

## Earth and the Universe

Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

**EQ:** How do the Earth's location in space, rotation, revolution, precession, and nutation affect the seasons?

The **universe** is made up of many galaxies. Galaxies are made up of many stars. Some stars have planetary systems similar to our solar system. Earth is a **satellite planet** of one particular star.... our Sun.

Our solar system is located in the **Milky Way Galaxy**. The Milky Way is part of a cluster of about 30 other galaxies.

**The Milky Way Galaxy:** The central bulge is at the center. Spiral arms are around the central bulge. They contain mostly blue stars, gas and dust. The Solar system and Earth are located in one of the spiral arms. Earth is the 3<sup>rd</sup> planet from the Sun in our solar system. There are blue stars and red stars in our galaxy. Blue stars are young and hot stars. Red stars are old and cooler stars.

**Earth** is an **oblate spheroid**. It is wider at the equator than at the poles. This is caused by the rotation of the Earth on its axis. The **Earth's axis** is an imaginary line that runs through the center of the Earth from the north pole to the south pole. The Earth is "tilted" with relation to this imaginary line  $23.5^\circ$ . The Earth's tilt is **responsible for the seasons**. The Earth's movement around the Sun is called a revolution, one complete revolution is equal to 365.25 days. The **revolution and the tilt** are the main causes of the seasons:

**Rotation:** One rotation about the Earth's axis takes 24 hours. This is called a day. Rotation about the Earth's occurs from west to east. (Counter clockwise) Earth's rotation is the cause for day and night and Coriolis effect.

**Precession:** The rotation of the Earth's axis is called precession. The angle remains the same. This will affect the stars near the poles. Precession does not change the seasons as long as the  $23.5^\circ$  tilt stays the same but it **changes Earth's northern star** every few thousand years.

**Nutation:** The "wobble" about the precessional axis is called **nutation**. Nutation is a change in the in the angle of tilt by  $\frac{1}{2}^\circ$  one way or the other. Results in the tilt either being  $23^\circ$  or  $24^\circ$ . This occurs over an **18 year period**. This is due to the Moon. **This causes a slight change in the seasons.**

**Barycenter:** A barycenter is the point between two objects where they balance each other. It is kind of like the center of gravity. The **center of gravity** is the point in the middle of all the material that makes up an object, mass. When a moon orbits a planet, or a planet orbits a star, both bodies are orbiting around a point that lies outside the larger body. The moon does not orbit the exact center of the Earth, but a point about 1710 km below the Earth's surface. The sun is not stationary in the solar system. It moves as the planets tug on it, but it never gets too far from the solar system barycenter.

**Kepler's Three Laws of Planetary Motion:** Johannes Kepler was a German mathematician, astronomer and astrologer. He was a key figure in the 17<sup>th</sup> century scientific revolution. Kepler's Laws describe the motion of the planets around the sun. Kepler knew of 6 planets: Earth, Venus, Mercury, Mars, Jupiter and Saturn.

**Kepler's First Law:** States that planets move around the sun in **ellipses**, with the sun at one focus. What does this really mean? This means that the distance between the planet and the sun varies, as the planet goes around.

**Kepler's Scond Law:** Each planet moves around the Sun so that an imaginary line joining the planet and the Sun will sweep over equal areas in time. This means that because the orbits are **elliptical**, the planet's travel at different speeds at different positions in the orbit. When planets are **closer to the sun they are faster**.

**Kepler's Third Law:** The *farther a planet is from the Sun, the longer it takes to make one complete revolution.*