Chapter 112. Texas Essential Knowledge and Skills for Science

Subchapter C. High School

Statutory Authority: The provisions of this Subchapter C issued under the Texas Education Code, §28.002, unless otherwise noted.

§112.41. Implementation of Texas Essential Knowledge and Skills for Science, High School.

The provisions of this subchapter shall be implemented by school districts beginning September 1, 1998, and at that time shall supersede §75.64 of this title (relating to Science).

Source: The provisions of this §112.41 adopted to be effective September 1, 1998, 22 TexReg 7647.

§112.42. Integrated Physics and Chemistry.

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Prerequisites: none. This course is recommended for students in Grades 9 or 10.

(b) Introduction.

(1) In Integrated Physics and Chemistry, students conduct field and laboratory investigations, use scientific methods during investigations, and make informed decisions using critical-thinking and scientific problem-solving. This course integrates the disciplines of physics and chemistry in the following topics: motion, waves, energy transformations, properties of matter, changes in matter, and solution chemistry.

(2) Science is a way of learning about the natural world. Students should know how science has built a vast body of changing and increasing knowledge described by physical, mathematical, and conceptual models, and also should know that science may not answer all questions.

(3) A system is a collection of cycles, structures, and processes that interact. Students should understand a whole in terms of its components and how these components relate to each other and to the whole. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems and can be observed and measured as patterns. These patterns help to predict what will happen next and can change over time.

(4) Investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations, and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(c) Knowledge and skills.

(1) **Scientific processes.** The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.

The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations; and

(B) make wise choices in the use and conservation of resources and the disposal or recycling of materials.

(2) **Scientific processes.** The student uses scientific methods during field and laboratory investigations.

The student is expected to:

(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology;

(B) collect data and make measurements with precision;

(C) organize, analyze, evaluate, make inferences, and predict trends from data; and

(D) communicate valid conclusions.

(3) **Scientific processes.** The student uses critical thinking and scientific problem solving to make informed decisions.

The student is expected to:

(A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information;

(B) draw inferences based on data related to promotional materials for products and services;

(C) evaluate the impact of research on scientific thought, society, and the environment;

(D) describe connections between physics and chemistry, and future careers; and

(E) research and describe the history of physics, chemistry, and contributions of scientists.

(4) **Science concepts.** The student knows concepts of force and motion evident in everyday life.

The student is expected to:

(A) calculate speed, momentum, acceleration, work, and power in systems such as in the human body, moving toys, and machines;

		(B) investigate and describe applications of Newton's laws such as in vehicle restraints, sports activities, geological processes, and satellite orbits;
		(C) analyze the effects caused by changing force or distance in simple machines as demonstrated in household devices, the human body, and vehicles; and
		(D) investigate and demonstrate mechanical advantage and efficiency of various machines such as levers, motors, wheels and axles, pulleys, and ramps.
(5)	**Science concepts.** The student knows the effects of waves on everyday life.	The student is expected to:
		(A) demonstrate wave types and their characteristics through a variety of activities such as modeling with ropes and coils, activating tuning forks, and interpreting data on seismic waves;
		(B) demonstrate wave interactions including interference, polarization, reflection, refraction, and resonance within various materials;
		(C) identify uses of electromagnetic waves in various technological applications such as fiber optics, optical scanners, and microwaves; and
		(D) demonstrate the application of acoustic principles such as in echolocation, musical instruments, noise pollution, and sonograms.
(6)	**Science concepts.** The student knows the impact of energy transformations in everyday life.	The student is expected to:
		(A) describe the law of conservation of energy;
		(B) investigate and demonstrate the movement of heat through solids, liquids, and gases by convection, conduction, and radiation;
		(C) analyze the efficiency of energy conversions that are responsible for the production of electricity such as from radiant, nuclear, and geothermal sources, fossil fuels such as coal, gas, oil, and the movement of water or wind;

		(D) investigate and compare economic and environmental impacts of using various energy sources such as rechargeable or disposable batteries and solar cells;
		(E) measure the thermal and electrical conductivity of various materials and explain results;
		(F) investigate and compare series and parallel circuits;
		(G) analyze the relationship between an electric current and the strength of its magnetic field using simple electromagnets; and
		(H) analyze the effects of heating and cooling processes in systems such as weather, living, and mechanical.
(7)	**Science concepts.** The student knows relationships exist between properties of matter and its components.	The student is expected to:
		(A) investigate and identify properties of fluids including density, viscosity, and buoyancy;
		(B) research and describe the historical development of the atomic theory;
		(C) identify constituents of various materials or objects such as metal salts, light sources, fireworks displays, and stars using spectral-analysis techniques;
		(D) relate the chemical behavior of an element including bonding, to its placement on the periodic table; and
		(E) classify samples of matter from everyday life as being elements, compounds, or mixtures.
(8)	**Science concepts.** The student knows that changes in matter affect everyday life.	The student is expected to:
		(A) distinguish between physical and chemical changes in matter such as oxidation, digestion, changes in states, and stages in the rock cycle;
		(B) analyze energy changes that accompany chemical reactions such as those occurring in heat packs, cold packs, and glow sticks to classify them as endergonic or exergonic reactions;
		(C) investigate and identify the law of conservation of mass;

		(D) describe types of nuclear reactions such as fission and fusion and their roles in applications such as medicine and energy production; and
		(E) research and describe the environmental and economic impact of the end-products of chemical reactions.
(9)	**Science concepts.** The student knows how solution chemistry is a part of everyday life.	The student is expected to:
		(A) relate the structure of water to its function as the universal solvent;
		(B) relate the concentration of ions in a solution to physical and chemical properties such as pH, electrolytic behavior, and reactivity;
		(C) simulate the effects of acid rain on soil, buildings, statues, or microorganisms;
		(D) demonstrate how various factors influence solubility including temperature, pressure, and nature of the solute and solvent; and
		(E) demonstrate how factors such as particle size, influence the rate of dissolving.

