

Text of Adopted Amendment to 19 TAC

Chapter 130. Texas Essential Knowledge and Skills for Career and Technical Education

Subchapter O. Science, Technology, Engineering, and Mathematics

§130.404. Principles of Technology (One Credit), Adopted 2015.

- (a) General requirements. This course is recommended for students in Grades 10-12. Prerequisites: one credit of high school science and Algebra I. Students must meet the 40% laboratory and fieldwork requirement. This course satisfies a high school science graduation requirement. Students shall be awarded one credit for successful completion of this course.
- (b) Introduction.
 - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
 - (2) The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services, including laboratory and testing services, and research and development services.
 - (3) In Principles of Technology, students will conduct laboratory and field investigations, use scientific practices [~~methods~~] during investigations, and make informed decisions using critical thinking and scientific problem solving. Various systems will be described in terms of space, time, energy, and matter. Students will study a variety of topics that include laws of motion, conservation of energy, momentum, electricity, magnetism, thermodynamics, and characteristics and behavior of waves. Students will apply physics concepts and perform laboratory experimentations for at least 40% of instructional time using safe practices.
 - (4) 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 by empirical science .
 - (5) 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.
 - (6) 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).
 - (7) 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.
 - (8) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
 - (9) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.
- (c) Knowledge and skills.

- (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
 - (A) demonstrate knowledge of how to dress appropriately, speak politely, and conduct oneself in a manner appropriate for the profession;
 - (B) show the ability to cooperate, contribute, and collaborate as a member of a group in an effort to achieve a positive collective outcome;
 - (C) present written and oral communication in a clear, concise, and effective manner;
 - (D) demonstrate time-management skills in prioritizing tasks, following schedules, and performing goal-relevant activities in a way that produces efficient results; and
 - (E) demonstrate punctuality, dependability, reliability, and responsibility in performing assigned tasks as directed.

- (2) 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.

- (3) The student uses scientific methods and equipment 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)(4) of this section;
 - (B) know that 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) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as 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 spectrometers, 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,]~~ and slinky springs ~~[wave motion ropes, and laser pointers]~~ ;

- (G) use a wide variety of additional course equipment as appropriate such as ripple tank with wave generator, wave motion rope, tuning forks, hand-held visual spectroscopes, discharge tubes with power supply (H, He, Ne, Ar), electromagnetic spectrum charts, laser pointers, micrometer, caliper, [~~radiation monitor,~~] computer, data acquisition probes, scientific calculators, graphing technology, electrostatic kits, [~~ballistic pendulum,~~] electroscope, inclined plane, optics bench, optics kit, polarized film, prisms, pulley with table clamp, motion detectors, photogates, friction blocks, ballistic carts or equivalent, resonance tube, [~~ring stand screen, four inch ring,~~] stroboscope, resistors, copper wire, switches, iron filings, and/or other equipment and materials that will produce the same results [~~graduated cylinders, and ticker timer]~~ ;
- (H) make measurements and record data with accuracy and precision using scientific notation and International System (SI) units;
- ~~[(I) identify and quantify causes and effects of uncertainties in measured data;]~~
- (I) ~~[(I)]~~ organize, evaluate, and make inferences from data, including the use of tables, charts, and graphs;
- (J) ~~[(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
- (K) ~~[(L)]~~ express ~~[and manipulate]~~ relationships among physical variables quantitatively, including the use of graphs, charts, and equations.
- (4) 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;]~~
- (C) ~~[(D)]~~ explain the impacts of the scientific contributions of a variety of historical and contemporary scientists on scientific thought and society;
- (D) ~~[(E)]~~ research and describe the connections between physics and future careers; and
- (E) ~~[(F)]~~ express , manipulate, and interpret relationships symbolically to make predictions and solve problems mathematically ~~[, including problems requiring proportional reasoning and graphical vector addition]~~ .
- (5) The student uses the scientific process to investigate physical concepts. The student is expected to:
- (A) demonstrate an understanding that scientific hypotheses are tentative and testable statements that must be capable of being supported by observational evidence;
- (B) demonstrate an understanding that scientific theories are based on physical phenomena and are capable of being tested by multiple independent researchers;
- (C) design and implement investigative procedures;
- (D) demonstrate the appropriate use and care of laboratory equipment;
- (E) demonstrate accurate measurement techniques using precision instruments;
- (F) record data using scientific notation and International System (SI) of units;
- (G) identify and quantify causes and effects of uncertainties in measured data;

