Ohio State Science Academic Content Standards

GRADE: 9

Standard	*Benchmark*	*Grade Level Indicator*
Earth and Space Sciences	A – Explain how evidence from stars and other celestial objects provide information about the processes that cause changes in composition and scale of the physical universe.	1. 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. 2. Describe the current scientific evidence that supports the theory of the explosive expansion of the universe, the Big Bang, over 10 billion years ago.
	C – Explain the 4.5 billion-year-history of Earth and the 4 billion-year-history of life on Earth based on observable scientific evidence in the geologic record.	3. Explain that gravitational forces govern the characteristics and movement patterns if the planets, comets and asteroids in the solar system.
	F – Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of Earth and space sciences.	8. Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., heliocentric theory and plate tectonics theory).
Physical Sciences	D – Explain the movement of objects by applying Newton's three laws of motion.	21. Demonstrate that motion is a measurable quantity that depends on the observer's frame of reference and describe the object's motion in terms of position, velocity, acceleration and time. 22. Demonstrate that any object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced (net) force acts on it. 23. Explain the change in motion (acceleration) of an object. Demonstrate that the acceleration is proportional to the net force acting on the object and inversely proportional to the mass of the object. (F_{net} =ma. Note that weight is the gravitational force on a mass.) 24. Demonstrate that whenever one object exerts a force on another, an equal amount of force is exerted back on the first object.
	F – Explain how energy may change form or be redistributed but the total quantity of energy is conserved.	14. Summarize how nuclear reactions convert a small amount of matter into a large amount of energy. (Fission involves the splitting of a large nucleus into smaller nuclei; fusion is the joining of two small nuclei into a larger nucleus at extremely high energies.)
	G – Demonstrate that waves (e.g., sound, seismic, water and light) have energy and waves can transfer energy when they interact with matter.	18. 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).
	H – Trace the historical development of scientific theories and ideas, and describe emerging issues	26. Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many

	in the study of physical sciences.	different investigators (e.g., atomic theory, quantum theory and Newtonian mechanics).
Science and Technology	A – Explain the ways in which the processes of technological design respond to the needs of society.	2. Identify a problem or need, propose designs and choose among alternative solutions for the problem. 3. Explain why a design should be continually assessed and the ideas of the design should be tested, adapted and refined.
Scientific Inquiry	A – Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.	1. Distinguish between observations and inferences given a scientific situation. 3. Construct, interpret and apply physical and conceptual models that represent or explain systems, objects, events or concepts. 6. Draw logical conclusions based on scientific knowledge and evidence from investigations.
Scientific Ways of Knowing	A – Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world.	1. Comprehend that many scientific investigations require the contributions of women and men from different disciplines in and out of science. These people study different topics, use different techniques and have different standards of evidence but share a common purpose – to better understand a portion of our universe.
	B – Explain how scientific inquiry is guided by knowledge, observations, ideas and questions	5. Justify that scientific theories are explanations of large bodies of information and/or observations that withstand repeated testing. 7. Recognize that scientific knowledge and explanations have changed over time, almost always building on earlier knowledge.
	D – Recognize that scientific literacy is part of being a knowledgeable citizen.	8. Illustrate that much can be learned about the internal workings of science and the nature of science from the study of scientist, their daily work and their efforts to advance scientific knowledge in their area of study. 9. Investigate how the knowledge, skills and interests learned in science classes apply to the careers students plan to pursue.

GRADE: 10

Standard	*Benchmark*	*Grade Level Indicator*
Earth and Space Sciences	F – Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of Earth and space sciences.	7. Describe advances and issues in Earth and space science that have important long-lasting effects on science and society (e.g., geologic time scales, global warming, depletion of resources and exponential population growth).
Science and Technology	B – Explain that science and technology are interdependent; each drives the other.	1. Cite examples of ways that scientific inquiry is driven by the desire to understand the natural world and how technology is driven by the need to meet human needs and solve human problems. 2. Describe examples of scientific advances and emerging technologies and how they may impact society.
Scientific Ways of Knowing	A – Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural	1. Discuss science as a dynamic body of knowledge that can lead to the development of entirely new disciplines. 2. Describe that scientists may disagree about explanations of phenomena, about interpretation of data or about the value of rival theories, but they do agree that questioning, response to criticism and open communication are integral to the process of science.

	world.	3. Recognize that science is a systematic method of continuing investigation based on observation, hypothesis testing, measurement, experimentation and theory building, which leads to more adequate explanations of natural phenomena.
	D – Recognize that scientific literacy is part of being a knowledgeable citizen.	9. Investigate how the knowledge, skills and interests learned in science classes apply to the careers students plan to pursue.