Source: The provisions of this §112.42 adopted to be effective September 1, 1998, 22 TexReg 7647.

§112.43. Biology.

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Prerequisites: none. This course is recommended for students in Grades 9, 10, or 11.

(b) Introduction.

(1) In Biology, students conduct field and laboratory investigations, use scientific methods during investigations, and make informed decisions using critical-thinking and scientific problem-solving. Students in Biology study a variety of topics that include: structures and functions of cells and viruses; growth and development of organisms; cells, tissues, and organs; nucleic acids and genetics; biological evolution; taxonomy; metabolism and energy transfers in living organisms; living systems; homeostasis; ecosystems; and plants and the environment.

(2) Science is a way of learning about the natural world. Students should know how science has built a vast body of changing and increasing knowledge described by physical, mathematical, and conceptual models, and also should know that science may not answer all questions.

(3) A system is a collection of cycles, structures, and processes that interact. Students should understand a whole in terms of its components and how these components relate to each other and to the whole. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems and can be observed and measured as patterns. These patterns help to predict what will happen next and can change over time.

(4) Investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations, and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(c) Knowledge and skills.

(1)	**Scientific processes.** The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	The student is expected to: (A) demonstrate safe practices during field and laboratory investigations; and (B) make wise choices in the use and conservation of resources and the disposal or recycling of materials.
(2)	**Scientific processes.** The student uses scientific methods during field and laboratory investigations.	The student is expected to: (A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology; (B) collect data and make measurements with precision; (C) organize, analyze, evaluate, make inferences, and predict trends from data; and (D) communicate valid conclusions.
(3)	**Scientific processes.** The student uses critical thinking and scientific problem solving to make informed decisions.	The student is expected to: (A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information; (B) evaluate promotional claims that relate to biological issues such as product labeling and advertisements; (C) evaluate the impact of research on scientific thought, society, and the environment; (D) describe the connection between biology and future careers;

		(E) evaluate models according to their adequacy in representing biological objects or events; and (F) research and describe the history of biology and contributions of scientists.
(4)	**Science concepts.** The student knows that cells are the basic structures of all living things and have specialized parts that perform specific functions, and that viruses are different from cells and have different properties and functions.	The student is expected to: (A) identify the parts of prokaryotic and eukaryotic cells; (B) investigate and identify cellular processes including homeostasis, permeability, energy production, transportation of molecules, disposal of wastes, function of cellular parts, and synthesis of new molecules; (C) compare the structures and functions of viruses to cells and describe the role of viruses in causing diseases and conditions such as acquired immune deficiency syndrome, common colds, smallpox, influenza, and warts; and (D) identify and describe the role of bacteria in maintaining health such as in digestion and in causing diseases such as in streptococcus infections and diphtheria.
(5)	**Science concepts.** The student knows how an organism grows and how specialized cells, tissues, and organs develop.	The student is expected to: (A) compare cells from different parts of plants and animals including roots, stems, leaves, epithelia, muscles, and bones to show specialization of structure and function; (B) identify cell differentiation in the development of organisms; and (C) sequence the levels of organization in multicellular organisms to relate the parts to each other and to the whole.
(6)	**Science concepts.** The student knows the structures and functions of nucleic acids in the mechanisms of genetics.	The student is expected to: (A) describe components of deoxyribonucleic acid (DNA), and illustrate how information for specifying the traits of an organism is carried in the DNA; (B) explain replication, transcription, and translation using models of DNA and ribonucleic acid (RNA);

		(C) identify and illustrate how changes in DNA cause mutations and evaluate the significance of these changes; (D) compare genetic variations observed in plants and animals; (E) compare the processes of mitosis and meiosis and their significance to sexual and asexual reproduction; and (F) identify and analyze karyotypes.
(7)	**Science concepts.** The student knows the theory of biological evolution.	The student is expected to: (A) identify evidence of change in species using fossils, DNA sequences, anatomical similarities, physiological similarities, and embryology; and (B) illustrate the results of natural selection in speciation, diversity, phylogeny, adaptation, behavior, and extinction.
(8)	**Science concepts.** The student knows applications of taxonomy and can identify its limitations.	The student is expected to: (A) collect and classify organisms at several taxonomic levels such as species, phylum, and kingdom using dichotomous keys; (B) analyze relationships among organisms and develop a model of a hierarchical classification system based on similarities and differences using taxonomic nomenclature; and (C) identify characteristics of kingdoms including monerans, protists, fungi, plants, and animals.
(9)	**Science concepts.** The student knows metabolic processes and energy transfers that occur in living organisms.	The student is expected to: (A) compare the structures and functions of different types of biomolecules such as carbohydrates, lipids, proteins, and nucleic acids; (B) compare the energy flow in photosynthesis to the energy flow in cellular respiration; (C) investigate and identify the effects of enzymes on food molecules; and (D) analyze the flow of matter and energy through different trophic levels and between organisms and the physical environment.

