FYI Eclipses of the Sun and Moon

A **solar eclipse** occurs when the moon aligns exactly between the sun and Earth—a rare occurrence. Even though it might seem that an eclipse should take place during each full moon phase, irregularities in the moon's orbit usually prevent one from happening.

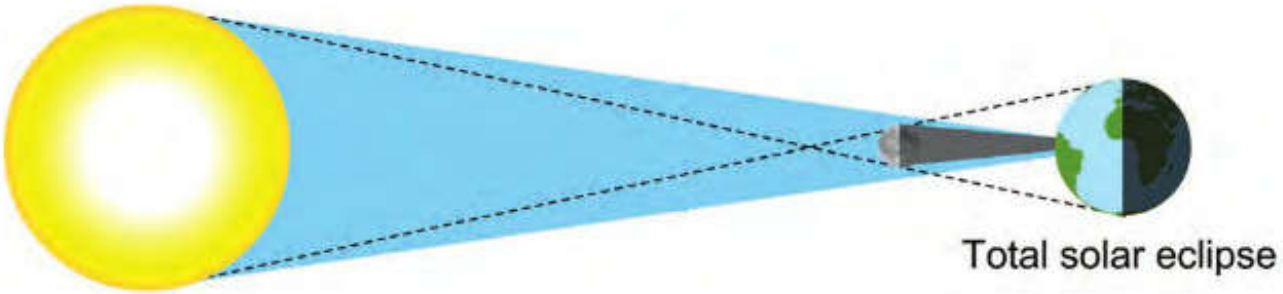

Figure 4-4: Diagram showing why a solar eclipse occurs when the moon comes between Earth and the sun and covers the disk of the sun, casting a shadow on Earth. (NOT to scale; neither the distances nor the diameters are to scale.)

In the previous activity, it was noted that the orbit of the moon is inclined about 5° to the Earth-sun plane, or the ecliptic line that defines the plane of the solar system. If we revisit a diagram of the moon's orbit (see below), you will notice that the moon's orbit intersects with the plane of the solar system at only two points. These points are called **nodes**. For an eclipse of any kind to occur, the line connecting the two nodes must intersect the Earth-sun plane. The **line of nodes** shifts slowly counterclockwise along the moon's orbit, making a full circle every 18.6 years. As the line of nodes approaches and then reaches the Earth-sun line, eclipses are liable to occur. The rest of the time, the moon is either too far below or above the Earth-sun line to cause a solar eclipse, or to be eclipsed by Earth's shadow.

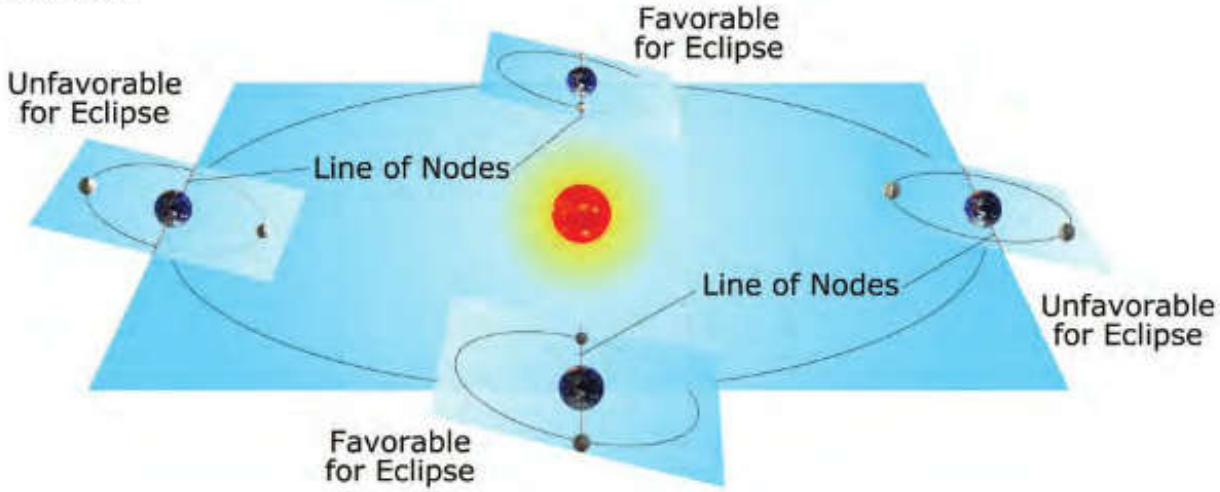

Figure 4-5: Diagram showing why eclipses don't happen more often. The moon is usually either above or below the Earth-sun plane. Eclipses only occur when the line of nodes is lined up with the Earth-sun plane defined by the ecliptic. (NOT to scale; neither the distances nor the diameters are to scale.)

Figure 4-6: Illustration showing a total solar eclipse over time. The moon moves between Earth and the sun, from the right to the left, causing the total solar eclipse seen in Turkey in April 2006. The sun's corona is visible for only a few minutes during totality (central drawing).

What does a solar eclipse look like? Are there different kinds of eclipses? The answer to these questions depends on your frame of reference as an observer on Earth and also on irregularities inherent in the moon's orbit.

A **total solar eclipse** occurs when the moon completely covers the disk of the sun. Sometimes, jets of solar gas called **prominences** can be seen shooting into the outer reaches of the solar atmosphere, which astronomers call the **corona**. Since the moon has to be between the sun and Earth, solar eclipses always happen when there is a new moon phase. Although a solar eclipse might seem likely each month, the moon is rarely in alignment with the sun and Earth. Instead, the moon passes either below the sun-Earth line or above it as it makes its monthly journey around the planet.