GRADE: 11

Standard	*Benchmark*	*Grade Level Indicator*
Earth and Space Sciences	A – Explain how technology can be used to gather evidence and increase our understanding of the universe.	1. Describe how the early Earth was different from the planet we live on today, and explain the formation of the Sun, Earth and the rest of the solar system from a nebular cloud of dust and gas approximately 4.5 billion years ago.
	B – Describe how the Earth is made up of a series of interconnected systems and how a change in one system affects other systems.	2. 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).
	D – Summarize the historical development of scientific theories and ideas and describe emerging issues in the study of Earth and space sciences.	15. Use historical examples of how new ideas are limited by the context in which they are conceived; are often rejects by the social establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., global warming, Heliocentric Theory and Theory of Continental Drift). 16. Describe advances in Earth and space sciences that have important long-lasting effects on science and society (e.g., global warming, Heliocentric Theory and Plate Tectonics Theory).
Scientific Ways of Knowing	A – Explain how scientific evidence is used to develop and revise scientific predictions, ideas and theories.	1. Analyze a set of data to derive a hypothesis and apply that hypothesis to a similar phenomena (e.g., biome data). 2. Apply scientific inquiry to evaluate results of scientific investigations, observations, theoretical models and the explanations proposed by other scientists. 4. Explain why scientists can assume that the universe is a vast single system in which the basic rules are the same everywhere. 7. Explain how theories are judged by how well they fit with other theories, the range of included observations, how well they explain observations and how effective they are in predicting new findings.
	C – Explain how societal issues and considerations affect the progress of science and technology.	8. Explain that the decision to develop a new technology is influenced by societal opinions and demands and by cost benefit considerations. 11. Research the role of science and technology in careers that students plan to pursue.

GRADE: 12

Standard	*Benchmark*	*Grade Level Indicator*
Earth and Space Sciences	A – Explain how technology can be used to gather evidence and increase our understanding of the universe.	1. 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. 2. Explain how large-scale motion of objects in the universe is governed by gravitational forces and detected by observing electromagnetic radiation. 3. 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 can detect. 4. 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.
Physical Sciences	C – Describe how atoms and molecules can gain or lose energy only in discrete amounts.	12. Describe how different atomic energy levels are associated with the electron configurations of atoms and electron configurations (and/or conformations) of molecules. 13. 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.
	D – Apply principles of forces and motion to mathematically analyze, describe and predict the net effects on objects or systems.	8. Describe how the observed wavelength of a wave depends upon the 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, bat echoes and police radar). 9. 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 distanced between them.
	E – Summarize the historical development of scientific theories and idea within the study of physical sciences.	14. Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., nuclear energy, quantum theory and theory of relativity).
Science and Technology	A – Predict how human choices today will determine the quality and quantity of life on Earth.	1. Explain how science often advances with the introduction of new technologies and how solving technological problems often results in new scientific knowledge. 2. Describe how new technologies often extend the current levels of scientific understanding and introduce new areas of research. 3. Research how scientific inquiry is driven by the desire to understand the natural world and how technological design is driven by the need to meet human needs and sole human problems.
Scientific Inquiry	A – Make appropriate choices when designing and participating in scientific investigations by using cognitive and manipulative skills when collecting data	1. Formulate testable hypotheses. Develop and explain the appropriate procedures, controls and variables (dependent and independent) in scientific experimentation. 2. Derive simple mathematical relationships that have predictive power from experimental data(e.g., derive an equation from a graph and vice verse, determine whether a

	and formulating conclusions from the data.	linear or exponential relationship exits among the data in the table.
Scientific Ways of Knowing	A – Explain how scientific evidence is used to develop and revise scientific predictions, ideas and theories.	3. Select a scientific model, concept or theory and explain how it has been revised over time based on new knowledge, perceptions or technology. 5. Describe how individuals and teams contributed 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 – Explain how societal issues and considerations affect the progress of science / technology.	7. Describe the current and historical contributions of diverse peoples and cultures to science and technology and the scarcity and inaccessibility of information on some of these contributions.