

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, §§7.102(c)(4), 28.002, and 28.025, unless otherwise noted.

§112.31. Implementation of Texas Essential Knowledge and Skills for Science, High School, Beginning with School Year 2010-2011.

The provisions of §§112.32-112.39 of this subchapter shall be implemented by school districts beginning with the 2010-2011 school year.

Source: The provisions of this §112.31 adopted to be effective August 4, 2009, 34 TexReg 5063; amended to be effective August 24, 2010, 35 TexReg 7230.

§112.38. Integrated Physics and Chemistry, Beginning with School Year 2010-2011 (One Credit).

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

(b) Introduction.

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

(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 scientifically testable.

(3) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation are experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.

(4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information).

(5) Science, systems, and models. A system is a collection of cycles, structures, and processes that interact. 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. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(c) **Knowledge and skills.**

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

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

(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.

(2) Scientific processes. The student uses scientific methods during laboratory and field investigations. The student is expected to:

(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;

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

(C) collect data and make measurements with precision;

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

(E) communicate valid conclusions.

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions. The student is expected to:

(A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

(B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;

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

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

(E) describe connections between physics and chemistry and future careers; and

(F) research and describe the history of physics and 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) describe and calculate an object's motion in terms of position, displacement, speed, and acceleration;

(B) measure and graph distance and speed as a function of time using moving toys;

(C) investigate how an object's motion changes only when a net force is applied, including activities and equipment such as toy cars, vehicle restraints, sports activities, and classroom objects;

(D) assess the relationship between force, mass, and acceleration, noting the relationship is independent of the nature of the force, using equipment such as dynamic carts, moving toys, vehicles, and falling objects;

(E) apply the concept of conservation of momentum using action and reaction forces such as students on skateboards;

(F) describe the gravitational attraction between objects of different masses at different distances, including satellites; and

(G) examine electrical force as a universal force between any two charged objects and compare the relative strength of the electrical force and gravitational force.

(5) Science concepts. The student recognizes multiple forms of energy and knows the impact of energy transfer and energy conservation in everyday life. The student is expected to:

(A) recognize and demonstrate that objects and substances in motion have kinetic energy such as vibration of atoms, water flowing down a stream moving pebbles, and bowling balls knocking down pins;

(B) demonstrate common forms of potential energy, including gravitational, elastic, and chemical, such as a ball on an inclined plane, springs, and batteries;

(C) demonstrate that moving electric charges produce magnetic forces and moving magnets produce electric forces;

(D) investigate the law of conservation of energy;

(E) investigate and demonstrate the movement of thermal energy through solids, liquids, and gases by convection, conduction, and radiation such as in weather, living, and mechanical systems;

(F) evaluate the transfer of electrical energy in series and parallel circuits and conductive materials;

(G) explore the characteristics and behaviors of energy transferred by waves, including acoustic, seismic, light, and waves on water as they superpose on one another, bend around corners, reflect off surfaces, are

absorbed by materials, and change direction when entering new materials;

(H) analyze energy conversions such as those from radiant, nuclear, and geothermal sources; fossil fuels such as coal, gas, oil; and the movement of water or wind; and

(I) critique the advantages and disadvantages of various energy sources and their impact on society and the environment.

(6) Science concepts. The student knows that relationships exist between the structure and properties of matter. The student is expected to:

(A) examine differences in physical properties of solids, liquids, and gases as explained by the arrangement and motion of atoms, ions, or molecules of the substances and the strength of the forces of attraction between those particles;

(B) relate chemical properties of substances to the arrangement of their atoms or molecules;

(C) analyze physical and chemical properties of elements and compounds such as color, density, viscosity, buoyancy, boiling point, freezing point, conductivity, and reactivity;

(D) relate the physical and chemical behavior of an element, including bonding and classification, to its placement on the Periodic Table; and

(E) relate the structure of water to its function as a solvent and investigate the properties of solutions and factors affecting gas and solid solubility, including nature of solute, temperature, pressure, pH, and concentration.

