

## Standard S6E2

**S6E2. Students will understand the effects of the relative positions of the earth, moon, and sun.**

**a. Demonstrate the phases of the moon by showing the alignment of the earth, moon, and sun.**

The Moon's phases occur because from Earth we see only portions of the Moon's illuminated side (the side receiving the sun's rays), depending on the moon's relative position to the earth. The moon never goes away or changes shape—we just see a different fraction of sunlight being reflected from the moon to Earth.

We divide the moon's orbital cycle into several segments or phases. After the **new moon** phase, the moon **waxes**, or appears to **grow** larger, and we see more of the moon's face. The lighted area increases over time from right to left (from our perspective on Earth). Remember: **“The light starts on the right.”** When the sun-earth-moon angle is very small, we see only a thin bright curve, called the **waxing crescent**. Over the next seven days the angle between the sun, Earth, and the moon grows to 90 degrees. We see the sunlight spread to cover the right half of the moon. This is called the **first quarter**. The visible part of the moon continues to wax through the **gibbous phase** over the next seven days until we see the **full moon**. As the cycle continues, we say the moon is **waning, or getting smaller**. The amount of lighted area we see decreases, and the darkened area increases from right to left. You can tell if the moon is waxing or waning by whether the right side of the moon is dark or light. (right side light=waxing, left side light=waning). Remember: **“The light starts on the right.”** This entire process from new moon to new moon takes **about 28 days**.

We always see the **same side of the moon** because the **moon's rotation and revolution take the same amount of time**.

**b. Explain the alignment of the earth, moon, and sun during solar and lunar eclipses.**

When an object such as the moon or Earth pass between the Sun and another object, it casts a shadow called an **eclipse**. Any object that is lit by the Sun will cast a shadow. The darkest portion of this shadow faces directly away from the Sun. In this portion of the shadow, called an **umbra**, all light is blocked. Around the umbra is an area of a partial shadow where some light is blocked and other light is not blocked. This lighter shadow surrounding the umbra is called the **penumbra**.

When the Moon moves into the earth's shadow, a **lunar eclipse** occurs. In other words, the moon is blocked or eclipsed from our view on Earth. A lunar eclipse is the most common and observable type of eclipse and can only happen at **night** and during the **full moon** phase when the moon is directly behind the earth compared to the sun. In a lunar eclipse, all or part of the moon is a dark reddish color. The sun, the earth and the moon are aligned in such a straight path, that the only light that reaches the moon is light that has passed through the Earth's' atmosphere. Our atmosphere makes the Moon appear to be colored red.

When the Moon passes between the sun and the earth, a **solar eclipse** occurs. The moon's shadow falls on the Earth, causing a portion of Earth to become dark. Total solar eclipses last for only around seven minutes. Solar eclipses can only occur during the **day** and during the **new moon** phase. Because the moon is much smaller than the Earth, the shadow of the Moon does not completely cover the surface of the Earth. During a solar eclipse, the sun is blocked or eclipsed from our view on Earth.

The Moon's orbit is **tilted** 5 degrees in relation to the plane of Earth's orbit. Therefore, the Moon's orbit is usually either above or below the Sun-Earth line making eclipses rare.

**c. Relate the tilt of the earth to the distribution of sunlight throughout the year and its effect on climate.**

The Sun is the source of all light and warmth on the Earth; however, not all places on Earth receive the same amount of sunlight. Because the Earth is tilted on its axis, currently at an angle of  $23.5^\circ$  perpendicular to its orbit, different parts of the earth are either tilted toward or away from the sun at various times of the year. When one hemisphere is tilted towards the sun, the other hemisphere is tilted away from the sun. Therefore when it is summer in the Northern Hemisphere, it is winter in the Southern Hemisphere. This tilt of the earth is what causes the seasons. Seasons do not occur because the Earth is closer to the Sun in the summer, and farther from the Sun in the winter. (Due to Earth's elliptical orbit, the Earth is actually closest to the Sun on January 1<sup>st</sup> and farthest away from the Sun on July 1<sup>st</sup>.)

Areas near the equator (tropical zones) stay warm and wet year-round, while other areas (the poles; polar zones) places remain cold. One reason for this is latitude. When the Northern Hemisphere is tilted toward the sun, sunlight falls directly upon the Tropic of Cancer. When the Southern Hemisphere is tilted toward the sun, sunlight falls directly upon the Tropic of Capricorn. Areas of the world that are located between these two lines are within the tropical climatic zone because they receive large amounts of direct sunlight throughout the year and are warmer than other places on earth. The temperate zones are the areas of Earth located between the tropical zones and the polar zones and are characterized by moderate temperatures and moderate precipitation.