Prepared by the State Board of Education CTE TEKS Work Groups

Final Recommendations, January 2024

These recommendations reflect the final recommendations to the career and technical education (CTE) Texas Essential Knowledge and Skills (TEKS) for the Science, Technology, Engineering, and Mathematics (STEM) Career Cluster that have been recommended by State Board of Education's TEKS work group for the STEM science courses. Proposed additions are shown in green font with underlines (additions). Proposed deletions are shown in red font with strikethroughs (~~deletions~~). Text proposed to be moved from its current student expectation is shown in purple, italicized font with strikethrough (*~~moved text~~*) and is shown in the proposed new location in purple, italicized font with underlines (*new text location*).

Comments identified on the left-hand side link to explanations at the bottom of each page for the work group's proposed recommendations.

FINAL RECOMMENDATIONS, STEM SCIENCE CTE TEKS TABLE OF CONTENTS

§127.795. Applied Physics and Engineering (One Credit), Adopted 2024.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2025-2026 school year.

(b) General requirements. This course is recommended for students in Grades 10-12. Prerequisites: one credit of Algebra I and one ~~two~~ credit~~s~~ of high school science. Corequisite: one credit of high school science. 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.

(c) 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.

Comment[1](2) The Engineering Career Cluster focuses on ~~The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on~~ the planning, designing, testing, building, and maintaining of machines, structures, materials, systems, and processes using empirical evidence and science, technology, and math principles. ~~managing, and providing scientific research and professional and technical services, including laboratory and testing services, and research and development services.~~

(3) In Applied Physics and Engineering ~~Principles of Engineering and Applied Physics~~, students conduct laboratory and field investigations, use scientific and engineering practices during investigations, and make informed decisions using critical thinking and scientific problem solving. Various systems are described in terms of space, time, energy, and matter. Students study a variety of topics that include laws of motion, conservation of energy, momentum, electricity, magnetism, thermodynamics, and characteristics and behavior of waves. Students apply physics concepts and perform laboratory experimentations for at least 40% of instructional time using safe practices.

(4) 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.

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

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

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

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

[1] Paragraph matches the proposed career cluster for Engineering

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

(B) Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models.

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

(8) Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested, while models allow for boundary specification and provide tools for understanding the ideas presented. 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.

(9) Students are encouraged to participate in extended learning experiences such as career and technical student organizations, other leadership or extracurricular organizations, or practical, hands-on activities or experiences through which a learner interacts with industry professionals in a workplace, which may be an in-person, virtual, or simulated setting. Learners prepare for employment or advancement along a career pathway by completing purposeful tasks that develop academic, technical, and employability skills.

(10) 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.

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

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

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

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

(D) use appropriate tools such as ammeters, balances, ballistic carts or equivalent, batteries, calipers, Celsius thermometers, consumable chemicals, collision apparatus, computers and modeling software, constant velocity cars, data acquisition probes and software, discharge tubes with power supply (H, He, Ne, Ar), dynamics and force demonstration equipment, electroscopes, electrostatic generators, electrostatic kits, friction blocks, graphing technology, hand-held visual spectroscopes, hot plates, iron filings, laser pointers, light bulbs, macrometers, magnets, magnetic compasses, mass sets, metric rulers, meter sticks, models and diagrams, motion detectors, multimeters, optics bench, optics kit, optic lenses, pendulums, photogates, plane mirrors, polarized film, prisms, protractors, resistors, ripple tank with wave generators, rope or string, scientific calculators, simple machines, slinky springs, springs, spring scales, standard laboratory glassware, stopwatches, switches, tuning forks, timing devices, trajectory apparatus, voltmeters, wave motion ropes, wires, or other equipment and materials that will produce the same results;

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

Comment[2](F) organize quantitative and qualitative data using notebooks or engineering journals, bar charts, line graphs, scatter plots, data tables, equations, conceptual mathematical relationships, labeled drawings and diagrams, or ~~and~~ graphic organizers such as Venn diagrams;

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

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

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

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

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

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

Comment[3](D) assess and optimize ~~evaluate~~ experimental processes and engineering designs.