(7) Science concepts. The student knows that changes in matter affect everyday life. The student is expected to:

(A) investigate changes of state as it relates to the arrangement of particles of matter and energy transfer;

(B) recognize that chemical changes can occur when substances react to form different substances and that these interactions are largely determined by the valence electrons;

(C) demonstrate that mass is conserved when substances undergo chemical change and that the number and kind of atoms are the same in the reactants and products;

(D) analyze energy changes that accompany chemical reactions such as those occurring in heat packs, cold packs, and glow sticks and classify them as exothermic or endothermic reactions;

(E) describe types of nuclear reactions such as fission and fusion and their roles in applications such as medicine and energy production; and

(F) research and describe the environmental and economic impact of the end-products of chemical reactions such as those that may result in acid rain, degradation of water and air quality, and ozone depletion.

Source: The provisions of this §112.38 adopted to be effective August 4, 2009, 34 TexReg 5063.

§112.39. Physics, Beginning with School Year 2010-2011 (One Credit).

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Algebra I is suggested as a prerequisite or co-requisite. This course is recommended for students in Grade 9, 10, 11, or 12.

(b) Introduction.

(1) Physics. In Physics, students conduct laboratory and field 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; forces; thermodynamics; characteristics and behavior of waves; and atomic, nuclear, and quantum physics. Students who successfully complete Physics will acquire factual knowledge within a conceptual framework, practice experimental design and interpretation, work collaboratively with colleagues, and develop critical thinking skills.

(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 scientifically testable.

(3) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation can be experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.

(4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods and ethical and social decisions that involve the application of scientific information.

(5) Scientific systems. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in terms of 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. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(c) **Knowledge and skills.**

(1) Scientific processes. The student conducts investigations, for at least 40% of instructional time, using safe, environmentally appropriate, and ethical practices. These investigations must involve actively obtaining and analyzing data with physical equipment, but may also involve experimentation in a simulated environment as well as field observations that extend beyond the classroom. The student is expected to:

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

(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.

(2) Scientific processes. The student uses a systematic approach to answer scientific laboratory and field investigative questions. The student is expected to:

(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;

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

(C) know that 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 may be subject to change as new areas of science and new technologies are developed;

(D) distinguish between scientific hypotheses and scientific theories;

(E) design and implement investigative procedures, including making observations, asking well-defined questions, formulating testable hypotheses, identifying variables, selecting appropriate equipment and technology, and evaluating numerical answers for reasonableness;

(F) demonstrate the use of course apparatus, equipment, techniques, and procedures, including multimeters (current, voltage, resistance), triple beam balances, batteries, clamps, dynamics demonstration equipment, collision apparatus, data acquisition probes, discharge tubes with power supply (H, He, Ne, Ar), hand-held visual spectrosopes, hot plates, slotted and hooked lab masses, bar magnets, horseshoe magnets, plane mirrors, convex lenses, pendulum support, power supply, ring clamps, ring stands, stopwatches, trajectory apparatus, tuning forks, carbon paper, graph paper, magnetic compasses, polarized film, prisms, protractors, resistors, friction blocks, mini lamps (bulbs) and sockets, electrostatics kits, 90-degree rod clamps, metric rulers, spring scales, knife blade switches, Celsius thermometers, meter sticks, scientific calculators, graphing technology, computers, cathode ray tubes with horseshoe magnets, ballistic carts or equivalent, resonance tubes, spools of nylon thread or string, containers of iron filings, rolls of white craft paper, copper wire, Periodic Table, electromagnetic spectrum charts, slinky springs, wave motion ropes, and laser pointers;

(G) use a wide variety of additional course apparatus, equipment, techniques, materials, and procedures as appropriate such as ripple tank

with wave generator, wave motion rope, micrometer, caliper, radiation monitor, computer, ballistic pendulum, electroscope, inclined plane, optics bench, optics kit, pulley with table clamp, resonance tube, ring stand screen, four inch ring, stroboscope, graduated cylinders, and ticker timer;

(H) make measurements with accuracy and precision and record data using scientific notation and International System (SI) units;

(I) identify and quantify causes and effects of uncertainties in measured data;

(J) organize and evaluate data and make inferences from data, including the use of tables, charts, and graphs;

(K) communicate valid conclusions supported by the data through various methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports; and

(L) express and manipulate relationships among physical variables quantitatively, including the use of graphs, charts, and equations.

