CC **TOPIC III**

Earth In The Universe

I. Early beliefs

A. Observations of **celestial objects** (beyond the atmosphere) have been made for thousands of years to:

1. find direction
2. note the passage of time
3. express values and traditions

B. **Constellations** - star patterns in the sky (like the Big Dipper)

1. **Circumpolar constellations** - group of 5 constellations that appear to move around Polaris each night.

II. Size scale

A. Astronomical objects, from biggest to smallest...

1. **Universe** - all known objects/energy in all of space
2. **Galaxies** - collections of billions of stars (like **Milky Way** galaxy)
3. **Solar System** - sun, planets (and their moons), comets, & asteroids
4. **Sun** - a typical, medium sized star
5. **Earth** - one of the planets orbiting the sun
6. **Moon** - natural satellite orbiting planet

III. Origin of the universe

A. **Big Bang** - theory that a giant "explosion" some 13.7 billion years ago created the universe, and that it has been **expanding** from this explosion ever since.

B. Evidence for the Big Bang Theory:

1. **Cosmic background radiation** - can still be detected (in all directions) from the original big bang
2. **Stellar radiation** - star light is affected by a star's motion.
   How it works:
   a) **spectrum** (plural is **spectra**) - colors produced when wavelengths of light are separated (like ROY-G-BIV)
   b) Spectra of galaxies shows a shift toward the **RED** end of the spectrum, due to the **Doppler Effect**.

<u>Doppler Effect</u> - shift in light/sound waves as the source moves either toward or away from the observer.

a) **<u>RED</u> shift** - waves are spread out when object is moving ***away*** from the observer

b) **<u>BLUE</u> shift** - waves are compressed when object is moving ***toward*** the observer

IV. Structure of universe

A. **<u>Galaxies</u>** - billions of stars

1) shapes include spiral, elliptical, and irregular
2) are actually billions of galaxies in the universe

B. **Milky Way** - our galaxy

1) spiral shaped
2) Our Solar System in one spiral arm about **2/3 out from galactic center**

V. Stars - like our sun, but much farther away

A. Form from <u>clouds</u> of molecules in space

1. Gravity **compresses** this cloud, and the interior (center) becomes very hot.
2. **Nuclear fusion** starts, forming heavier elements out of lighter ones in the core of the star.
3. Fusion releases great amounts of energy over millions of years.

B. Stars differ from each other in size, temperature, and age.

1. Are classified using the **<u>Luminosity & Temperature of Stars Diagram</u>** (see chart in Ref. Tables ... p. 15), comparing a star's **luminosity** with the star's **<u>temperature</u>** (and **<u>color)</u>**.
   a) Bright stars are near the top, and dim stars are at the bottom.
   b) Hot stars (blue) are to the left, cool stars (red) are to the right.
2. **<u>Main sequence</u>** - the diagonal band across the star graph where most plotted stars are found.
3. **<u>Giants & Super giants</u>** - bigger, dimmer stars (red) that are older than the main sequence stars
4. **<u>White dwarfs</u>** - old stars that have collapsed, making them very small, very dense, and very hot.
5. **<u>Black dwarfs</u>** - cooled white dwarfs to the point where nuclear fusion stops (a "dead" star)

C. **<u>Death of stars</u>** - depends on the mass of the original star

1. High mass stars:
    a) go from Supergiant to supernova (an exploding star) to:
        1) ***very*** high mass stars then become black holes
        2) just *high* mass stars become neutron stars
2. Lower mass stars:
    a) fade to a white dwarf, then to a black dwarf

VI. The Solar System - formed about 4.6 billion years ago from dust/gas cloud (from supernova) pulled together by gravity. Impact events (due to gravity pulling things in) affected surface features, climate, and evolution of life on Earth.

