Oakwood City School District
Astronomy

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, and cosmology. There will be a laboratory component to the course.

This course meets the graduation requirements of an advanced science course.

Science Inquiry and Application Standards

During the years of grades 9 through 12 all students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas. These are ongoing skills that will be developed and intertwined within the content of each course.

- Identify questions and concepts that guide scientific investigations
- Design and conduct scientific investigations
- Use technology and mathematics to improve investigations and communications
- Formulate and revise explanations and models using logic and evidence (critical thinking)
- Recognize and analyze explanations and models
- Communicate and support a scientific argument

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English Language Arts Standards for Science & Technical Subjects

I. Key Ideas and Details

A. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

B. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

C. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

II. Craft and Structure

A. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

B. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

C. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

III. Integration of Knowledge and Ideas

A. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

B. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

C. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

IV. Range of Reading and Level of Text Complexity

A. By the end of grade 12, read and comprehend science/technical texts in the grades 11–12 text complexity band independently and proficiently.

Writing Standards for Science & Technical Subjects

I. Text Types and Purposes Standard 1

A. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
B. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
C. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
D. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
E. Provide a concluding statement or section that follows from or supports the argument presented.

II. Text Types and Purposes Standard 2

A. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
B. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
C. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
D. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
E. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

III. Production and Distribution of Writing

A. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
B. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
C. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

IV. Research to Build and Present Knowledge

A. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
B. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
C. Draw evidence from informational texts to support analysis, reflection, and research.

V. Range of Writing

A. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Content Standards

I. Sense of Scale/History

A. Overview of the Universe and Sense of Scale

1. 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.
2. Explain interstellar distances are measured in light years (e.g., the nearest star beyond the sun is 4.3 light years away).
3. Explain that gravitational forces govern the characteristics and movement patterns of the planets, comets and asteroids in the Solar System.
4. Explain that the universe is composed of vast amounts of matter, most of which is at incomprehensible distances and held together by gravitational force.
5. Explain how the large-scale motion of objects in the universe is governed by gravitational forces and detected by observing electromagnetic radiation.
6. 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

1. Illustrate the Copernican Principle with historical examples — how Earth's place in the Universe has been pulled further from the center with successive discoveries.
2. 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.
3. Describe the several discoveries involved in understanding the Earth as one planet among many, orbiting a star, which is one star among many

II. Observational Astronomy — What to Look For

A. Celestial Motions
1. Describe how the positions and motions of the objects in the universe cause predictable and cyclic events.
2. 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.
3. 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).

III. Observational Astronomy — How We Look

A. Nature of Light
1. Demonstrate that waves (e.g., sound, seismic, water, light) have energy and waves can transfer energy when they interact with matter.
2. 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).
3. 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
1. Describe how the optical properties of the Earth's atmosphere allow for certain types of observations, and prohibit or limit other types of observations.
2. Describe how the optical properties of human eyes provide limits on naked-eye observations, and how telescopes and binoculars can improve astronomical observations.
3. Illustrate the functions and powers of a telescope and be able to evaluate the relative strengths and weaknesses of two telescopes in comparison.
4. Provide a simple description of a few of the most important research telescopes on the Earth and in orbit.
5. Describe how the universe is studied by the use of equipment such as telescopes, probes, satellites and spacecraft.

6. Name and describe tools used to study the universe (e.g., telescopes, probes, satellites and spacecraft).
7. Explain how technology can be used to gather evidence and increase our understanding of the universe.
8. 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.
9. 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.

IV. Stars

A. Measuring Stars

1. Explain how the large-scale motion of objects in the universe is governed by gravitational forces and detected by observing electromagnetic radiation.
2. 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.
3. Describe how atoms and molecules can gain or lose energy only in discrete amounts.
4. 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).
5. 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.
6. Describe how different atomic energy levels are associated with the electron configurations of atoms and electron configurations (and/or conformations) of molecules.
7. 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.
8. Lives and Structure of Stars

B. Stellar Structure
   1. Describe the basic functioning of a star, focusing on the production, flow and release of energy.
   2. 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.
   3. Recognize that some atomic nuclei are unstable and will spontaneously break down.
   4. 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, and during changes of state the temperature remains constant.
   5. 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).
   6. 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
   1. Explain how the interstellar medium is observed at various wavelengths of light.
   2. Describe the most likely end-point of a star, given its initial mass.
   3. Examine the life cycle of a star and predict the next likely stage of a star.
   4. Explain how evidence from stars and other celestial objects provide information about the processes that cause changes in the composition and scale of the physical universe.

V. Galaxies, Cosmology, Life

A. Galaxies
   1. 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.

2. Explain that the universe consists of billions of galaxies that are classified by shape.

B. Cosmology
1. Describe how high-redshift supernova observations have altered astronomer's views on the expansion rate of the Universe.
2. Explain that the universe is composed of vast amounts of matter, most of which is at incomprehensible distances and held together by gravitational force. Describe how the universe is studied by the use of equipment such as telescopes, probes, satellites and spacecraft.
3. Describe the current scientific evidence that supports the theory of the explosive expansion of the universe, the Big Bang, over 10 billion years ago.
4. Explain why scientists can assume that the universe is a vast single system in which the basic rules are the same everywhere.
5. 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 problem).

C. Life
1. Examine the conditions that make life of Earth possible, and describe the likelihood of these conditions being replicated elsewhere in the Universe.