

two crescent and two gibbous phases are intermediate phases, each of which lasts for about a week between the primary phases, during which time the exact fraction of the Moon's disk that is illuminated gradually changes.

The phases of the Moon are related to (actually, caused by) the relative positions of the Moon and Sun in the sky. For example, New Moon occurs when the Sun and Moon are quite close together in the sky. Full Moon occurs when the Sun and Moon are at nearly opposite positions in the sky - which is why a Full Moon rises about the time of sunset, and sets about the time of sunrise, for most places on Earth. First and Last Quarters occur when the Sun and Moon are about 90 degrees apart in the sky. In fact, the two "half Moon" phases are called First Quarter and Last Quarter because they occur when the Moon is, respectively, one- and three-quarters of the way around the sky (i.e., along its orbit) from New Moon.

The relationship of the Moon's phase to its angular distance in the sky from the Sun allows us to establish very exact definitions of when the primary phases occur, independent of how they appear. Technically, the phases New Moon, First Quarter, Full Moon, and Last Quarter are defined to occur when the excess of the apparent ecliptic (celestial) longitude of the Moon over that of the Sun is 0, 90, 180, and 270 degrees, respectively. These definitions are used when the dates and times of the phases are computed for almanacs, calendars, etc. Because the difference between the ecliptic longitudes of the Moon and Sun is a monotonically and rapidly increasing quantity, the dates and times of the phases of the Moon computed this way are instantaneous and well defined.

The percent of the Moon's surface illuminated is a more refined, quantitative description of the Moon's appearance than is the phase. Considering the Moon as a circular disk, the ratio of the area illuminated by direct sunlight to its total area is the fraction of the Moon's surface illuminated; multiplied by 100, it is the percent illuminated. At New Moon the percent illuminated is 0; at First and Last Quarters it is 50%; and at Full Moon it is 100%. During the crescent phases the percent illuminated is between 0 and 50% and during gibbous phases it is between 50% and 100%.

For practical purposes, phases of the Moon and the percent of the Moon illuminated are independent of the location on the Earth from where the Moon is observed. That is, all the phases occur at the same time regardless of the observer's position.