COMPARISON OF THE OHIO ACADEMIC CONTENT STANDARDS AND THE HIGH SCHOOL GRADUATION QUALIFYING EXAM (HSGQE) COMPETENCIES

Science: Grade-band 9-10

Ohio has adopted academic content standards in science. These standards describe what students should know and be able to do and go beyond the proficiency learning outcomes. Over the next several years, Ohio will implement a standards-based assessment system. New achievement tests will replace the proficiency tests.

This chart shows the match between the academic content standards and the Science High School Graduation Qualifying Exam (HSGQE) competencies. The academic content standards provide the basis for instructional planning, and educators can use this chart as a supplementary resource while the new Ohio Graduation Test is being developed.

OHIO ACADEMIC CONTENT STANDARDS GRADES 9-10 BENCHMARKS	SCIENCE HSGQE COMPETENCIES AND EXCERPTS FROM *INFORMATION GUIDE*
Scientific Inquiry Standard 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. **Scientific Ways of Knowing Standard** A. Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world. **Scientific Ways of Knowing Standard** B. Explain how scientific inquiry is guided by knowledge, observations, ideas and questions.	**Strand I – History and Nature of Science** **1. Evaluate or design scientific investigations to formulate and/or revise scientific explanations and models.** This competency assesses students' abilities necessary to do scientific inquiry and understandings of historical and current scientific investigations of physical, living, earth and space, and designed systems. This includes students' ability to make predictions; identify questions and/or scientific ideas that guide investigations; design and/or critique scientific investigations including recognizing sources of experimental errors; identifying controls; manipulating variables; generate accurate conclusions from data; and extend given investigations to seek more information.
Scientific Inquiry Standard	**Strand I – Nature of Science**

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. **Scientific Ways of Knowing Standard** A. Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world. **Scientific Ways of Knowing Standard** B. Explain how scientific inquiry is guided by knowledge, observations, ideas and questions. **Scientific Ways of Knowing Standard** C. Describe the ethical practices and guidelines in which science operates. **Scientific Ways of Knowing Standard** D Recognize that scientific literacy is part of being a knowledgeable citizen.	**2. Evaluate information derived from popular and technical sources to determine its scientific validity in making evidence-based decisions.** This competency assesses students' understandings of the nature of scientific knowledge and evidence used in making evidence-based decisions. This includes students' ability to analyze or evaluate the scientific validity of information derived from popular and technical sources by applying rules of evidence, empirical standards, logical argument (identifying faulty reasoning), or skeptical review. Applying rules of evidence includes identifying the use of empirical, accurate, and verifiable data as the basis for scientific descriptions and explanations. Applying empirical standards includes discussing appropriate methods for collecting and communicating evidence obtained from observations and/or experiments, checking measurements, and gathering different kinds of data related to the same natural phenomena. This also includes students' ability to compare results from scientific investigations of physical, living, earth and space, and designed systems with existing theories or models; to compare information to distinguish fact from opinion, distinguish between accurate or misleading data including identifying statements that go beyond the evidence; or to analyze such sources as articles, advertisements, or graphs in a scientific manner, e.g., plausibility of conclusions.

Scientific Inquiry Standard 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. **Scientific Ways of Knowing Standard** D Recognize that scientific literacy is part of being a knowledgeable citizen. **Science and Technology Standard** A. Explain the ways in which the processes of technological design respond to the needs of society.	**Strand I – Nature of Science** **3. Given a personal, societal, or global circumstance, identify, interpret, and/or apply appropriate safety precautions and equipment.** This competency assesses students' understanding that the potential for accidents and the existence of hazards (e.g., chemical, biological, electrical, physical) imposes the need for injury prevention in the design of scientific investigations. This includes students' ability to determine the proper use of equipment or to identify and/or explain appropriate safety rules or procedures (e.g., relating associated hazards, consequences, benefits) in the context of given scientific investigations of physical, living, earth and space, and designed systems; or to interpret, apply or evaluate safety equipment, procedures, documents and symbols in the context of everyday societal and global events (e.g., residential, workplace, transportation).
Earth and Space Sciences Standard F. Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of Earth and space sciences. **Life Sciences Standard** J. Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of life sciences. **Physical Sciences Standard** H. Trace the historical development of scientific theories and ideas, and describe emerging issues in the study of physical sciences.	**Strand I – Nature of Science** **4. Given a particular scientific theory or protocol, explain how and/or why the theory or protocol may have changed over time.** This competency assesses students' understandings of the nature of scientific knowledge and historical perspectives regarding efforts to advance science; it does not include a comprehensive understanding of history. This includes students' ability to examine historical modifications of given scientific explanations to determine consistency with experimental and observational data; to determine the accuracy of predictions; or to explain how changes in scientific explanations build on earlier knowledge as new