From the vantage point of an Earth-orbiting satellite, a solar eclipse looks quite different. The shadow formed on the surface of Earth by the tip of the cone-shaped shadow cast by the moon traces a path over a very small region. Not everyone on Earth gets the opportunity to observe a solar eclipse when it occurs.

If you look closely at the eclipse shadow in Figure 4-8, you will notice that the central portion of the shadow is very dark, while the outer portion of the shadow is not. Only observers in the dark central portion of the shadow—called the **umbra**—will see a total solar eclipse. Observers in the lighter, outer portion of the shadow—called the **penumbra**—will see only part of the sun's disk covered and will observe a **partial solar eclipse**. The eclipse shadow moves over the surface of Earth quickly because Earth is rotating and the moon is also moving in its orbit. Therefore, most solar eclipses last only 5 minutes or so at a given location.

Figure 4-7: Photograph of a partial solar eclipse taken through a filter. Only a portion of the sun is covered by the moon during a partial solar eclipse. Partial solar eclipses are more common than total ones.

Figure 4-8: Photograph, taken by an astronaut on the International Space Station during the total solar eclipse of March 2006, showing the shadow of the moon cast on Earth. The darkest portion of the shadow is about 100 miles across.

You may remember that the moon's orbit has perigee and apogee points that describe when the moon is at its nearest and farthest distance from Earth. When the moon is at apogee, it appears somewhat smaller in the sky since it is a little farther away. If a solar eclipse occurs when the moon is at apogee, the sun is not completely covered by the disk of the moon, and an **annular eclipse** occurs.

Checking In

1. Explain why there is not a solar or lunar eclipse every month.
2. What phase must the moon be in for a solar eclipse to take place?

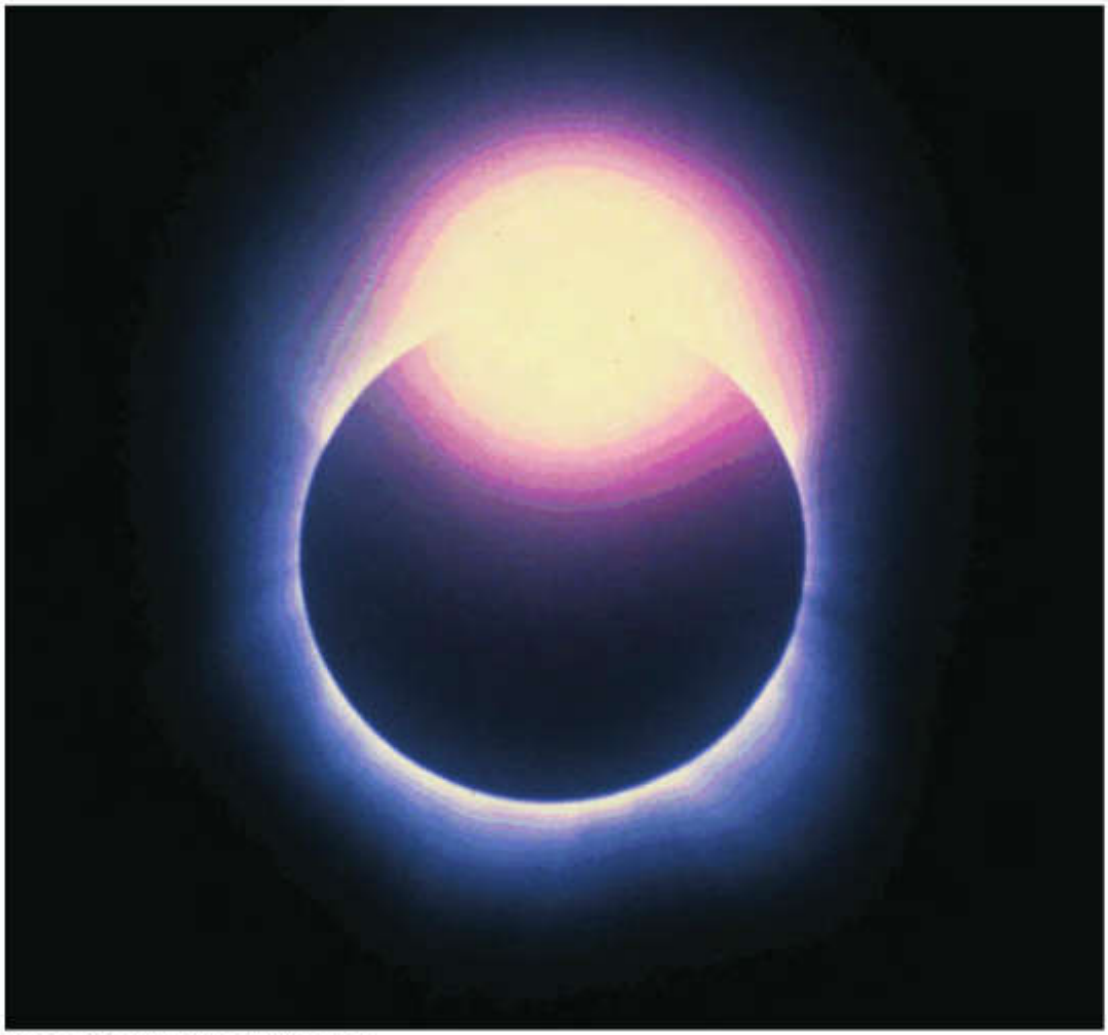

Image of the sun very near total eclipse