ATTACHMENT II
Text of Proposed New 19 TAC

Chapter 112. Texas Essential Knowledge and Skills for Science

Subchapter B. Middle School

§112.25. Implementation of Texas Essential Knowledge and Skills for Science, Middle School, Adopted 2021.

(a) The provisions of §§112.26-112.28 of this subchapter shall be implemented by school districts.

(b) No later than July 31, 2023, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills for science as adopted in §§112.26-112.28 of this subchapter.

(c) If the commissioner makes the determination that instructional materials funding has been made available under subsection (b) of this section, §§112.26-112.28 of this subchapter shall be implemented beginning with the 2024-2025 school year and apply to the 2024-2025 and subsequent school years.

(d) If the commissioner does not make the determination that instructional materials funding has been made available under subsection (b) of this section, the commissioner shall determine no later than July 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that §§112.26-112.28 of this subchapter shall be implemented for the following school year.

(e) Sections 112.18-112.20 of this subchapter shall be superseded by the implementation of §§112.26-112.28 of this subchapter.

§112.26. Science, Grade 6, Adopted 2021.

(a) Introduction.

(1) In Grades 6 through 8 Science, content is organized into recurring strands. The concepts within each grade level build on prior knowledge, prepare students for the next grade level, and establish a foundation for high school courses. In Grade 6, the following concepts will be addressed in each strand.

(A) Scientific and engineering practices. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the grade level and question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified.

(i) Scientific practices. Students ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models.

(ii) Engineering practices. Students identify problems and design solutions using appropriate tools and models.

(B) Matter and energy. Students build upon their knowledge of properties of solids, liquids, and gases and further explore their molecular energies. In Grade 6, students learn how elements are classified as metals, nonmetals, or metalloids based on their properties on the Periodic Table. Students have previous experience with mixtures in Grade 5. Grade 6 furthers their understanding by investigating the different types of mixtures. Subsequent grades will learn about compounds. In Grade 6, students compare the density of substances relative to fluids and identify evidence of chemical changes.

(C) Force, motion, and energy. Students investigate the relationship between force and motion using a variety of means, including calculations and measurements through the study of Newton's Third Law of Motion. Subsequent grades will study force and motion through Newton's First and Second Laws of Motion. Energy occurs as either potential or kinetic energy. Potential energy can take several forms, including gravitational, elastic, and chemical energy. Energy is conserved throughout systems by changing from one form to another and transfers through waves.

(D) Earth and space. Cycles within Sun, Earth, and Moon systems are studied as students learn about seasons and tides. Students identify that the Earth is divided into spheres and examine the processes within and organization of the geosphere. Researching the advantages and disadvantages of short- and long-term uses of resources enables informed decision making about resource management.

(E) Organisms and environments. All living organisms are made up of smaller units called cells. Ecosystems are organized into communities, populations, and organisms. Students compare and contrast variations within organisms and how they impact survival. Students examine relationships and interactions between organisms, biotic factors, and abiotic factors in an ecosystem.

(2) Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable.

(3) Scientific hypotheses and theories. Students are expected to know that:

(A) hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories; and

(B) scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established and highly reliable explanations, but they may be subject to change as new areas of science and new technologies are developed.

(4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. Students distinguish between scientific decision-making practices and ethical and social decisions that involve science.

(5) Recurring themes and concepts. Science consists of recurring themes and making connections between overarching concepts. Recurring themes include structure and function, systems, models, and patterns. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Models have limitations but provide a tool for understanding the ideas presented. Students analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(6) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(b) Knowledge and skills.

(1) Scientific and engineering practices. The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:

(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

(B) use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;

(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;

(D) use appropriate tools such as graduated cylinders, metric rulers, periodic tables, balances, scales, thermometers, temperature probes, laboratory ware, timing devices, pH indicators, hot plates, models, microscopes, slides, life science models, petri dishes, dissecting kits, magnets, spring scales or force sensors, tools that model wave behavior, satellite images, and hand lenses;

(E) collect quantitative data using the International System of Units (SI) and qualitative data as evidence;

(F) construct appropriate tables, graphs, maps, and charts using repeated trials and means to organize data;

(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

(H) distinguish between scientific hypotheses, theories, and laws.