- (H) organize and evaluate data, including the use of tables, charts, and graphs;
 - (I) communicate conclusions supported through various methods such as laboratory reports, labeled drawings, graphic organizers, journals, summaries, oral reports, or technology-based reports; and
 - (J) record, express, and manipulate data using graphs, charts, and equations.
- (6) The student demonstrates appropriate safety techniques in the field and laboratory environments. The student is expected to:
- (A) master relevant safety procedures;
 - (B) comply with safety guidelines as described in various manuals, instructions, and regulations;
 - (C) identify and classify hazardous materials and wastes; and
 - (D) make prudent choices in the conservation and use of resources and the appropriate disposal of hazardous materials and wastes.
- (7) The student describes and applies the laws governing motion in a variety of situations. The student is expected to:
- (A) generate and interpret relevant equations using graphs and charts for one- and two-dimensional motion, including:
 - (i) using and describing one-dimensional equations and graphical vector addition for displacement, distance, speed, velocity, average velocity, frames of reference, acceleration, and average acceleration;
 - (ii) using and describing two-dimensional equations for projectile and circular motion; and
 - (iii) using and describing vector forces and resolution; and
 - (B) describe and calculate the effects of forces on objects, including law of inertia and impulse and conservation of momentum , using methods, including free-body force diagrams. [;]
 - ~~[(C) — develop and interpret free body force diagrams; and]~~
 - ~~[(D) — identify and describe motion relative to different frames of reference.]~~
- (8) The student describes 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 the magnitude of gravitational forces between two objects;
 - (C) describe and calculate the magnitude of electric [~~electrical~~] forces;
 - (D) describe the nature and identify everyday examples of magnetic forces and fields;
 - (E) describe the nature and identify everyday examples of electromagnetic forces and fields;
 - (F) characterize materials as conductors or insulators based on their electric [~~electrical~~] properties; and
 - (G) design and construct both series and parallel circuits and calculate current, potential difference, resistance, and power of various circuits . [;]
 - ~~[(H) — investigate and describe the relationship between electric and magnetic fields in applications such as generators, motors, and transformers; and]~~
 - ~~[(I) — describe technological applications of the strong and weak nuclear forces in nature.]~~

- (9) The student describes and applies the laws of the conservation of energy and momentum. The student is expected to:
- (A) describe the transformational process between work, potential energy, and kinetic energy (work-energy theorem);
 - (B) use examples to analyze and calculate the relationships among work, kinetic energy, and potential energy;
 - (C) describe and calculate the mechanical energy of, the power generated within, the impulse applied to, and the momentum of a physical system; and
 - (D) describe and apply the laws of conservation of energy and conservation of momentum.
- (10) The student analyzes the concept of thermal energy. The student is expected to:
- ~~[(A) 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;]~~
- ~~[(B) contrast and give examples of different processes of thermal energy transfer, including conduction, convection, and radiation; and]~~
- ~~[(C) analyze and] explain technological examples such as solar and wind energy that illustrate the four laws of thermodynamics and the processes of thermal energy transfer [; including the law of conservation of energy and the law of entropy] .~~
- (11) The student analyzes the properties of wave motion and optics. 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 period, velocity, frequency, amplitude, and wavelength;
 - (C) investigate and calculate the relationship between wave speed, frequency, and wavelength;
 - (D) compare and contrast the characteristics and behaviors of transverse waves, including electromagnetic waves and the electromagnetic spectrum, and longitudinal waves, including sound waves;
 - (E) investigate behaviors of waves, including reflection, refraction, diffraction, interference, resonance, polarization, and the Doppler effect; and
 - (F) describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens . [~~and~~]
- ~~[(G) describe the role of wave characteristics and behaviors in medical and industrial technology applications.]~~
- (12) The student analyzes the concepts 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 emission spectra produced by various atoms;
 - (C) calculate and describe the applications [significance] of mass-energy equivalence [and apply it in explanations of phenomena such as nuclear stability, fission, and fusion] ;
 - (D) describe the process of radioactive decay given an isotope and half-life;
 - (E) describe the role of mass-energy equivalence for areas such as nuclear stability, fission, and fusion; and
 - (F) explore technology applications of atomic, nuclear, and quantum phenomena using the standard model such as nuclear stability, fission, and fusion, nanotechnology, radiation

therapy, diagnostic imaging, semiconductors, superconductors, solar cells, and nuclear power.