**Galaxies, Cosmology, Astrobiology Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Astronomy objectives sheet**

**Astronomy Content Standards**

**SAST2. Students will describe the scientific view of the origin of the universe, the evolution of matter and the development of resulting celestial objects.**

a. Outline the main arguments and evidence in support of the standard cosmological model. (e.g. elements, solar systems, and universe).

**SAST4. Students analyze the dynamic nature of astronomy by comparing and contrasting evidence supporting current views of the universe with historical views.**

a. Evaluate the impact that technological advances, as an agent of change, have had on our modern view of the solar system and universe.

b. Explain the relevance of experimental contributions of scientists to the advancement of the field of astronomy.

**SAST6: Students will explore connections between cosmic phenomena and conditions necessary for life.**

a. Characterize the habitable zone in solar systems and habitable planetary bodies in our own and other solar systems.

b. Describe the tools and techniques used to identify extrasolar planets and explore extrasolar planetary atmospheres.

c. Describe signatures of life on other worlds and early Earth.

d. Explain how astronomical hazards and global atmospheric changes have impacted the evolution of life on Earth.



**Characteristics of science standards**

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

SCSh6. Students will communicate scientific investigations and information clearly.

SCSh7. Students analyze how scientific knowledge is developed.

SCSh8. Students will understand important features of the process of scientific inquiry.

**Essential Questions**

* How are stars organized in galaxies?
* How did the universe begin? How do we know?
* How will the universe end? How do we know?
* Under what conditions would life be likely to form?
* Are there other planets outside our own solar system? How do we look for them?
* What are the signatures of life?

**Textbook references:** *Foundations of Astronomy* Chapters 15,16,18 and 26

**Key Terms**

Milky Way, Sgr A\*, globular clusters, dark matter, elliptical galaxy, spiral galaxy, barred spiral galaxy, Hubble tuning fork diagram, Hubble Law, cosmic background radiation, neutrinos, redshift, steady state theory, dark energy, critical density, Hubble constant, closed vs. open vs. flat universe, exoplanets, Doppler shift, transit method, life, Goldilocks principle

***Review Questions***

***Galaxies***

1. What type of galaxy is our Milky Way galaxy?
2. How do we map out the structure of our Milky Way if we are located inside it?
3. Where is the center of the Milky Way?
4. What appears to be located at the center of the Milky Way? How do we know?
5. Sketch out a side view of our Milky Way. Label the nucleus, the nuclear bulge, the spiral arms, where our sun is located. Could we ever really see it this way? Why?
6. How far are we from the center of the Milky Way? How far across is the Milky Way?
7. Our Sun is one star in the Milky Way. How many total stars are inside our Milky Way?
8. What is dark matter? How do we know it exists?
9. What is a galaxy?
10. How are galaxies classified?
11. Sketch and label a Hubble tuning fork diagram.
12. How are spiral galaxies different from elliptical galaxies?
13. Is the shape of a galaxy the result of evolution or change? (In other words, will a spiral galaxy eventually become an elliptical galaxy?) Why does a galaxy take on the shape that it does?

***Cosmology***

1. What is cosmology?
2. What is the Hubble Law?
3. If a galaxy is found to be at 150 Mpc away, calculate its velocity using the Hubble Law.
4. Describe what the redshift of galaxies indicates about the universe?
5. What is cosmic background radiation?
6. What is the scientific evidence for the Big Bang?
7. How old is the universe? How do we know?
8. Is there a center of the universe? Is there an edge of the universe?
9. What does the fate of the universe depend on?
10. According to the most recent research, how does it look like our universe will end?

***Astrobiology***

1. What are exoplanets? Describe some of the methods of how we look for exoplanets?
2. What is life? What does all life have in common?
3. Describe the *habitable zone* around a star.
4. What characteristics on a planet are necessary for life to exist?
5. What signatures of life are we looking for in order to determine if there is life on another planet?
6. What is the Goldilocks principle?
7. How do astronomers look for signatures of life on other planets, or other objects within our solar system?
8. Within our solar system, what are some of the best candidates that could support life and why?
9. What astronomical hazards threaten life on a planet, and how could these change life on the planet?