(2) Scientific and engineering practices. The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:

(A) identify advantages and limitations of models such as their size, scale, properties, and materials;

(B) analyze data by identifying any significant descriptive statistical features, patterns, sources of error, or limitations;

(C) use mathematical calculations to assess quantitative relationships in data; and

(D) evaluate experimental and engineering designs.

(3) Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:

(A) develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;

(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

(C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

(4) Scientific and engineering practices. The student knows the contributions of scientists and recognizes the importance of scientific research and innovation on society. The student is expected to:

(A) relate the impact of past and current research on scientific thought and society, including the process of science, cost-benefit analysis, and contributions of diverse scientists as related to the content;

(B) make informed decisions by evaluating evidence from multiple appropriate sources to assess the credibility, accuracy, cost-effectiveness, and methods used; and

(C) research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a science, technology, engineering, and mathematics (STEM) field to investigate STEM careers.

(5) Recurring themes and concepts. The student understands that recurring themes and concepts provide a framework for making connections across disciplines. The student is expected to:

(A) identify and apply patterns to understand and connect scientific phenomena or to design solutions;

(B) identify and investigate cause-and-effect relationships to explain scientific phenomena or analyze problems;

(C) analyze how differences in scale, proportion, or quantity affect a system's structure or performance;

(D) examine and model the parts of a system and their interdependence in the function of the system;

(E) analyze and explain how energy flows and matter cycles through systems and how energy and matter are conserved through a variety of systems;

(F) analyze and explain the complementary relationship between the structure and function of objects, organisms, and systems; and

(G) analyze and explain how factors or conditions impact stability and change in objects, organisms, and systems.

(6) Matter and energy. The student knows that matter is made of atoms, can be classified according to its properties, and can undergo changes. The student is expected to:

(A) compare solids, liquids, and gases in terms of their structure, shape, volume, and kinetic energy of atoms and molecules;

(B) investigate the physical properties of matter to distinguish between pure substances, homogeneous mixtures (solutions), and heterogeneous mixtures;

(C) classify elements on the periodic table as metals, nonmetals, and metalloids using their physical properties;

(D) compare the density of substances relative to various fluids; and

(E) identify the formation of a new substance by using the evidence of a possible chemical change, including production of a gas, change in thermal energy, production of a precipitate, and color change.

(7) Force, motion, and energy. The student knows the nature of forces and their role in systems that experience stability or change. The student is expected to:

(A) identify and explain how forces act on objects, including gravity, friction, magnetism, applied forces, and normal forces, using real-world applications;

(B) calculate the net force on an object in a horizontal or vertical direction using diagrams and determine if the forces are balanced or unbalanced; and

(C) identify simultaneous force pairs that are equal in magnitude and opposite in direction that result from the interactions between objects using Newton's Third Law of Motion.

(8) Force, motion, and energy. The student knows that the total energy in systems is conserved through energy transfers and transformations. The student is expected to:

(A) compare and contrast gravitational, elastic, and chemical potential energies with kinetic energy;

(B) describe how energy is conserved through transfers and transformations in systems such as electrical circuits, food webs, amusement park rides, or photosynthesis; and

(C) explain how energy is transferred through transverse and longitudinal waves.

(9) Earth and space. The student models the cyclical movements of the Sun, Earth, and Moon and describes their effects. The student is expected to:

(A) model and illustrate how the tilted Earth revolves around the Sun, causing changes in seasons; and

(B) describe and predict how the positions of the Earth, Sun, and Moon cause daily, spring, and neap cycles of ocean tides due to gravitational forces.

(10) Earth and space. The student understands the rock cycle and the structure of Earth. The student is expected to:

(A) differentiate between the biosphere, hydrosphere, atmosphere, and geosphere and identify components of each system;

(B) model and describe the layers of Earth, including the inner core, outer core, mantle, and crust; and

(C) describe how metamorphic, igneous, and sedimentary rocks form and change through geologic processes in the rock cycle.

(11) Earth and space. The student understands how resources are managed. The student is expected to research and describe why resource management is important and how conservation, increased efficiency, and technology can help manage air, water, soil, and energy resources.

(12) Organisms and environments. The student knows that interdependence occurs between living systems and the environment. The student is expected to:

(A) investigate how organisms and populations in an ecosystem depend on and may compete for biotic factors such as food and abiotic factors such as availability of light and water, range of temperatures, or soil composition;

(B) describe and give examples of predatory, competitive, and symbiotic relationships between organisms, including mutualism, parasitism, and commensalism; and

(C) describe the hierarchical organization of organism, population, and community within an ecosystem.