(10)	**Science concepts.** The student knows that, at all levels of nature, living systems are found within other living systems, each with its own boundary and limits.	The student is expected to: (A) interpret the functions of systems in organisms including circulatory, digestive, nervous, endocrine, reproductive, integumentary, skeletal, respiratory, muscular, excretory, and immune; (B) compare the interrelationships of organ systems to each other and to the body as a whole; and (C) analyze and identify characteristics of plant systems and subsystems.
(11)	**Science concepts.** The student knows that organisms maintain homeostasis.	The student is expected to: (A) identify and describe the relationships between internal feedback mechanisms in the maintenance of homeostasis; (B) investigate and identify how organisms, including humans, respond to external stimuli; (C) analyze the importance of nutrition, environmental conditions, and physical exercise on health; and (D) summarize the role of microorganisms in maintaining and disrupting equilibrium including diseases in plants and animals and decay in an ecosystem.
(12)	**Science concepts.** The student knows that interdependence and interactions occur within an ecosystem.	The student is expected to: (A) analyze the flow of energy through various cycles including the carbon, oxygen, nitrogen, and water cycles; (B) interpret interactions among organisms exhibiting predation, parasitism, commensalism, and mutualism; (C) compare variations, tolerances, and adaptations of plants and animals in different biomes; (D) identify and illustrate that long-term survival of species is dependent on a resource base that may be limited; and (E) investigate and explain the interactions in an ecosystem including food chains, food webs, and food pyramids.

(13)	**Science concepts.** The student knows the significance of plants in the environment.	The student is expected to: (A) evaluate the significance of structural and physiological adaptations of plants to their environments; and (B) survey and identify methods of reproduction, growth, and development of various types of plants.

Source: The provisions of this §112.43 adopted to be effective September 1, 1998, 22 TexReg 7647.

§112.44. Environmental Systems.

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Suggested prerequisite: one unit of high school science. This course is recommended for students in Grades 10, 11, or 12.

(b) Introduction.

(1) In Environmental Systems, students conduct field and laboratory investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study a variety of topics that include: biotic and abiotic factors in habitats; ecosystems and biomes; interrelationships among resources and an environmental system; sources and flow of energy though an environmental system; relationship between carrying capacity and changes in populations and ecosystems; and changes in environments.

(2) Science is a way of learning about the natural world. Students should know how science has built a vast body of changing and increasing knowledge described by physical, mathematical, and conceptual models, and also should know that science may not answer all questions.

(3) A system is a collection of cycles, structures, and processes that interact. Students should understand a whole in terms of its components and how these components relate to each other and to the whole. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems and can be observed and measured as patterns. These patterns help to predict what will happen next and can change over time.

(4) Investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations, and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(c) Knowledge and skills.

(1)	**Scientific processes.** The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	The student is expected to: (A) demonstrate safe practices during field and laboratory investigations; and (B) make wise choices in the use and conservation of resources and the disposal or recycling of materials.
(2)	**Scientific processes.** The student uses scientific methods during field and laboratory investigations.	The student is expected to: (A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology; (B) collect data and make measurements with precision; (C) organize, analyze, evaluate, make inferences, and predict trends from data; and (D) communicate valid conclusions.
(3)	**Scientific processes.** The student uses critical thinking and scientific problem solving to make informed decisions.	The student is expected to: (A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information; (B) make responsible choices in selecting everyday products and services using scientific information; (C) evaluate the impact of research on scientific thought, society, and the environment; (D) describe the connection between environmental science and future careers; and (E) research and describe the history of environmental science and contributions of scientists.
(4)	**Science concepts.** The student knows the relationships of biotic and abiotic factors within habitats, ecosystems, and biomes.	The student is expected to: (A) identify indigenous plants and animals, assess their role within an ecosystem, and compare them to plants and animals in other ecosystems and biomes;

		(B) make observations and compile data about fluctuations in abiotic cycles and evaluate the effects of abiotic factors on local ecosystems and biomes; (C) evaluate the impact of human activity such as methods of pest control, hydroponics, organic gardening, or farming on ecosystems; (D) predict how the introduction, removal, or reintroduction of an organism may alter the food chain and affect existing populations; and (E) predict changes that may occur in an ecosystem if biodiversity is increased or reduced.
(5)	**Science concepts.** The student knows the interrelationships among the resources within the local environmental system.	The student is expected to: (A) summarize methods of land use and management; (B) identify source, use, quality, and conservation of water; (C) document the use and conservation of both renewable and non-renewable resources; (D) identify renewable and non-renewable resources that must come from outside an ecosystem such as food, water, lumber, and energy; (E) analyze and evaluate the economic significance and interdependence of components of the environmental system; and (F) evaluate the impact of human activity and technology on land fertility and aquatic viability.
(6)	**Science concepts.** The student knows the sources and flow of energy through an environmental system.	The student is expected to: (A) summarize forms and sources of energy; (B) explain the flow of energy in an ecosystem; (C) investigate and explain the effects of energy transformations within an ecosystem; and (D) investigate and identify energy interactions in an ecosystem.

