Oakwood City School District Astronomy Science Standards

One goal of science education is to help students become scientifically literate citizens able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science and to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact both themselves and others.

Astronomy is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires three units of science. Each course should include inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.

In this one semester course the student will gain an understanding of the basic structure of the universe, the methods astronomers use for probing the universe, and the physical processes that govern the behavior and development of astronomical systems. Topics will include a short history of astronomy, moon phases, telescope principles and operation, properties of light, atomic absorption and emission, the interstellar medium, stellar structure and evolution, compact objects (including black holes), galaxies, cosmology, and the possibilities of life elsewhere in the universe. There will be a laboratory component to the course.

Astronomy Standards

Sense of Scale/History

A. Overview of the Universe and Sense of Scale
   a. Describe the large-scale structure of the Universe, including the relative and absolute sizes of planets, stars, solar systems, star clusters, galaxies, clusters of galaxies, super-clusters, and the Universe.
   b. Explain interstellar distances are measured in light years (e.g., the nearest star beyond the sun is 4.3 light years away).
   c. Explain that gravitational forces govern the characteristics and movement patterns of the planets, comets and asteroids in the Solar System.
   d. Explain that the universe is composed of vast amounts of matter, most of which is at incomprehensible distances and held together by gravitational forces.
   e. Explain how the large-scale motion of objects in the universe is governed by gravitational forces and detected by observing electromagnetic radiation.
   f. Describe how gravitational forces act between all masses and always create a force of attraction. Recognize that the strength of the force is proportional to the masses and weakens rapidly with increasing distance between them.

B. History of Astronomy
   a. Illustrate the Copernican Principle with historical examples — how Earth's place in the Universe has been pulled further from the center with successive discoveries.
   b. Demonstrate that ancient to modern civilizations have used more and more advanced calendrical systems, which have been dependent on astronomical observations and assisted in better astronomical predictions.
   c. Describe the several discoveries involved in understanding the Earth as one planet among many, orbiting a star, which is one star among many.

Observational Astronomy: What to Look For

A. Celestial Motions
   a. Describe how the positions and motions of the objects in the universe cause predictable and cyclic events.
   b. Describe how objects in the Solar System are in regular and predictable motions that explain such phenomena as days, years, seasons, eclipses, tides and moon cycles.
   c. Analyze how the regular and predictable motions of Earth, Sun and Moon explain phenomena on Earth (e.g., seasons, tides, eclipses and phases of the Moon).

Observational Astronomy: How we Look

A. Nature of Light
   a. Demonstrate that waves (e.g., sound, seismic, water, light) have energy and waves can transfer energy when they interact with matter.
   b. Demonstrate that electromagnetic radiation is a form of energy. Recognize that light acts as a wave. Show that visible light is a part of the electromagnetic spectrum (e.g., radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays).
   c. Show how the properties of a wave depend on the properties of the medium through which it travels. Recognize that electromagnetic waves can be propagated without a medium.

B. Detection of Light
   a. Describe how the optical properties of the Earth's atmosphere allow for certain types of observations, and prohibit or limit other types of observations.
   b. Describe how the optical properties of human eyes provide limits on naked-eye observations, and how telescopes and binoculars can improve astronomical observations.
   c. Illustrate the functions and powers of a telescope and be able to evaluate the relative strengths and weaknesses of two telescopes in comparison.
   d. Describe how the universe is studied by the use of equipment such as telescopes, probes, satellites and spacecraft.
   e. Name and describe tools used to study the universe (e.g., telescopes, probes, satellites and spacecraft).
   f. Explain how technology can be used to gather evidence and increase our understanding of the universe.
   g. Explain how scientists obtain information about the universe by using technology to detect electromagnetic radiation that is emitted, reflected or absorbed by stars and other objects.
   h. Explain how information about the universe is inferred by understanding that stars and other objects in space emit, reflect or absorb electromagnetic radiation, which we then detect.

Stars

A. Measuring Stars
   a. Explain how information about the universe is inferred by understanding that stars and other objects in space emit, reflect or absorb electromagnetic radiation, which we then detect.
   b. Describe how atoms and molecules can gain or lose energy only in discrete amounts.
   c. Describe how the observed wavelength of a wave depends upon the relative motion of the source and the observer (Doppler effect). If either is moving towards the other, the observed wavelength is shorter; if either is moving

away, the observed wavelength is longer (e.g., weather radar, moving stars and galaxies, police radar).
d. Describe how gravitational forces act between all masses and always create a force of attraction. Recognize that the strength of the force is proportional to the masses and weakens rapidly with increasing distance between them.
e. Describe how different atomic energy levels are associated with the electron configurations of atoms and electron configurations (and/or conformations) of molecules.
f. Explain how atoms and molecules can gain or lose energy in particular discrete amounts (quanta or packets); therefore they can only absorb or emit light at the wavelengths corresponding to these amounts.

B. Stellar Structure
a. Describe the basic functioning of a star, focusing on the production, flow and release of energy.
b. Describe that stars produce energy from nuclear reactions and that processes in stars have led to the formation of all elements beyond hydrogen and helium.
c. Recognize that some atomic nuclei are unstable and will spontaneously break down.
d. Explain how thermal energy exists in the random motion and vibrations of atoms and molecules. Recognize that the higher the temperature, the greater the average atomic or molecular motion.
e. Demonstrate that thermal energy can be transferred by conduction, convection or radiation (e.g., through materials by the collision of particles, moving air masses or across empty space by forms of electromagnetic radiation).
f. Recognize that nuclear forces are much stronger than electromagnetic forces, and electromagnetic forces are vastly stronger than gravitational forces. The strength of the nuclear forces explains why greater amounts of energy are released from nuclear reactions (e.g., from atomic and hydrogen bombs and in the Sun and other stars).

C. Stellar Evolution
a. Explain how the interstellar medium is observed at various wavelengths of light.
b. Describe the most likely end-point of a star, given its initial mass.
c. Examine the life cycle of a star and predict the next likely stage of a star.
d. Explain how evidence from stars provides information about the processes that cause changes in the composition of subsequent generations of stars.

Galaxies, Cosmology & Life

A. Galaxies
a. Explain how astronomers infer that the whole universe is expanding by understanding how light seen from distant galaxies has longer apparent wavelengths than comparable light sources close to Earth.
b. Explain that the universe consists of billions of galaxies that are classified by shape.

B. Cosmology
    a. Describe how high-redshift supernova observations have altered astronomer's views on the expansion rate of the Universe.
    b. Describe the current scientific evidence that supports the theory of the expansion of the universe, beginning with the Big Bang.
    c. Explain why scientists can assume that the universe is a vast single system in which the basic rules are the same everywhere.
    d. Describe how individuals and teams contribute to science and engineering at different levels of complexity (e.g., an individual may conduct basic field studies, hundreds of people may work together on major scientific questions or technical problems).

C. Life
    a. Examine the conditions that make life on Earth possible, and describe the likelihood of these conditions being replicated elsewhere in the Universe.
    b. Describe how the history of life on Earth gives us guidance as to what we may expect in the development of life elsewhere in the galaxy.
    c. Explain what methods of communication seem possible between us and hypothetical distant civilizations.