A. **<u>Sun</u>** - a typical star in a vast universe. The center of our solar system.

B. **<u>Planets</u>** (see Ref. Tables ... p. 15)

1. Move around the sun in nearly circular orbits, with motions that are cyclic and predictable.
2. Characteristics of planets are affected by each planet's location in relationship to the sun (colder the further from sun, *except* for Venus)
    a) <u>Terrestrial planets</u> - Mercury, Venus, Earth, Mars
        1) are small, rocky, and dense
    b) <u>Jovian planets</u> - Jupiter, Uranus, Saturn, Neptune
        1) large, gaseous, and low density
3. Gravity caused Earth and other planets to become <u>layered</u> according to **density** differences in their materials.

C. **<u>Moons</u>** - orbit the planets

1. Earth is orbited by one moon, and many artificial satellites
2. Other planets have varying number of moons (0 to 18+)

D. **<u>Asteroids</u>, <u>comets</u>, and <u>meteors</u>**

1. <u>Asteroids</u> - chunks of material orbiting sun between Mars and Jupiter
2. <u>Comets</u> - "dirty snow balls" orbiting sun from beyond Pluto
3. <u>Meteors</u> - "shooting stars" debris that falls through earth's atmosphere
    a) Impact events have been correlated with mass extinctions and global climatic change.
    b) Impact craters have been identified in the Earth's crust.

VII. <u>Scale model</u> of Solar System

A. Relationship between actual distances with some determined measurement.
ex. 1 inch = 100 million km (see Ref. Tables ... p. 15)

VIII. **<u>Two</u> basic motions** (these are <u>regular</u> and <u>predictable</u>, so measurement of **TIME** on earth is based on these earth motions.)

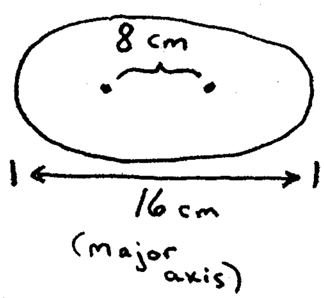
A. **<u>ROTATION</u>** – spinning on an axis
   1. <u>Earth</u> – once every 24 hours

B. **<u>REVOLUTION</u>** – orbiting around something
   1. <u>Earth</u> – orbits sun once every 365 ¼ days
   2. <u>Moon</u> – orbits earth once every 27.3 days
   3. <u>planets</u> – all orbit sun... longer the farther out from the sun (See Ref. Tables ... p. 15)

IX. **<u>Ellipse</u>** - actual shape of planet **ORBITS**, with the sun at one focus

A. **<u>Eccentricity</u>** –describes the "flatness" of an ellipse.
   1. see equation in Ref. Tables ... p. 1

Sample: Find the eccentricity.



$$\text{eccentricity} = \frac{\text{distance between foci}}{\text{length of major axis}}$$

$$\text{eccentricity} = \frac{8\text{ cm}}{16\text{ cm}}$$

$$\text{eccentricity} = 0.5$$

1. The <u>larger</u> the eccentricity, the **flatter** the ellipse.
2. Each planet orbit has a different eccentricity (see Ref. Tables ... p. 15)

X. **Gravitation** - influences the motion of celestial objects

A. Gravity is **directly proportional** to an object's **mass**.
   1. more massive objects have greater gravity

B. The amount is ***<u>indirectly</u>*** **proportional** to an object's **distance**.
   1. farther from an object means you feel *less* gravity from it

XI. Planet orbits

A. An equilibrium exists between **gravity** and **inertia** (things in motion tend to stay in motion) to keep the planets in orbit.

B. The **closer** a planet is to the sun, the **faster** it travels in its orbit...due to more of the sun's gravity.

   1. **Kinetic energy** – energy of motion (greatest when closest to sun)
   2. **Potential energy** – stored energy of position (greatest when farthest from sun)

C. **Planet period** – time needed for one orbit

   1. The farther from the sun a planet is, the **longer** the planet's period of revolution (its year).
   2. Planets ("wanderers") **appear** to move slowly compared to their background constellations due to their revolution.
      a) Apparent diameter and brightness of planets change in a cyclic and predictable fashion as viewed from earth (highest when planet is closest to earth).