(7)	**Science concepts.** The student knows the relationship between carrying capacity and changes in populations and ecosystems.	The student is expected to: (A) relate carrying capacity to population dynamics; (B) calculate exponential growth of populations; (C) evaluate the depletion of non-renewable resources and propose alternatives; and (D) analyze and make predictions about the impact on populations of geographic locales, natural events, diseases, and birth and death rates.
(8)	**Science concepts.** The student knows that environments change.	The student is expected to: (A) analyze and describe the effects on environments of events such as fires, hurricanes, deforestation, mining, population growth, and municipal development; (B) explain how regional changes in the environment may have a global effect; (C) describe how communities have restored an ecosystem; and (D) examine and describe a habitat restoration or protection program.

Source: The provisions of this §112.44 adopted to be effective September 1, 1998, 22 TexReg 7647.

§112.45. Chemistry.

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Suggested prerequisites: one unit of high school science, Algebra I, and completion of or concurrent enrollment in a second year of math. This course is recommended for students in Grades 10, 11, or 12.

(b) Introduction.

(1) In Chemistry, students conduct field and laboratory investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study a variety of topics that include: characteristics of matter; energy transformations during physical and chemical changes; atomic structure; periodic table of elements; behavior of gases; bonding; nuclear fusion and nuclear fission; oxidation-reduction reactions; chemical equations; solutes; properties of solutions; acids and bases; and chemical reactions. Students will investigate how chemistry is an integral part of our daily lives.

(2) Science is a way of learning about the natural world. Students should know how science has built a vast body of changing and increasing knowledge described by physical, mathematical, and conceptual models, and also should know that science may not answer all questions.

(3) A system is a collection of cycles, structures, and processes that interact. Students should understand a whole in terms of its components and how these components relate to each other and to the whole. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems and can be observed and measured as patterns. These patterns help to predict what will happen next and can change over time.

(4) Investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations, and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(c) Knowledge and skills.

(1) **Scientific processes.** The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	The student is expected to: (A) demonstrate safe practices during field and laboratory investigations; and (B) make wise choices in the use and conservation of resources and the disposal or recycling of materials.
(2) **Scientific processes.** The student uses scientific methods during field and laboratory investigations.	The student is expected to: (A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology; (B) collect data and make measurements with precision; (C) express and manipulate chemical quantities using scientific conventions and mathematical procedures such as dimensional analysis, scientific notation, and significant figures; (D) organize, analyze, evaluate, make inferences, and predict trends from data; and (E) communicate valid conclusions.
(3) **Scientific processes.** The student uses critical thinking and scientific problem solving to make informed decisions.	The student is expected to: (A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information; (B) make responsible choices in selecting everyday products and services using scientific information;

		(C) evaluate the impact of research on scientific thought, society, and the environment; (D) describe the connection between chemistry and future careers; and (E) research and describe the history of chemistry and contributions of scientists.
(4)	**Science concepts.** The student knows the characteristics of matter.	The student is expected to: (A) differentiate between physical and chemical properties of matter; (B) analyze examples of solids, liquids, and gases to determine their compressibility, structure, motion of particles, shape, and volume; (C) investigate and identify properties of mixtures and pure substances; and (D) describe the physical and chemical characteristics of an element using the periodic table and make inferences about its chemical behavior.
(5)	**Science concepts.** The student knows that energy transformations occur during physical or chemical changes in matter.	The student is expected to: (A) identify changes in matter, determine the nature of the change, and examine the forms of energy involved; (B) identify and measure energy transformations and exchanges involved in chemical reactions; and (C) measure the effects of the gain or loss of heat energy on the properties of solids, liquids, and gases.
(6)	**Science concepts.** The student knows that atomic structure is determined by nuclear composition, allowable electron cloud, and subatomic particles.	The student is expected to: (A) describe the existence and properties of subatomic particles; (B) analyze stable and unstable isotopes of an element to determine the relationship between the isotope's stability and its application; and (C) summarize the historical development of the periodic table to understand the concept of periodicity.

(7)	**Science concepts.** The student knows the variables that influence the behavior of gases.	The student is expected to: (A) describe interrelationships among temperature, particle number, pressure, and volume of gases contained within a closed system; and (B) illustrate the data obtained from investigations with gases in a closed system and determine if the data are consistent with the Universal Gas Law.
(8)	**Science concepts.** The student knows how atoms form bonds to acquire a stable arrangement of electrons.	The student is expected to: (A) identify characteristics of atoms involved in chemical bonding; (B) investigate and compare the physical and chemical properties of ionic and covalent compounds; (C) compare the arrangement of atoms in molecules, ionic crystals, polymers, and metallic substances; and (D) describe the influence of intermolecular forces on the physical and chemical properties of covalent compounds.
(9)	**Science concepts.** The student knows the processes, effects, and significance of nuclear fission and nuclear fusion.	The student is expected to: (A) compare fission and fusion reactions in terms of the masses of the reactants and products and the amount of energy released in the nuclear reactions; (B) investigate radioactive elements to determine half-life; (C) evaluate the commercial use of nuclear energy and medical uses of radioisotopes; and (D) evaluate environmental issues associated with the storage, containment, and disposal of nuclear wastes.
(10)	**Science concepts.** The student knows common oxidation-reduction reactions.	The student is expected to: (A) identify oxidation-reduction processes; and (B) demonstrate and document the effects of a corrosion process and evaluate the importance of electroplating metals.

