Earth in Space

(Chapter 12 – Section 1)

Key Terms:

astronomy	**axis**	**rotation**
revolution	**orbit**	**calendar**
solstice	**equinox**	

Standard 8.4.e: **Students know the appearance, general composition, relative position and size, and motion of objects in the solar system, including planets, planetary satellites, comets, and asteroids.**

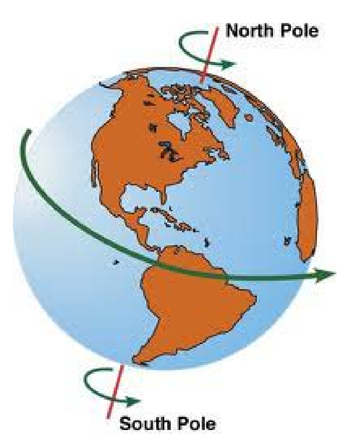
Objective 12.1.1 – **After this lesson, you should be able to demonstrate how Earth moves in space.**
Objective 12.1.2 – **After this lesson, you should be able to explain the causes of the cycle of seasons on Earth.**

Each year, ancient Egyptian farmers eagerly awaited the annual flooding of the Nile river. For thousands of years, their planting was ruled by it. The annual flooding deposited rich soil in which the farmers had to be ready to plow and plant their fields along the river. Therefore, the Egyptians wanted to predict when flooding would occur. Around 3000 B.C., people noticed that the bright star Sirius first became visible in the early morning sky every year shortly before the flooding began. The Egyptians used this knowledge to predict each year's flood. The ancient Egyptians were among the first people to study the stars. **The study of the moon, stars, and other objects in space is called astronomy.**

How Earth Moves:

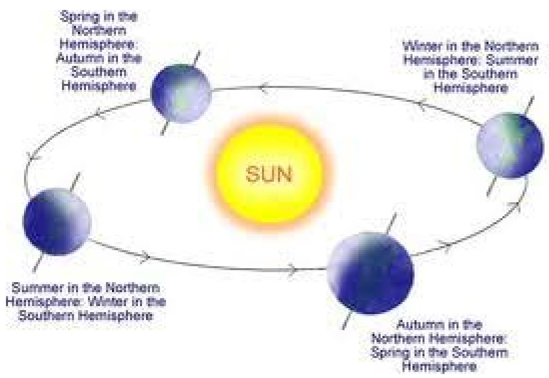
Ancient astronomers studied the movements of the sun, and the moon as they appeared to travel across the sky. It seemed to them as though Earth was standing still and the sun and moon were moving. In reality, the sun and moon seem to move across the sky because Earth is rotating on its axis. At the same time as this motion, the Earth also moves around the sun. **Earth moves through space in two major ways: rotation and revolution.**

- **Rotation –** Look at the illustration at right. **The imaginary line that passes through Earth's center and the North and South poles is Earth's axis. The spinning of Earth on its axis is called rotation.**
  Earth's rotation causes day and night. As Earth rotates eastward, the sun appears to move westward across the sky. It is day on the side of Earth facing the sun. As Earth continues



to turn to the east, the sun appears to set in the west. It takes about 24 hours to rotate once. Each 24-hour cycle is called a **day**.

- **Revolution –** In addition to rotating on its axis, Earth travels around the sun. **As shown in the picture at left, a revolution is the movement of one object around another**. One complete revolution of Earth around the sun is called a **year**. Earth follows a path, or orbit, as it revolves around the sun. **Earth's orbit is not quite circular. It is a slightly elongated circle, or ellipse.**

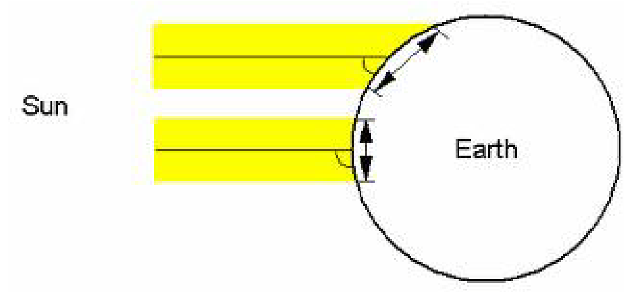


- **Calendar –** People of many different cultures have struggled to establish calendars based on the length of time that Earth takes to revolve around the sun. **A calendar is a system of organizing time that defines the beginning, length, and divisions of a year.**
  The ancient Egyptians created one of the first calendars. Egyptian astronomers counted the number of days between each first appearance of the star Sirius in the morning. In this way, they found that there are about 365 days in a year.
  Dividing the year into smaller parts was also difficult. Early people used moon cycles to divide the year. The time for one full moon to the next is about 29 ½ days. A year of 12 of these "Moonths" adds up to only 354 days. The ancient Egyptian's calendar had 12 months of 30 days each, with an extra 5 days at the end.
  The Romans borrowed the Egyptians calendar of 365 days. But in fact, Earth orbits the sun in about 365 ¼ days. The Romans adjusted the Egyptian calendar by adding one day every four years. You know this fourth year as "**leap year**." During a leap year, February is given 29 days instead of its usual 28. Using a system of leap years helps ensure that annual events, such as the beginning of summer, occur on the same date each year.
  The Roman calendar was off by a little bit more than 11 minutes a year. Over the centuries, these minutes added up. By the 1500's, the beginning of spring was about ten days too early. To straighten things out, Pope Gregory XIII dropped ten days from the year 1582. **He also made some other minor changes to the Roman system to form the calendar we use today and it is referred to as the *Gregorian calendar*.**