Science and Technology Standard B. Explain that science and technology are interdependent: each drives the other. **Scientific Ways of Knowing Standard** A. Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world. **Scientific Ways of Knowing Standard** B. Explain how scientific inquiry is guided by knowledge, observations, ideas and questions.	evidence becomes available, including explaining how the introduction of a new technology extends scientific descriptions and explanations. For example, given excerpts or summaries of significant changes in scientific knowledge (e.g., atomic theory, Newton's laws, cell theory, diversity of life, plate tectonics, structure of the universe, harnessing power), test items written for this competency may require students to match a scientific theory with the observations or discoveries that led to that theory, to determine appropriate inferences that can be made from a theory, to determine limitations of a theory, or to determine the impact of a new discovery or technology (e.g., microscope, telescope) on an existing theory.
Physical Sciences Standard A. Describe that matter is made of minute particles called atoms and atoms are comprised of even smaller components. Explain the structure and properties of atoms. **Physical Sciences Standard** B. Explain how atoms react with each other to form other substances, and molecules can react with each other to form even different substances. **Physical Sciences Standard** C. Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration, ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance. **Physical Sciences Standard** F. Explain how energy may change form or be redistributed,	**Strand II – Physical Science** **5. Relate uses, properties, and chemical processes (reactions) of matter to the behavior and/or arrangement of small particles which compose matter.** This competency assesses students' basic understandings of the scientific evidence and explanation of atomic and molecular structure, the relationship between properties of matter and its structure, and investigations of the properties of substances and their changes through chemical and physical interactions. This includes students' ability to relate repeating patterns of physical and chemical properties of substances to families of elements with similar properties, limited to the first three periods of the periodic table of elements; to (simple) bonds between atoms that are created when electrons are paired by being transferred or shared and to conservation principles; and to the structure of and nature of interactions among substances, including differentiating metals from non-metals or acids from bases. This also includes students' ability to accurately relate

but the total quantity of energy is conserved.	observations of physical changes or changes in the physical properties or state of substances (solids, liquids, gases) to basic kinetic theory or conservation principles.
Physical Sciences Standard D Explain the movement of objects by applying Newton's three laws of motion.	**Strand II – Physical Science** **6. Describe and predict the effects of forces (e.g., elastic, gravitational, electric, magnetic) on objects and on the motion of objects within a system.** Test items for this competency will assess students' understandings of the basic concepts of motions, forces and inertia. This includes students' ability to examine objects in given circumstances in order to determine the acting forces and to apply basic concepts of forces to describe the net effect of forces applied to objects within systems; or to apply the laws of motion to describe or predict changes in relative direction and/or rate of motion.
Physical Sciences Standard E. Demonstrate that energy can be considered to be either kinetic (due to motion) or potential (stored). **Physical Sciences Standard** F. Explain how energy may change form or be redistributed, but the total quantity of energy is conserved.	**Strand II – Physical Science** **7. Analyze transformations of energy and recognize its conservation (constancy) within a system.** This competency requires students to demonstrate a basic understanding of the transfer, transformation and conservation of energy, including energy associated with heat, light, electricity, sound, mechanical motion and chemical interactions.
Physical Sciences Standard G. Demonstrate that waves (e.g., sound, seismic, water,	**Strand II – Physical Science** **8. Given that waves (e.g., sound, light) carry energy,**

light) have energy and waves can transfer energy when they interact with matter. **Science and Technology Standard** A. Explain the ways in which the processes of technological design respond to the needs of society.	**compare and predict interactions of waves with matter.** This competency requires students to demonstrate a basic understanding of waves and the interactions of wave energy and matter. This includes comparing and predicting the behavior and properties of electromagnetic and mechanical waves (e.g., speed, wavelength, frequency, energy content); and the nature of wave motion and the interaction of waves with various forms of matter, including by transmission (e.g., refraction), absorption, reflection (e.g., scattering), or observable effects due to relative motion (e.g., Doppler effect). This includes comparing waves, predicting the path of reflected or refracted waves, or determining risks and benefits of the use of electromagnetic (e.g., x-rays, microwaves) or sound waves in everyday settings.
Earth and Space Sciences Standard A. Explain how evidence from stars and other celestial objects produce information about the processes that cause changes in the composition and scale of the physical universe.	*No comparison to benchmark*
Earth and Space Sciences Standard B. Explain that many processes occur in patterns within the Earth's systems. **Earth and Space Sciences Standard** 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.	**Strand III- Earth and Space Science** **9. Relate internal and external sources of energy in the Earth system to processes and cycles (e.g., air, water, or land) occurring since the Earth's origin.** This competency requires students to demonstrate a basic understanding of energy in the earth system, geochemical cycles and natural changes and fluctuations over time in the earth system.