(11)	**Science concepts.** The student knows that balanced chemical equations are used to interpret and describe the interactions of matter.	The student is expected to: (A) identify common elements and compounds using scientific nomenclature; (B) demonstrate the use of symbols, formulas, and equations in describing interactions of matter such as chemical and nuclear reactions; and (C) explain and balance chemical and nuclear equations using number of atoms, masses, and charge.
(12)	**Science concepts.** The student knows the factors that influence the solubility of solutes in a solvent.	The student is expected to: (A) demonstrate and explain effects of temperature and the nature of solid solutes on the solubility of solids; (B) develop general rules for solubility through investigations with aqueous solutions; and (C) evaluate the significance of water as a solvent in living organisms and in the environment.
(13)	**Science concepts.** The student knows relationships among the concentration, electrical conductivity, and colligative properties of a solution.	The student is expected to: (A) compare unsaturated, saturated, and supersaturated solutions; (B) interpret relationships among ionic and covalent compounds, electrical conductivity, and colligative properties of water; and (C) measure and compare the rates of reaction of a solid reactant in solutions of varying concentration.
(14)	**Science concepts.** The student knows the properties and behavior of acids and bases.	The student is expected to: (A) analyze and measure common household products using a variety of indicators to classify the products as acids or bases; (B) demonstrate the electrical conductivity of acids and bases; (C) identify the characteristics of a neutralization reaction; and (D) describe effects of acids and bases on an ecological system.

(15)	**Science concepts.** The student knows factors involved in chemical reactions.	The student is expected to: (A) verify the law of conservation of energy by evaluating the energy exchange that occurs as a consequence of a chemical reaction; and (B) relate the rate of a chemical reaction to temperature, concentration, surface area, and presence of a catalyst.

Source: The provisions of this §112.45 adopted to be effective September 1, 1998, 22 TexReg 7647.

§112.46. Aquatic Science.

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Suggested prerequisite: one unit of high school science. This course is recommended for students in Grades 10, 11, or 12.

(b) Introduction.

(1) In Aquatic Science, students conduct field and laboratory investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study a variety of topics that include: components of an aquatic ecosystem; relationships among aquatic habitats and ecosystems; roles of cycles within an aquatic environment; adaptations of aquatic organisms; changes within aquatic environments; geological phenomena and fluid dynamics effects; and origin and use of water in a watershed.

(2) Science is a way of learning about the natural world. Students should know how science has built a vast body of changing and increasing knowledge described by physical, mathematical, and conceptual models, and also should know that science may not answer all questions.

(3) A system is a collection of cycles, structures, and processes that interact. Students should understand a whole in terms of its components and how these components relate to each other and to the whole. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems and can be observed and measured as patterns. These patterns help to predict what will happen next and can change over time.

(4) Investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations, and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(c) Knowledge and skills.

(1) **Scientific processes.** The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.

The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations; and

(B) make wise choices in the use and conservation of resources and the disposal or recycling of materials.

(2) **Scientific processes.** The student uses scientific methods during field and laboratory investigations.

The student is expected to:

(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology;

(B) collect data and make measurements with precision;

(C) express and manipulate quantities using mathematical procedures such as dimensional analysis, scientific notation, and significant figures;

(D) organize, analyze, evaluate, make inferences, and predict trends from data; and

(E) communicate valid conclusions.

(3) **Scientific processes.** The student uses critical thinking and scientific problem solving to make informed decisions.

The student is expected to:

(A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information;

(B) make responsible choices in selecting everyday products and services using scientific information;

(C) evaluate the impact of research on scientific thought, society, and the environment;

(D) describe the connection between aquatic science and future careers; and

(E) research and describe the history of aquatic science and contributions of scientists.

(4) **Science concepts.** The student knows the components of aquatic ecosystems.

The student is expected to:

(A) differentiate among freshwater, brackish, and saltwater ecosystems;

		(B) research and identify biological, chemical, geological, and physical components of an aquatic ecosystem; and (C) collect and analyze baseline quantitative data such as pH, salinity, temperature, mineral content, nitrogen compounds, and turbidity from an aquatic environment.
(5)	**Science concepts.** The student knows the relationships within and among the aquatic habitats and ecosystems in an aquatic environment.	The student is expected to: (A) observe and compile data over a period of time from an established aquatic habitat documenting seasonal changes and the behavior of organisms; (B) observe and evaluate patterns and interrelationships among producers, consumers, and decomposers in an aquatic ecosystem; (C) identify the interdependence of organisms in an aquatic environment such as a pond, river, lake, ocean, or aquifer, and the biosphere; and (D) evaluate trends in data to determine the factors that impact aquatic ecosystems.
(6)	**Science concepts.** The student knows the roles of cycles in an aquatic environment.	The student is expected to: (A) identify the role of various cycles such as carbon, nitrogen, water, and nutrients in an aquatic environment; (B) interpret the role of aquatic systems in climate and weather; and (C) collect and evaluate global environmental data using technology.
(7)	**Science concepts.** The student knows environmental adaptations of aquatic organisms.	The student is expected to: (A) classify different aquatic organisms using dichotomous keys; (B) compare and describe how adaptations allow an organism to exist within an aquatic environment; (C) predict adaptations of an organism prompted by environmental changes; and (D) compare differences in adaptations of aquatic organisms to fresh water and marine environments.