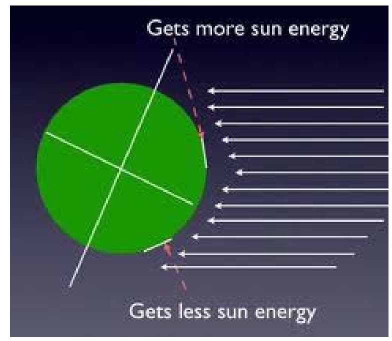
The Seasons on Earth:

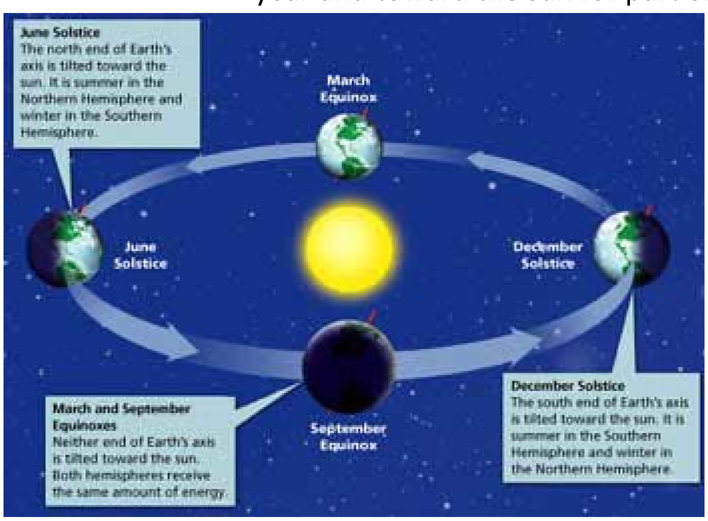
Most places outside the tropics and polar regions have four distinct seasons: winter, spring, summer, and autumn (fall). For instance, it is generally warmer near the equator than at the poles. ***Why is this so?***

- **How Sunlight Hits Earth –** The figure at right shows how the sun would strike the surface if Earth's axis was straight up and down. Notice that sunlight hits Earth's surface most directly near the equator. Near the poles (north and south), sunlight arrives at a steep angle. As a result, it is spread out over a greater area. That is why it is warmer near the equator than near the poles.



- **Earth's Tilted Axis –** If Earth's axis were straight up and down relative to its orbit as in the figure above, temperatures would remain fairly constant year-round. There would be no seasons. **Earth has seasons because its axis is tilted at angle of 23.5^{O} from the vertical as it revolves around the sun.**
  Now let's take a look at the Earth as it revolves around the sun: Notice that Earth's axis is always tilted at an angle of 23.5^{O} from the vertical. As the Earth revolves around the sun, the north end of its axis is tilted away from the sun for part of the year and toward the sun for part of the year.





Summer and winter are caused by Earth's tilt as it revolves around the sun. The change in seasons is not caused by changes in Earth's distance from the sun. In fact, Earth is farthest from the sun when it is summer in the Northern Hemisphere.

- **Earth in June –** In June, the north end of Earth's axis is tilted toward the sun. In the Northern Hemisphere, the noon sun is high in the sky and there are more hours of daylight than darkness. The combination of direct rays and more hours of sunlight heats the surface more in June than at any other time of the year. It is summer in the Northern Hemisphere. At the same time south of the equator, the sun's rays are less direct. The sun is low in the sky and days are shorter than nights. The combination of less direct rays and fewer hours of sunlight heats Earth's surface less than at any other time of the year. It is winter in the Southern Hemisphere.

- **Earth in December –** In December, people in the Southern Hemisphere receive the most direct sunlight, so it is summer there. At the same time, the sun's rays in the Northern Hemisphere are more slanted and there are fewer hours of daylight. So it is winter in the Northern Hemisphere.

- **Solstices –** The sun reaches its farthest position north or south of the equator twice each year. **Each of these days, when the sun is farthest north or south of the equator, is known as a solstice. The day when the sun is farthest north of the equator is the summer solstice in the Northern Hemisphere. It is also the winter solstice in the Southern Hemisphere.** This solstice occurs around June 21 each year. It is the longest day of the year in the Northern Hemisphere and the shortest day of the year in the Southern Hemisphere.
  Similarly, around December 21, the sun is farthest south of the equator. This is the winter solstice in the Northern Hemisphere and the summer solstice in the Southern Hemisphere.
- **Equinoxes –** Halfway between the solstices, neither hemisphere is tilted toward or away from the sun. This occurs twice a year, when the noon sun is directly overhead at the equator. **Each of these days is known as an equinox, which means “equal night.”** During an equinox, day and night are each about 12 hours long everywhere on Earth. **The vernal (spring) equinox occurs around March 21 and marks the beginning of spring in the Northern Hemisphere. The autumnal (fall) equinox occurs around September 22. It marks the beginning of fall in the Northern Hemisphere.**