Earth and Space Sciences Standard D. Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources. **Earth and Space Sciences Standard** E. Explain the processes that move and shape Earth's surface.	
Earth and Space Sciences Standard B. Explain that many processes occur in patterns within the Earth's systems. **Earth and Space Sciences** 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.	**Strand III – Earth and Space Science** **10. Describe relationships among the Earth, other planets, and other objects in the solar system.** *This competency requires students to demonstrate a basic understanding of the solar system and predictable natural relationships (e.g., cause and effect) in the solar system. **Note: Much of the content focus of this competency now aligns with the 6-8 grade-band of the new academic content standards. Content that remains aligned from this competency requires students to demonstrate a basic understanding of plausible comparisons and natural relationships of objects in the solar system and that gravitational forces govern characteristics and natural movement and/or patterns in the earth system: rock sequences and fossils, meteor and meteorite, sunlight and growth seasons.*
Earth and Space Sciences Standard D. Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.	**Strand III – Earth and Space Science** **11. Relate changes in the form or distribution of matter to the cyclic and finite nature of resources within the closed Earth system.** This competency requires students to demonstrate basic understanding of natural structures in the earth system, the cyclical and finite nature of earth's resources and

	environmental quality. This competency is more focused on the physical (non-living) aspects of the environment.
Life Sciences Standard A. Explain that cells are the basic unit of structure and function of living organisms that all cells come from pre-existing cells and that there are a variety of cell types. **Life Sciences Standard** B. Explain the characteristics of life as indicated by cellular processes and describe the process of cell division and development.	**Strand IV – Life Science** **12. Analyze and compare regulatory processes (e.g., neural, endocrine, immune) in living things.** This competency assesses students' understandings of the nature of structure, function, and natural cycles of living systems. This includes a basic understanding of the cell requirements and functions and systems.
Life Sciences Standard C. Explain the genetic mechanisms and molecular basis of inheritance. **Life Sciences Standard** E. Explain how evolutionary relationships contribute to an understanding of the unity and diversity of life.	**Strand IV – Life Science** **13. Relate the chemical basis of life to heredity, diversity, species survival, adaptations, and extinction.** This competency assesses students' understandings of the basic nature of DNA and genes, the relationship of traits to genes and chromosomes, mutation, and the reproductive success of individuals or species. The focus of this competency is on molecular biology and on individual organisms.
Life Sciences Standard C. Explain the genetic mechanisms and molecular basis of inheritance. **Life Sciences Standard** E. Explain how evolutionary relationships contribute to an understanding of the unity and diversity of life.	**Strand IV – Life Science** **14. Relate heredity of organisms to the long-term survival of populations based on mutations, variations in populations, and changes in populations as a result of differential reproduction.** The focus of this competency is on populations and their

Life Sciences Standard H. Describe a foundation of biological evolution as the change in gene frequency of a population over time, and explain the historical and current scientific developments, mechanisms and processes of biological evolution. (The intent of this benchmark does not mandate the teaching or testing of intelligent design.) **Life Sciences Standard** I. Explain how natural selection and other evolutionary mechanisms account for unity and diversity of life forms past and present.	changes over time. Items may require students to demonstrate a basic understanding of natural selection, changes in populations over time, natural variation, and commonalities and differences among species.
Life Sciences Standard B. Explain the characteristics of life as indicated by cellular processes and describe the process of cell division and development. **Life Sciences Standard** D. Explain the flow of energy and the cycling of matter through biological and ecological systems (cellular, organism, and ecological). **Life Sciences Standard** F. Explain the structure and function of ecosystems and relate how ecosystems change over time. **Life Sciences Standard** G. Describe how human activities can impact the status of natural systems.	**Strand IV – Life Science** **15. Explain how living things interact with the living and non-living components of the environment.** This competency assesses students' understandings of the nature of matter, energy, and organization in living systems, including the impact of environmental quality on living systems, and the relationship between human activities and the survival of species.