(8)	**Science concepts.** The student knows that aquatic environments change.	The student is expected to: (A) predict effects of chemical, organic, physical, and thermal changes on the living and nonliving components of an aquatic ecosystem; (B) analyze the cumulative impact of natural and human influence on an aquatic system; (C) identify and describe a local or global issue affecting an aquatic system; and (D) analyze and discuss human influences on an aquatic environment including fishing, transportation, and recreation.
(9)	**Science concepts.** The student knows that geological phenomena and fluid dynamics affect aquatic systems.	The student is expected to: (A) demonstrate the principles of fluid dynamics including Archimedes' and Bernoulli's Principles and hydrostatic pressure; (B) identify interrelationships of plate tectonics, ocean currents, climates, and biomes; and (C) research and describe fluid dynamics in an upwelling.
(10)	**Science concepts.** The student knows the origin and use of water in a watershed.	The student is expected to: (A) identify sources and determine the amounts of water in a watershed including groundwater and surface water; (B) research and identify the types of uses and volumes of water used in a watershed; and (C) identify water quantity and quality in a local watershed.

Source: The provisions of this §112.46 adopted to be effective September 1, 1998, 22 TexReg 7647.

§112.47. Physics.

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Suggested prerequisites: one unit of high school science, Algebra I, and completion of or concurrent enrollment in a second year of mathematics. This course is recommended for students in Grades 10, 11, or 12.

(b) Introduction.

(1) In Physics, students conduct field and laboratory investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study a variety of topics that include: laws of motion; changes within physical systems and conservation of energy and momentum; force; thermodynamics; characteristics and behavior of waves; and quantum physics. This course provides students with a conceptual framework, factual knowledge, and analytical and scientific skills.

(2) Science is a way of learning about the natural world. Students should know how science has built a vast body of changing and increasing knowledge described by physical, mathematical, and conceptual models, and also should know that science may not answer all questions.

(3) A system is a collection of cycles, structures, and processes that interact. Students should understand a whole in terms of its components and how these components relate to each other and to the whole. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems and can be observed and measured as patterns. These patterns help to predict what will happen next and can change over time.

(4) Investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations, and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(c) Knowledge and skills.

(1) **Scientific processes.** The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	The student is expected to: (A) demonstrate safe practices during field and laboratory investigations; and (B) make wise choices in the use and conservation of resources and the disposal or recycling of materials.
(2) **Scientific processes.** The student uses scientific methods during field and laboratory investigations.	The student is expected to: (A) plan and implement experimental procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology; (B) make quantitative observations and measurements with precision;

		(C) organize, analyze, evaluate, make inferences, and predict trends from data; (D) communicate valid conclusions; (E) graph data to observe and identify relationships between variables; and (F) read the scale on scientific instruments with precision.
(3)	**Scientific processes.** The student uses critical thinking and scientific problem solving to make informed decisions.	The student is expected to: (A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information; (B) express laws symbolically and employ mathematical procedures including vector addition and right-triangle geometry to solve physical problems; (C) evaluate the impact of research on scientific thought, society, and the environment; (D) describe the connection between physics and future careers; and (E) research and describe the history of physics and contributions of scientists.
(4)	**Science concepts.** The student knows the laws governing motion.	The student is expected to: (A) generate and interpret graphs describing motion including the use of real-time technology; (B) analyze examples of uniform and accelerated motion including linear, projectile, and circular; (C) demonstrate the effects of forces on the motion of objects; (D) develop and interpret a free-body diagram for force analysis; and (E) identify and describe motion relative to different frames of reference.
(5)	**Science concepts.** The student knows that changes occur within a physical system and recognizes that energy and momentum are conserved.	The student is expected to: (A) interpret evidence for the work-energy theorem;

		(B) observe and describe examples of kinetic and potential energy and their transformations; (C) calculate the mechanical energy and momentum in a physical system such as billiards, cars, and trains; and (D) demonstrate the conservation of energy and momentum.
(6)	**Science concepts.** The student knows forces in nature.	The student is expected to: (A) identify the influence of mass and distance on gravitational forces; (B) research and describe the historical development of the concepts of gravitational, electrical, and magnetic force; (C) identify and analyze the influences of charge and distance on electric forces; (D) demonstrate the relationship between electricity and magnetism; (E) design and analyze electric circuits; and (F) identify examples of electrical and magnetic forces in everyday life.
(7)	**Science concepts.** The student knows the laws of thermodynamics.	The student is expected to: (A) analyze and explain everyday examples that illustrate the laws of thermodynamics; and (B) evaluate different methods of heat energy transfer that result in an increasing amount of disorder.
(8)	**Science concepts.** The student knows the characteristics and behavior of waves.	The student is expected to: (A) examine and describe a variety of waves propagated in various types of media and describe wave characteristics such as velocity, frequency, amplitude, and behaviors such as reflection, refraction, and interference; (B) identify the characteristics and behaviors of sound and electromagnetic waves; and (C) interpret the role of wave characteristics and behaviors found in medicinal and industrial applications.