(13) Organisms and environments. The student knows that organisms have an organizational structure and variations can influence survival of populations. The student is expected to:

(A) describe the historical development of cell theory and explain how organisms are composed of one or more cells, which come from pre-existing cells and are the basic unit of structure and function;

(B) identify and compare the basic characteristics of organisms, including prokaryotic and eukaryotic, unicellular and multicellular, and autotrophic and heterotrophic; and

(C) describe how variations within a population can be an advantage or disadvantage to the survival of a population as environments change.

§112.27. Grade 7, Adopted 2021.

(a) Introduction.

(1) In Grades 6 through 8 Science, content is organized into recurring strands. The concepts within each grade level build on prior knowledge, prepare students for the next grade level, and establish a foundation for high school courses. In Grade 7, the following concepts will be addressed in each strand.

(A) Scientific and engineering practices. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the grade level and question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified.

(i) Scientific practices. Students ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models.

(ii) Engineering practices. Students identify problems and design solutions using appropriate tools and models.

(B) Matter and energy. Students have prior experience with elements in Grade 6 and develop an understanding that compounds are also pure substances in Grade 7. Students investigate the differences between elements and compounds through observations, descriptions of physical properties, and chemical reactions. Students build upon their understanding of solutions by exploring aqueous solutions.

(C) Force, motion, and energy. Students measure, calculate, graph, and investigate how forces impact linear motion. Students build upon their understanding of the laws of motions by exploring Newton's First Law of Motion. Temperature is a measure of the average kinetic energy of molecules. Thermal energy is transferred by conduction, convection, or radiation in order to reach thermal equilibrium.

(D) Earth and space. Students explore characteristics and organization of objects and the role of gravity within our solar system. Earth has a specific set of characteristics that allows life to exist. Students further their understanding of the geosphere by illustrating how Earth's features change over time through tectonic movement. Students investigate how humans depend on and affect the hydrosphere.

(E) Organisms and environments. Students further their understanding of organisms as systems made up of cells organized into tissues, tissues into organs, and organs into organ systems by identifying the main functions of the organs within the human body. During both sexual and asexual reproduction, traits are passed on to the next generation. Students understand how traits in populations can change through the processes of natural and artificial selection. Students analyze how energy flows through trophic levels and how biodiversity impacts an ecosystem's sustainability. Students gain an understanding of the taxonomic classifications of organisms and how characteristics determine their classification.

(2) Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable.

(3) Scientific hypotheses and theories. Students are expected to know that:

(A) hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories; and

(B) scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established and highly reliable explanations, but they may be subject to change as new areas of science and new technologies are developed.

(4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be

carried out. Students distinguish between scientific decision-making practices and ethical and social decisions that involve science.

(5) Recurring themes and concepts. Science consists of recurring themes and making connections between overarching concepts. Recurring themes include structure and function, systems, models, and patterns. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Models have limitations but provide a tool for understanding the ideas presented. Students analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(6) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(b) Knowledge and skills.

(1) Scientific and engineering practices. The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:

(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

(B) use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;

(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;

(D) use appropriate tools such as graduated cylinders, metric rulers, periodic tables, balances, scales, thermometers, temperature probes, laboratory ware, timing devices, pH indicators, hot plates, models, microscopes, slides, life science models, petri dishes, dissecting kits, magnets, spring scales or force sensors, tools that model wave behavior, satellite images, and hand lenses;

(E) collect quantitative data using the International System of Units (SI) and qualitative data as evidence;

(F) construct appropriate tables, graphs, maps, and charts using repeated trials and means to organize data;

(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

(H) distinguish between scientific hypotheses, theories, and laws.

(2) Scientific and engineering practices. The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:

(A) identify advantages and limitations of models such as their size, scale, properties, and materials;

(B) analyze data by identifying any significant descriptive statistical features, patterns, sources of error, or limitations;

(C) use mathematical calculations to assess quantitative relationships in data; and

(D) evaluate experimental and engineering designs.