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:

(A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

(B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;

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

(D) explain the impacts of the scientific contributions of a variety of historical and contemporary scientists on scientific thought and society;

(E) research and describe the connections between physics and future careers; and

(F) express and interpret relationships symbolically in accordance with accepted theories to make predictions and solve problems mathematically, including problems requiring proportional reasoning and graphical vector addition.

(4) Science concepts. The student knows and applies the laws governing motion in a variety of situations. The student is expected to:

(A) generate and interpret graphs and charts describing different types of motion, including the use of real-time technology such as motion detectors or photogates;

(B) describe and analyze motion in one dimension using equations with the concepts of distance, displacement, speed, average velocity, instantaneous velocity, and acceleration;

(C) analyze and describe accelerated motion in two dimensions using equations, including projectile and circular examples;

(D) calculate the effect of forces on objects, including the law of inertia, the relationship between force and acceleration, and the nature of force pairs between objects;

(E) develop and interpret free-body force diagrams; and

(F) identify and describe motion relative to different frames of reference.

(5) Science concepts. The student knows the nature of forces in the physical world. The student is expected to:

(A) research and describe the historical development of the concepts of gravitational, electromagnetic, weak nuclear, and strong nuclear forces;

(B) describe and calculate how the magnitude of the gravitational force between two objects depends on their masses and the distance between their centers;

(C) describe and calculate how the magnitude of the electrical force between two objects depends on their charges and the distance between them;

(D) identify examples of electric and magnetic forces in everyday life;

(E) characterize materials as conductors or insulators based on their electrical properties;

(F) design, construct, and calculate in terms of current through, potential difference across, resistance of, and power used by electric circuit elements connected in both series and parallel combinations;

(G) investigate and describe the relationship between electric and magnetic fields in applications such as generators, motors, and transformers; and

(H) describe evidence for and effects of the strong and weak nuclear forces in nature.

(6) Science concepts. The student knows that changes occur within a physical system and applies the laws of conservation of energy and momentum. The student is expected to:

(A) investigate and calculate quantities using the work-energy theorem in various situations;

(B) investigate examples of kinetic and potential energy and their transformations;

(C) calculate the mechanical energy of, power generated within, impulse applied to, and momentum of a physical system;

(D) demonstrate and apply the laws of conservation of energy and conservation of momentum in one dimension;

(E) describe how the macroscopic properties of a thermodynamic system such as temperature, specific heat, and pressure are related to the molecular level of matter, including kinetic or potential energy of atoms;

(F) contrast and give examples of different processes of thermal energy transfer, including conduction, convection, and radiation; and

(G) analyze and explain everyday examples that illustrate the laws of thermodynamics, including the law of conservation of energy and the law of entropy.

(7) Science concepts. The student knows the characteristics and behavior of waves. The student is expected to:

(A) examine and describe oscillatory motion and wave propagation in various types of media;

(B) investigate and analyze characteristics of waves, including velocity, frequency, amplitude, and wavelength, and calculate using the relationship between wavespeed, frequency, and wavelength;

(C) compare characteristics and behaviors of transverse waves, including electromagnetic waves and the electromagnetic spectrum, and characteristics and behaviors of longitudinal waves, including sound waves;

(D) investigate behaviors of waves, including reflection, refraction, diffraction, interference, resonance, and the Doppler effect;

(E) describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens; and

(F) describe the role of wave characteristics and behaviors in medical and industrial applications.

(8) Science concepts. The student knows simple examples of atomic, nuclear, and quantum phenomena. The student is expected to:

(A) describe the photoelectric effect and the dual nature of light;

(B) compare and explain the emission spectra produced by various atoms;

(C) describe the significance of mass-energy equivalence and apply it in explanations of phenomena such as nuclear stability, fission, and fusion; and

(D) give examples of applications of atomic and nuclear phenomena such as radiation therapy, diagnostic imaging, and nuclear power and

examples of applications of quantum phenomena such as digital cameras.

Source: The provisions of this §112.39 adopted to be effective August 4, 2009, 34 TexReg 5063.

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For additional information, email rules@tea.state.tx.us.