(9)	**Science concepts.** The student knows simple examples of quantum physics.	The student is expected to: (A) describe the photoelectric effect; and (B) explain the line spectra from different gas-discharge tubes.

Source: The provisions of this §112.47 adopted to be effective September 1, 1998, 22 TexReg 7647.

§112.48. Astronomy.

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Suggested prerequisite: one unit of high school science. This course is recommended for students in Grades 11 or 12.

(b) Introduction.

(1) In Astronomy, students conduct field and laboratory investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study the following topics: information about the universe; scientific theories of the evolution of the universe; characteristics and the life cycle of stars; exploration of the universe; role of the Sun in our solar system; planets; and the orientation and placement of the Earth.

(2) Science is a way of learning about the natural world. Students should know how science has built a vast body of changing and increasing knowledge described by physical, mathematical, and conceptual models, and also should know that science may not answer all questions.

(3) A system is a collection of cycles, structures, and processes that interact. Students should understand a whole in terms of its components and how these components relate to each other and to the whole. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems and can be observed and measured as patterns. These patterns help to predict what will happen next and can change over time.

(4) Investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations, and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(c) Knowledge and skills.

(1)	**Scientific processes.** The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	The student is expected to: (A) demonstrate safe practices during field and laboratory investigations; and (B) make wise choices in the use and conservation of resources and the disposal or recycling of materials.

(2)	**Scientific processes.** The student uses scientific methods during field and laboratory investigations.	The student is expected to: (A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology; (B) collect data and make measurements with precision; (C) organize, analyze, evaluate, make inferences, and predict trends from data; and (D) communicate valid conclusions.
(3)	**Scientific processes.** The student uses critical thinking and scientific problem solving skills to make informed decisions.	The student is expected to: (A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information; (B) draw inferences based on data related to promotional materials for products and services; (C) evaluate the impact of research on scientific thought, society, and the environment; (D) describe the connection between astronomy and future careers; and (E) research and describe the history of astronomy and contributions of scientists.
(4)	**Science concepts.** The student knows scientific information about the universe.	The student is expected to: (A) observe and record data about lunar phases and uses that information to model the earth, moon, and sun system; and (B) describe characteristics of galaxies.
(5)	**Science concepts.** The student knows the scientific theories of the evolution of the universe.	The student is expected to: (A) research and analyze scientific empirical data on the estimated age of the universe; (B) research and describe the historical development of the Big Bang Theory; and (C) interpret data concerning the formation of galaxies and our solar system.

(6)	**Science concepts.** The student knows the characteristics and the life cycle of stars.	The student is expected to: (A) describe nuclear reactions in stars; (B) identify the characteristics of stars such as temperature, age, relative size, composition, and radial velocity using spectral analysis; and (C) identify the stages in the life cycle of stars by examining the Hertzsprung-Russell diagram.
(7)	**Science concepts.** The student knows how mathematical models, computer simulations, and exploration can be used to study the universe.	The student is expected to: (A) demonstrate the use of units of measurement in astronomy such as light year and Astronomical Units; (B) research and describe the historical development of the laws of universal gravitation and planetary motion and the theory of special relativity; (C) analyze a model that simulates planetary motion and universal gravitation; (D) identify the historical origins of the perceived patterns of constellations and their role in ancient and modern navigation; and (E) analyze the impact of the space program on the collection of data about the Earth and the universe.
(8)	**Science concepts.** The student knows the role of the Sun in our solar system.	The student is expected to: (A) identify the approximate mass, size, motion, temperature, structure, and composition of the Sun; (B) identify the source of energy within the Sun and explain that the Sun is the major source of energy for the Earth; and (C) describe the Sun's effects on the Earth.
(9)	**Science concepts.** The student knows that planets of different size, composition, and surface features orbit around the Sun.	The student is expected to: (A) observe the night-time sky to determine movement of the planets relative to stars; (B) compare the planets in terms of orbit, size, composition, rotation, atmosphere, moons, and geologic activity;

		(C) identify objects, other than planets, that orbit the Sun; and (D) relate the role of gravitation to the motion of the planets around the Sun and to the motion of moons and satellites around the planets.
(10)	**Science concepts.** The student knows how life on Earth is affected by its unique placement and orientation in our solar system.	The student is expected to: (A) compare the factors essential to life on Earth such as temperature, water, mass, and gases to conditions on other planets; (B) determine the effects of the Earth's rotation, revolution, and tilt on its environment; and (C) identify the effects of the moon on tides.

Source: The provisions of this §112.48 adopted to be effective September 1, 1998, 22 TexReg 7647.

§112.49. Geology, Meteorology, and Oceanography.

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Suggested prerequisite: one unit of high school science. This course is recommended for students in Grades 11 or 12.