(3) Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:

(A) develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;

(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

(C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

(4) Scientific and engineering practices. The student knows the contributions of scientists and recognizes the importance of scientific research and innovation on society. The student is expected to:

(A) relate the impact of past and current research on scientific thought and society, including the process of science, cost-benefit analysis, and contributions of diverse scientists as related to the content;

(B) make informed decisions by evaluating evidence from multiple appropriate sources to assess the credibility, accuracy, cost-effectiveness, and methods used; and

(C) research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a science, technology, engineering, and mathematics (STEM) field to investigate STEM careers.

(5) Recurring themes and concepts. The student understands that recurring themes and concepts provide a framework for making connections across disciplines. The student is expected to:

(A) identify and apply patterns to understand and connect scientific phenomena or to design solutions;

(B) identify and investigate cause-and-effect relationships to explain scientific phenomena or analyze problems;

(C) analyze how differences in scale, proportion, or quantity affect a system's structure or performance;

(D) examine and model the parts of a system and their interdependence in the function of the system;

(E) analyze and explain how energy flows and matter cycles through systems and how energy and matter are conserved through a variety of systems;

(F) analyze and explain the complementary relationship between structure and function of objects, organisms, and systems; and

(G) analyze and explain how factors or conditions impact stability and change in objects, organisms, and systems.

(6) Matter and energy. The student distinguishes between elements and compounds, classifies changes in matter, and understands the properties of solutions. The student is expected to:

(A) compare and contrast elements and compounds in terms of atoms and molecules, chemical symbols, and chemical formulas;

(B) distinguish between physical and chemical changes in matter;

(C) describe aqueous solutions in terms of solute and solvent, concentration, and dilution; and

(D) investigate and model how temperature, surface area, and agitation affect the rate of dissolution of solid solutes in aqueous solutions.

(7) Force, motion, and energy. The student describes the cause-and-effect relationship between force and motion. The student is expected to:

(A) calculate average speed using distance and time measurements from investigations;

(B) distinguish between speed and velocity in linear motion in terms of distance, displacement, and direction;

(C) measure, record, and interpret an object's motion using distance-time graphs; and

(D) analyze the effect of balanced and unbalanced forces on the state of motion of an object using Newton's First Law of Motion.

(8) Force, motion, and energy. The student understands the behavior of thermal energy as it flows into and out of systems. The student is expected to:

(A) investigate methods of thermal energy transfer into and out of systems, including conduction, convection, and radiation;

(B) investigate how thermal energy moves in a predictable pattern from warmer to cooler until all substances within the system reach thermal equilibrium; and

(C) explain the relationship between temperature and the kinetic energy of the particles within a substance.

(9) Earth and space. The student understands the patterns of movement, organization, and characteristics of components of our solar system. The student is expected to:

(A) describe the physical properties, locations, and movements of the Sun, planets, moons, meteors, asteroids, comets, Kuiper belt, and Oort cloud;

(B) describe how gravity governs motion within Earth’s solar system; and

(C) analyze the characteristics of Earth that allow life to exist such as the proximity of the Sun, presence of water, and composition of the atmosphere.

(10) Earth and space. The student understands the causes and effects of plate tectonics. The student is expected to:

(A) describe the evidence that supports that Earth has changed over time, including fossil evidence, plate tectonics, and superposition; and

(B) describe how plate tectonics causes ocean basin formation, earthquakes, mountain building, and volcanic eruptions, including supervolcanoes and hot spots.

(11) Earth and space. The student understands how human activity can impact the hydrosphere. The student is expected to:

(A) analyze the beneficial and harmful influences of human activity on groundwater and surface water in a watershed; and

(B) describe human dependence and influence on ocean systems and explain how human activities impact these systems.

(12) Organisms and environments. The student understands that ecosystems are dependent upon the cycling of matter and the flow of energy. The student is expected to:

(A) diagram the flow of energy within trophic levels and describe how the available energy decreases in successive trophic levels in energy pyramids; and

(B) describe how ecosystems are sustained by the continuous flow of energy and the recycling of matter and nutrients within the biosphere.

(13) Organisms and environments. The student knows how systems are organized and function to support the health of an organism and how traits are inherited. The student is expected to:

(A) identify and model the main functions of the systems of the human organism, including the circulatory, respiratory, skeletal, muscular, digestive, urinary, reproductive, integumentary, nervous, immune, and endocrine systems;

(B) describe the hierarchical organization of cells, tissues, organs, and organ systems within plants and animals;

(C) compare the results of asexual and sexual reproduction of plants and animals in relation to the diversity of offspring and the changes in the population over time; and

(D) describe and give examples of how natural and artificial selection change the occurrence of traits in a population over generations.

