Standard S6E1

S6E1. Students will explore current scientific views of the universe and how those views evolved.

a. Relate the nature of science to the progression of basic historical scientific models (geocentric, heliocentric, Big Bang) as they describe the formation of our solar system with the sun at its center.

-As technology improves and advances so does our understanding of our solar system, our galaxy and the universe. Before telescopes were invented, an ancient Greek astronomer, Ptolemy, believed the earth was the center of our solar system. (During this time, ancient astronomers also believed our solar system made up the entire universe.) This **Geocentric view** of the solar system states that **Earth is the center** of our solar system and that all known planets orbited or revolved around it. **Copernicus** later proposed the **Heliocentric** view of our solar system. The **Heliocentric** view states that **the sun is the center** of our solar system and that all planets revolve around the sun**. Johannes Kepler** later added that the planets' orbits were slightly **elliptical** (oval-shaped) and that the planets traveled at different speeds around the sun.

The **Big Bang** Theory was developed much later and is still debated today. The **Big Bang theory** is a theory which states that the universe began in an enormous explosion and estimates the age at about **15 billion years** old compared to the estimated age of the earth at 4.5 billion.

Scientists theorize that the Earth formed out of a **nebula** that contracted because of gravity. As it spun, scientists believe that the nebula formed a disk. Most of the nebula's mass (over 99%) was pulled to the center of the disk to form the sun. The planets were believed to have formed in a process known as **accretion** (accumulation or lumping up of matter) as they orbited within the disk. Eventually, the gravity/pressure became great enough inside the sun for **fusion** (energy produced by squeezing Hydrogen into Helium) to begin. **Fusion** is still the source of the Sun's energy.

b. Describe the position of the solar system in the Milky Way galaxy and the universe.

Our galaxy, the Milky Way, is located in the **local group** of about 30 galaxies. The Milky Way is about 100,000 light years across and is a spiral galaxy. **Spiral galaxies** are shaped like pinwheels and are easy to identify by their sweeping "arms." The "arms" rotate around the galaxy's center or **bulge**. The bulge of a spiral galaxy contains older redder stars. All of the stars that you see at night and our sun are part of the **Milky Way Galaxy**. On a clear night, the densest parts of the Milky Way Galaxy, the **disk and the bulge**, appear as a milky-looking band across the sky. Our **solar system (sun & and orbiting bodies)** is located in one of the **outer spiral arms** of the galaxy called the **Orion Arm** about **30,000 light years from the center** of the galaxy.

c. Compare and contrast the planets in terms of size relative to earth, surface and atmospheric features, relative distance from the sun, and ability to support life.

The four closest planets to the Sun are **Mercury, Venus, Earth, and Mars**. These four planets are called the **Inner planets** or the **Terrestrial planets**, because they have solid rocky surfaces like Earth. The inner planets also have few or no moons, little or no atmosphere, and past or present volcanic activity. The four large planets beyond the orbit of Mars and the Asteroid Belt are **Jupiter, Saturn, Uranus and Neptune** and are called the **Gas Giants** or the **Jovian** planets. The Jovian planets are all composed largely of gas, have many moons, and have rings.

-**Mercury:** Mercury, the planet closest to the Sun, has almost no permanent atmosphere, and its dusty surface of craters resembles the Moon. Mercury is the **smallest** planet with a diameter about 2/5 of Earth's.

-**Venus**: Venus is often called Earth's **twin** because the two planets are very close in size. The thick clouds that cover Venus create a **greenhouse effect** that keeps it sizzling at 864℉.

-**Earth:** Earth, like many other planets, is not perfectly round; it bulges at the equator and is flatter at the poles due to its rotation. From space the planet looks blue with white swirls, created by water and clouds. . It is the only planet with **water as a liquid, solid, and gas**. Currently, Earth is the only planet in our solar system that we know of that supports life.

-**Mars**: Three-quarters red, Mars also has dark blotches on it and white areas at the poles—these are white polar ice caps. It is believed that Mars **once had running water on its surface and may still have water frozen at the poles or as permafrost**. Other than Earth, this is probably the only other planet in the solar system that may be able to support life as we know it. Mars also has an atmosphere similar to Earth's but thinner.