(b) Introduction.

(1) In Geology, Meteorology, Oceanography, students conduct field and laboratory investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study a variety of topics that include: characteristics and conditions of the Earth; formation and history of the Earth; plate tectonics; origin and composition of minerals and rocks and the rock cycle; processes and products of weathering; natural energy resources; interactions in a watershed; characteristics of oceans; characteristics of the atmosphere; and the role of energy in weather and climate.

(2) Science is a way of learning about the natural world. Students should know how science has built a vast body of changing and increasing knowledge described by physical, mathematical, and conceptual models, and also should know that science may not answer all questions.

(3) A system is a collection of cycles, structures, and processes that interact. Students should understand a whole in terms of its components and how these components relate to each other and to the whole. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems and can be observed and measured as patterns. These patterns help to predict what will happen next and can change over time.

(4) Investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations, and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(c) Knowledge and skills.

(1) **Scientific processes.** The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	The student is expected to: (A) demonstrate safe practices during field and laboratory investigations; and (B) make wise choices in the use and conservation of resources and the disposal or recycling of materials.
(2) **Scientific processes.** The student uses scientific methods during field and laboratory investigations.	The student is expected to: (A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology; (B) collect data and make measurements with precision; (C) organize, analyze, evaluate, make inferences, and predict trends from data; and (D) communicate valid conclusions.
(3) **Scientific processes.** The student uses critical thinking and scientific problem solving to make informed decisions.	The student is expected to: (A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information; (B) draw inferences based on data related to promotional materials for products and services; (C) evaluate the impact of research on scientific thought, society, and the environment; (D) describe the connections between geology, meteorology, oceanography, and future careers; and (E) research and describe the history of geology, meteorology, oceanography, and contributions of scientists.
(4) **Science concepts.** The student knows the Earth's unique characteristics and conditions.	The student is expected to: (A) research and describe the Earth's unique placement in the solar system; and (B) analyze conditions on Earth that enable organisms to survive.

(5)	**Science concepts.** The student knows about the formation and history of the Earth.	The student is expected to: (A) research and describe the historical development of scientific theories of the Earth's formation; and (B) use current theories to design and construct a geologic time scale.
(6)	**Science concepts.** The student knows the processes of plate tectonics.	The student is expected to: (A) research and describe the historical development of the theories of plate tectonics including continental drift and sea-floor spreading; (B) analyze the processes that power the movement of the Earth's continental and oceanic plates and identify the effects of this movement including faulting, folding, earthquakes, and volcanic activity; and (C) analyze methods of tracking continental and oceanic plate movement.
(7)	**Science concepts.** The student knows the origin and composition of minerals and rocks and the significance of the rock cycle.	The student is expected to: (A) demonstrate the density, hardness, streak, and cleavage of particular minerals; (B) identify common minerals and describe their economic significance; (C) classify rocks according to how they are formed during a rock cycle; and (D) examine and describe conditions such as depth of formation, rate of cooling, and mineral composition that are factors in the formation of rock types.
(8)	**Science concepts.** The student knows the processes and end products of weathering.	The student is expected to: (A) distinguish chemical from mechanical weathering and identify the role of weathering agents such as wind, water, and gravity; (B) identify geologic formations that result from differing weathering processes; and (C) illustrate the role of weathering in soil formation.

(9)	**Science concepts.** The student knows the role of natural energy resources.	The student is expected to: (A) research and describe the origin of fossil fuels such as coal, oil, and natural gas; (B) analyze issues regarding the use of fossil fuels and other renewable, non-renewable, or alternative energy resources; and (C) analyze the significance and economic impact of the use of fossil fuels and alternative energy resources.
(10)	**Science concepts.** The student knows the interactions that occur in a watershed.	The student is expected to: (A) identify the characteristics of a local watershed such as average annual rainfall, run-off patterns, aquifers, locations of river basins, and surface water reservoirs; (B) analyze the impact of floods, droughts, irrigation, and industrialization on a watershed; and (C) describe the importance and sources of surface and subsurface water.
(11)	**Science concepts.** The student knows characteristics of oceans.	The student is expected to: (A) identify physical characteristics of ocean water including salinity, solubility, heat capacity, colligative properties, and density; (B) evaluate the effects of tides, tidal bores, and tsunamis; and (C) compare the topography of the ocean floor to the topography of the continents.
(12)	**Science concepts.** The student knows the characteristics of the atmosphere.	The student is expected to: (A) identify the atmosphere as a mixture of gases, water vapor, and particulate matter; (B) analyze the range of atmospheric conditions that organisms will tolerate including types of gases, temperature, particulate matter, and moisture; and (C) determine the impact on the atmosphere of natural events and human activity.

(13)	**Science concepts.** The student knows the role of energy in governing weather and climate.	The student is expected to: (A) describe the transfer of heat energy at the boundaries between the atmosphere, land masses, and oceans resulting in layers of different temperatures and densities in both the ocean and atmosphere; (B) identify, describe, and compare climatic zones; and (C) describe the effects of phenomena such as El Niño and the Jet Stream on local weather.

Source: The provisions of this §112.49 adopted to be effective September 1, 1998, 22 TexReg 7647.