(14) Organisms and environments. The student knows how the taxonomic system is used to describe relationships between organisms. The student is expected to:

(A) describe the taxonomic system that categorizes organisms based on similarities and differences shared among groups; and

(B) describe the characteristics of the recognized kingdoms and their importance in ecosystems such as bacteria aiding digestion or fungi decomposing organic matter.

§112.28. Grade 8, Adopted 2021.

(a) Introduction.

(1) In Grades 6 through 8 Science, content is organized into recurring strands. The concepts within each grade level build on prior knowledge, prepare students for the next grade level, and establish a foundation for high school courses. In Grade 8, the following concepts will be addressed in each strand.

(A) Scientific and engineering practices. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the grade level and question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified.

(i) Scientific practices. Students ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models.

(ii) Engineering practices. Students identify problems and design solutions using appropriate tools and models.

(B) Matter and energy. Students make connections between elements, compounds, and mixtures that were introduced in prior grade levels. Students examine the properties of water, acids, and bases. In addition, students understand the basic concept of conservation of mass using chemical equations.

(C) Force, motion, and energy. Students are introduced to Newton's Second Law of Motion and investigate how all three laws of motion act simultaneously within systems. Students understand that waves transfer energy and further explore the characteristics and applications of waves.

(D) Earth and space. Students learn that stars and galaxies are part of the universe. In addition, students use data to research scientific theories of the origin of the universe. Students learn how interactions in solar, weather, and ocean systems create changes in weather patterns and climate. In addition, students understand that climate can be impacted by natural events and human activities.

(E) Organisms and environments. Students identify the function of organelles. Traits are contained in genetic material that is found on genes within a chromosome from the parent. These traits influence the success of a species over time. Students explore how organisms and their populations respond to environmental changes, including those caused by human activities.

(2) Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable.

(3) Scientific hypotheses and theories. Students are expected to know that:

(A) hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories; and

(B) scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established and highly reliable explanations, but they may be subject to change as new areas of science and new technologies are developed.

(4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. Students distinguish between scientific decision-making practices and ethical and social decisions that involve science.

(5) Recurring themes and concepts. Science consists of recurring themes and making connections between overarching concepts. Recurring themes include structure and function, systems, models, and patterns. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Models have limitations but provide a tool for understanding the ideas presented. Students analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(6) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(b) Knowledge and skills.

(1) Scientific and engineering practices. The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:

(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

(B) use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;

(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;

(D) use appropriate tools such as graduated cylinders, metric rulers, periodic tables, balances, scales, thermometers, temperature probes, laboratory ware, timing devices, pH indicators, hot plates, models, microscopes, slides, life science models, petri dishes, dissecting kits, magnets, spring scales or force sensors, tools that model wave behavior, satellite images, weather maps, and hand lenses;

(E) collect quantitative data using the International System of Units (SI) and qualitative data as evidence;

(F) construct appropriate tables, graphs, maps, and charts using repeated trials and means to organize data;

(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

(H) distinguish between scientific hypotheses, theories, and laws.

(2) Scientific and engineering practices. The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:

(A) identify advantages and limitations of models such as their size, scale, properties, and materials;

(B) analyze data by identifying any significant descriptive statistical features, patterns, sources of error, or limitations;

(C) use mathematical calculations to assess quantitative relationships in data; and

(D) evaluate experimental and engineering designs.

(3) Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:

(A) develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;

(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

(C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

(4) Scientific and engineering practices. The student knows the contributions of scientists and recognizes the importance of scientific research and innovation on society. The student is expected to:

(A) relate the impact of past and current research on scientific thought and society, including the process of science, cost-benefit analysis, and contributions of diverse scientists as related to the content;

(B) make informed decisions by evaluating evidence from multiple appropriate sources to assess the credibility, accuracy, cost-effectiveness, and methods used; and

(C) research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a science, technology, engineering, and mathematics (STEM) field to investigate STEM careers.

