natural phenomenon involving the alternating rise and fall in the large fluid bodies of the earth caused by **the combined gravitational attraction of the Sun and Moon.**

The combination of these two variable forces produces the recurrent cycle of the tides. Tides may occur in both the oceans and seas, to a limited extent in large lakes, the atmosphere and, to a very minute degree, in the earth itself.

■ The period between succeeding tides varies as the result of many factors.

■ The tide-generating force represents the difference between 1: the **Diurnal Range** (the centrifugal force produced by the revolution of the earth around the common center-of-gravity of the Earth-Moon system) and 2: the **Mean Range** (the gravitational attraction of the Moon acting upon the Earth's overlying waters).

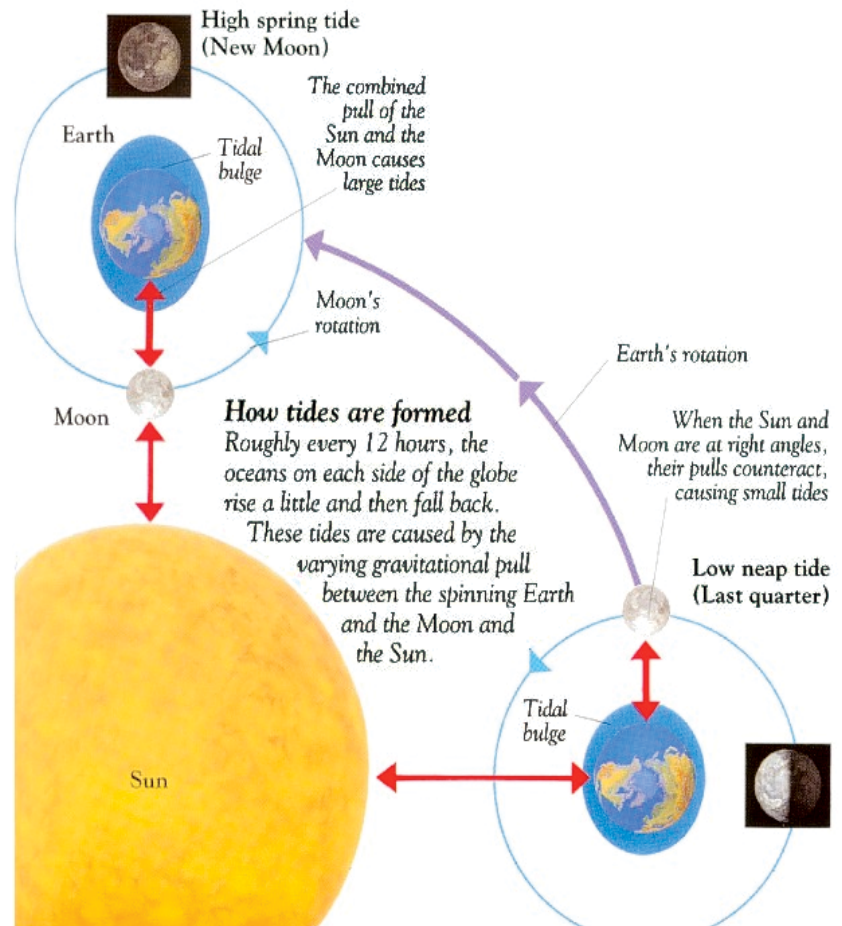
Since, on the average, the Moon is only 239,000 miles from the Earth compared with the Sun's distance of 93,000,000 miles, this closer distance makes the **Moon's influence on our tides 25 times stronger than that of the Sun.**

The effect of the tide generating forces of the Moon and Sun acting at angles to the earth's surface cause an accumulation of the waters of the oceans at two positions as measured through the center of the Earth. The force actually withdraws water from all points 90 degrees away from the positions of these **tidal bulges.** As the earth rotates beneath the greatest and smallest of these tide-generating forces, a sequence of two high tides, separated by two low tides, is usually produced each day. This is the semidiurnal tide.

As the planets move around the sky, twice in each lunar month, when the Sun, Moon, and Earth are directly aligned, the force acting on the tides is increased. If the Moon is aligned between the Earth and the Sun, it is called a **new moon**

If the moon is aligned on the opposite side of the earth from the sun it is called a **full moon**

At those two times, the Sun and the Moon exert their gravitational force in a mutual or additive fashion. The highest high tides and lowest low tides are



produced at these times. These tides are **spring tides.**

At two positions 90 degrees in between, the gravitational forces of the Moon and Sun tend to counteract each other to the greatest extent and the range between high and low tides is reduced. These are **neap tides.**

The semi-monthly variation between the spring and neap tides is called the **phase inequality.**

The angle of the Moon's monthly orbit to the equator and the angle of the Sun during the earth's yearly orbit to the equator produce a difference in the height of succeeding high tides and in the extent of depression of succeeding low tides. In extreme cases changes in planetary orbit and alignment can result in only one high tide and one low tide each cycle

**The thing to remember is the Sun and the Moon have the most effect on the tide**

## Charting and Predicting Tides

Tides are charted and predicted based on **Mean Lower Low Water (MLLW).** This became effective in 1980 when the government prescribed that data on all United States coastlines would be the same: