TEACHER BACKGROUND INFORMATION

(*The Universe*)

A. THE UNIVERSE:

The universe encompasses all matter in existence. According to the **Big Bang Theory**, the universe was formed 10-20 billion years ago from a massive cosmic explosion which launched matter in all directions. In fact, the universe still appears to be expanding outward, as evidenced by the observation that distant galaxies are continuously moving farther away from our own galaxy at great speeds.

B. GALAXIES:

Galaxies are groups of stars, planets, gases, dust, and other celestial objects which are held together by gravitational forces. Many scientists theorize that most galaxies formed during the first billion years following the initial expansion of the universe. Galaxies can be spiral, elliptical, or irregular in shape, depending on their momentum through space and gravitational interactions with other galaxies.

Spiral Galaxy: A spiral galaxy consists of interstellar matter arranged in a flat, disc-like shape with curved luminescent arms. These arms often contain many young stars which give the spirals a bright, bluish color. Some spiral galaxies also have a central nucleus or bulge which contains primarily older stars. Our solar system is located within the arm of a spiral galaxy called the **Milky Way**. The Milky Way Galaxy is 100,000 light years in diameter and 1,000 light years thick. Our sun (one of 200 billion stars within the Milky Way) travels for 250 million years before completing one orbit around the center of the galaxy. [Note: A light year is the distance one beam of light travels in a year in a vacuum. A light year is equal to 9460 billion kilometers (5880 billion miles).]

Elliptical Galaxy: Elliptical galaxies have a smooth shape and are yellow-red in color. These galaxies have little interstellar gas or dust and are primarily composed of older stars. Quite often elliptical galaxies will form clusters which grow over time as the gravitational pull of the clusters attract other galaxies toward them.

Irregular Galaxy: Irregular galaxies lack obvious symmetry. Some irregularly shaped galaxies may be younger galaxies which have not reached a symmetrical state. Other irregular galaxies occur when neighboring galaxies collide or exert gravitational forces upon one another which distort their shapes.

C. STARS:

Stars are gaseous spheres which form out of **nebulae**, clouds of interstellar gas and dust. Dense parts of these clouds collapse and compress their matter into a rotating, gas globule. Centrifugal forces within the globule cause a core surrounded by a disc of dust to form. The compressive forces acting upon the core cause increases in pressure and temperature within it. If the temperature of the core reaches about 15 million ° C (27 million ° F), nuclear fusion begins to take place. **Nuclear fusion** occurs when hydrogen atoms fuse to form larger helium atoms, a process which releases large amounts of energy. When a core begins to emit energy due to nuclear fusion, it has become a stable main-sequence star.

Hertzsprung-Russell Diagram: A **Hertzsprung-Russell Diagram** plots a star's brightness (absolute magnitude) against its average surface temperature. [Note: **Absolute magnitude** is a measure of a star's true brilliance, while **apparent magnitude** is a measure of how bright a star appears from Earth.] Ninety percent of all stars plot as main-sequence stars. **Main-sequence stars** are stars with surface temperatures directly proportionate to their brightness, i.e. the hotter the surface, the brighter the star (see table 1). In addition, main-sequence stars all generate energy by the nuclear fusion of hydrogen atoms. The other types of stars plotted on a Hertzsburg-Russell Diagram are primarily older stars.

Table 1: Comparison of surface temperature to brightness in main-sequence stars.

SURFACE TEMPERATURE (°C)	BRIGHTNESS (COLOR)
40,000	Bluest (Brightest)
18,000	Bluish
10,000	Blue-white
7,000	White
5,500	Yellow-white
4,000	Orange
3,000	Red (Least Bright)

Star Decay: The lifespan of a star is primarily determined by its mass at formation. In general, very large stars have a shorter lifespan than smaller stars, because large stars finish converting available hydrogen atoms to helium more quickly. Average sized stars, like our sun, often last for about 10 billion years. What happens to a star once its hydrogen supply has been depleted also depends on the mass of the star.

Mass 1.5 times that of the sun or less: As the core of the star is depleted of hydrogen, the star begins to cool and contract. As the core contracts it becomes hotter, and hydrogen atoms which existed in the outer layers of the star are pulled in toward the core where they are converted to helium. The star becomes very hot and swells outward, yet produces weak radiation. Weak radiation appears red, so this enlarged star is now called a **red giant**.

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The core of a red giant is hot enough to produce elements from helium via nuclear fusion; however, little energy is created. Once the hydrogen and helium atoms are used, the star begins to cool and contract again. The contraction produces heat which causes gases to be released from the star (which can be used in the creation of new stars), leaving the core behind. This process forms a **planetary nebula**. As the aging star continues to cool and contract, it becomes a dim, hot **white dwarf star**. White dwarf stars continue to shrink until their core is completely depleted, and they become small, cold, very dense **black dwarf stars**.

Mass 1.5 to 3 times greater than the sun: Stars of this mass begin to decay similarly to smaller stars, except that they are called **red super giants** instead of red giants due to their larger size. When red super giants cool, they contract very rapidly, causing a large increase in heat which allows the formation of heavy elements via nuclear fusion. This contraction also creates a tremendous explosion which releases atoms of helium, oxygen, carbon, and other elements into space. This explosion is called a **supernova**. A supernova radiates enough light energy to make it appear brighter than an entire galaxy. Following the supernova, the star, now consisting mainly of neutrons, collapses inward to form a **neutron star**.

Mass greater than 3 times the sun: These rare and massive stars also go through a supernova. However, when these stars collapse following a supernova, they contain a massive amount of dense matter due to their original size. The gravitational fields of these former stars are so strong that not even light can escape from them. These stars become **black holes**.

D. SOLAR SYSTEMS:

A **solar system** is composed of a star (or pair of stars) and all celestial objects which orbit it (or them). When a star is formed, the dust surrounding the initial core can form planets, asteroids, comets, and meteoroids. These objects are attracted by the star's gravitational force and orbit around it.

Planets: Planets are divided into two groups: major and minor. **Major planets** (such as Jupiter or Venus) can be either terrestrial or gaseous but all maintain a spherical shape. **Minor planets**, also known as **asteroids**, are rocky, irregular shaped bodies which can be up to several hundred miles across. Minor planets can be difficult to see in space because they have dark surfaces and do not reflect light well. Some planets, both major and minor, have natural satellites called **moons**. Moons vary greatly in size, composition, and origin. Some scientists believe that Earth's crater-ridden moon is actually a piece of the Earth which got knocked off early in the Earth's development.

Comets: Comets are chunks of rock, gas, and ice. Comets generally have very large eccentric orbits which can take up to hundreds or thousands of years to complete. As a comet nears a star, it heats up and begins to spew a bright tail of dust particles and gas. The comet trail always results from the solar wind, and points away from the sun.

Meteoroid: Meteoroids are small pieces of celestial debris. This debris can be pieces of planets, asteroids, comets, or any other rocky celestial body. We see meteor showers as the earth passes through this rocky dust in space. Meteor showers (erroneously known as falling stars and/or shooting stars) are the result of debris burning in earth's atmosphere. Occasionally, a large object falls to earth as a meteorite.