(5) Recurring themes and concepts. The student understands that recurring themes and concepts provide a framework for making connections across disciplines. The student is expected to:

(A) identify and apply patterns to understand and connect scientific phenomena or to design solutions;

(B) identify and investigate cause-and-effect relationships to explain scientific phenomena or analyze problems;

(C) analyze how differences in scale, proportion, or quantity affect a system's structure or performance;

(D) examine and model the parts of a system and their interdependence in the function of the system;

(E) analyze and explain how energy flows and matter cycles through systems and how energy and matter are conserved through a variety of systems;

(F) analyze and explain the complementary relationship between the structure and function of objects, organisms, and systems; and

(G) analyze and explain how factors or conditions impact stability and change in objects, organisms, and systems.

(6) Matter and energy. The student understands that matter can be classified according to its properties and matter is conserved in chemical changes that occur within closed systems. The student is expected to:

(A) explain by modeling how matter is classified as elements, compounds, homogeneous mixtures, or heterogeneous mixtures;

(B) describe the properties of cohesion, adhesion, and surface tension in water and relate to observable phenomena such as the formation of droplets, transport in plants, and insects walking on water;

(C) compare and contrast the properties of acids and bases, including pH relative to water, sour or bitter taste, and how these substances feel to the touch; and

(D) investigate how mass is conserved in chemical reactions and relate conservation of mass to the rearrangement of atoms using chemical equations, including photosynthesis.

(7) Force, motion, and energy. The student understands the relationship between force and motion within systems. The student is expected to:

(A) calculate and analyze how the acceleration of an object is dependent upon the net force acting on the object and the mass of the object using Newton's Second Law of Motion; and

(B) investigate and describe how Newton's three laws of motion act simultaneously within systems such as in vehicle restraints, sports activities, amusement park rides, Earth's tectonic activities, and rocket launches.

(8) Force, motion, and energy. The student knows how energy is transferred through waves. The student is expected to:

(A) compare the characteristics of amplitude, frequency, and wavelength in transverse waves, including the electromagnetic spectrum; and

(B) explain the use of electromagnetic waves in applications such as radiation therapy, wireless technologies, fiber optics, microwaves, ultraviolet sterilization, astronomical observations, and X-rays.

(9) Earth and space. The student describes the characteristics of the universe and the relative scale of its components. The student is expected to:

(A) describe the life cycle of stars and compare and classify stars using the Hertzsprung-Russell diagram;

(B) categorize galaxies as spiral, elliptical, and irregular and locate Earth’s solar system within the Milky Way galaxy; and

(C) research and analyze scientific data used as evidence to develop scientific theories that describe the origin of the universe.

(10) Earth and space. The student knows that interactions between Earth, ocean, and weather systems impact climate. The student is expected to:

(A) describe how energy from the Sun, hydrosphere, and atmosphere interact and influence weather and climate;

(B) identify global patterns of atmospheric movement and how they influence local weather; and

(C) describe the interactions between ocean currents and air masses that produce tropical cyclones, including typhoons and hurricanes.

(11) Earth and space. The student knows that natural events and human activity can impact global climate. The student is expected to:

(A) use scientific evidence to describe how natural events, including volcanic eruptions, meteor impacts, abrupt changes in ocean currents, and the release and absorption of greenhouse gases influence climate;

(B) use scientific evidence to describe how human activities such as the release of greenhouse gases, deforestation, and urbanization can influence climate; and

(C) describe efforts to mitigate climate change, including a reduction in greenhouse gas emissions.

(12) Organisms and environments. The student understands stability and change in populations and ecosystems. The student is expected to:

(A) explain how disruptions such as population changes, natural disasters, and human intervention impact the transfer of energy in food webs in ecosystems;

(B) describe how primary and secondary ecological succession affect populations and species diversity after ecosystems are disrupted by natural events or human activity; and

(C) describe how biodiversity contributes to the stability and sustainability of an ecosystem and the health of the organisms within the ecosystem.

(13) Organisms and environments. The student knows how cell functions support the health of an organism and how adaptation and variation relate to survival. The student is expected to:

(A) identify the function of the cell membrane, cell wall, nucleus, ribosomes, cytoplasm, mitochondria, chloroplasts, and vacuoles in plant or animal cells;

(B) describe the function of genes within chromosomes in determining inherited traits of offspring; and

(C) describe how variations of traits within a population lead to structural, behavioral, and physiological adaptations that influence the likelihood of survival and reproductive success of a species over generations.