-**Jupiter**: Jupiter is the largest planet in our solar system. About 1,300 Earths would fit into it. Its composition of gases makes it very colorful but its most distinguishing feature is "the **Great Red Spot**," an intense windstorm larger in size than Earth.

-**Saturn**: Saturn, the second-largest planet and has the most distinguished rings surrounding it. These **rings** are made of billions of ice particles.

-**Uranus**: Uranus is a greenish-blue planet, twice as far from the Sun as its neighbor Saturn. Uranus **orbits on its side** and rotates in **retrograde** (backwards compared to other planets).

-**Neptune**: Neptune is a stormy blue planet about 30 times farther from the Sun than Earth. Like Uranus, its blue color is due to its **methane** content.

- In **summary,** all the planets except Mercury have an atmosphere. Earth's atmosphere is primarily nitrogen and oxygen. Venus has a thick atmosphere of carbon dioxide, with traces of poisonous gases such as sulfur dioxide. Mars' carbon dioxide atmosphere is extremely thin. Jupiter, Saturn, Uranus and Neptune are primarily hydrogen and helium.

-Astronomical Units or AU's are a measurement unit used within the solar system.
1 A.U. = the distance of the Earth from the Sun or about 150 million KM.

d. Explain the motion of objects in the day/night sky in terms of relative position.

-The Earth and other planets in our solar system travel in **elliptical orbits** (oval-shaped) around the sun. It takes the Earth **365 ¼ days** to complete its entire **revolution (orbit)** of the sun**.** This cycle makes up our 365-day year. As the Earth is orbiting, it is also spinning on its own axis (**rotation**). This means that a different part of the Earth's surface faces the sun at each moment of a 24-hour day.

-The moon orbits around the earth. The moon revolves around the Earth in the same direction as the Earth rotates (**counterclockwise**), but at a slower speed. Because it takes about 28 days for the moon to orbit the Earth, it appears over the **eastern** horizon about an hour later each day and takes about one month for us to see all of the moon's phases.

-**The sun and moon do not rise or set**. They both appear to **rise in the east** and **set in the west** because of the **rotation** (spinning)of Earth on its axis.

e. Explain that gravity is the force that governs the motion in the solar system.

-Isaac Newton formulated three laws of motion and the **law of universal gravitation**. He concluded that inertia (the tendency of objects to continue moving in the same direction) and the **force of gravity keeps the planets in their orbits**. Planets have forward motions, as well as a pull toward the sun. **If the sun had no gravitational pull, the planets would not orbit the sun, but would move away from the sun in a straight line**. As a planet's distance from the sun increases, the pull toward the sun, called gravity, decreases. With less pull toward the sun, the orbiting speed of the planet decreases. Therefore, the farther away the planet from the sun the slower its revolution around the sun.
-The **strength of gravity** depends on the **mass** of the objects and their **distances** from each other.

f. Describe the characteristics of comets, asteroids, and meteors.

-Comets are believed to be leftover matter from the formation of our solar system. Each comet has only a tiny solid part, called a **nucleus**, often no bigger than a few kilometers across. The nucleus contains icy chunks and frozen gases with bits of embedded rock and dust. Most comets reside in the **Oort Cloud**. If their orbits are perturbed, they may follow a very elliptical orbit to the inner solar system. As a comet nears the Sun, it begins to warm and forms a gas **coma** around the nucleus. Comets, when visible on Earth, are seen for days or weeks. The tails of a comet **always point away from the Sun** due to the force of the solar wind.

-Asteroids are rocky fragments believed to be left over from the formation of the solar system about 4.5 billion years ago. Most of these fragments of ancient space rubble can be found orbiting the Sun in the **Asteroid Belt** between Mars and Jupiter**.** This region in our solar system contains thousands of asteroids ranging widely in size, but totally a mass less than Earth's moon

-"**Shooting stars" or meteors** are bits of material falling through Earth's atmosphere; they are heated to brightness by the friction of the air. Meteors are **not** stars. When coming through Earth's atmosphere, their bright trails are called **meteors**. While still hurtling through space they are called **meteoroids**. Large pieces that do not vaporize completely and reach the surface of the Earth are called **meteorites**. Remember: Meteorites land **"rite"** on Earth's surface.-Sometimes the number of meteors seen from Earth increases dramatically: these are called, "**meteor showers**." Meteor showers occur when the Earth's orbit takes it through the remains of where a comet has past and left debris.