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

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

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

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

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

[2] Changed so that students are not required to use all of the methods of organizing data.
[3] Make SE more measurable.

(A) analyze, evaluate, and critique scientific explanations and solutions by using empirical evidence, logical reasoning, and experimental and observational testing so as to encourage critical thinking by the student;

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

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

Comment[4](6) The student thinks critically and creatively to devise a system or process in applying fundamental engineering solutions ~~designs~~ needed for a project to meet desired needs and specifications within constraints. The student is expected to:

Comment[5](A)~~(C)~~ identify an engineering need through collaborative conversation or research; ~~*create, conduct, and communicate the findings of a customer needs assessment in writing and through collaborative conversation; and*~~

Comment[6] (B)~~(A)~~ develop a proposal to execute an engineering solution that includes metrics of performance and constraints such as economics, resources, or safety; ~~apply the design process to multiple solutions or prototypes through the development and initial planning, executing, monitoring and controlling, and evaluating, improving upon and closing a project;~~

Comment[7](C)~~(B)~~ analyze an implemented engineering solution and suggest changes to improve the engineering design or process; ~~use problem-solving techniques to develop technological solutions~~; and

Comment[8]~~(C)~~ ~~*create, conduct, and communicate the findings of a customer needs assessment in writing and through collaborative conversation; and*~~

(D) assess the risks or trade-offs and benefits of a design solution such as accessibility, aesthetics, codes, cost, functionality, ethical considerations, or sustainability.

(7) The student uses the scientific and engineering practices to investigate physical concepts and phenomena. The student is expected to:

Comment[9](A) develop and test ~~scientific and engineering~~ hypotheses that can be ~~are capable of being~~ supported by observational evidence;

comment[10](B) compare scientific concepts such as particle or wave behavior or the law of thermodynamics to describe physical phenomena; ~~theories and apply them appropriately based on physical phenomena such as wave behavior and heat transfer~~;

(C) design procedures to conduct an investigation;

(D) perform accurate measurement techniques using precision instruments and proper techniques;

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

(F) analyze and interpret data using equations, tables, charts, and graphs to reveal potential patterns, trends, and sources of error; and

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[4] Changed the word designs to solutions to build consistency with student expectations
[5] Moved from 6(C) to 6(A) to make the sequence logical and reworded to clarify the meaning
[6] Clarifying the standard, such as is there to support new teachers
[7] Old language was redundant with the newly revised A and B. We clarified and expanded on language in A and B.
[8] Moved from 6(C) to 6(A) to make the sequence logical
[9] Struck because the breakouts for this SE do not need to differentiate between types of hypotheses.
[10] Clarified the language

(G) communicate conclusions supported through various methods such as laboratory reports, labeled drawings, graphic organizers, journals, summaries, oral reports, or technology-based reports.

(8) The student demonstrates appropriate safety techniques in the field and laboratory environments. The student is expected to:

Comment[11](A) locate and use safety guidelines as described in various manuals, instructions, or ~~and~~ regulations;

Comment[12](B) identify~~, classify,~~ hazardous materials and properly dispose of ~~hazardous materials and~~ wastes; and

Comment[13](C) ~~evaluate factors such as cost, recyclability, and disposal when making choices in the conservation and use of resources.~~

(9) 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-dimensional motion;

Comment[14](B) define scalar and vector quantities;

Comment[15](C) use~~using and describing~~ one-dimensional equations ~~and graphical vector addition~~ for displacement, distance, speed, velocity, average velocity, frames of reference, acceleration, and average acceleration;

Comment[16](D) use~~using and describing~~ ~~one-dimensional equations and~~ graphical vector addition for displacement, ~~distance, speed,~~ velocity, average velocity, ~~frames of reference~~, acceleration, and average acceleration within a frame of reference;

(E)(~~C)~~ generate and interpret relevant equations using graphs and charts for two-dimensional motion;

Comment[17](F)(~~D)~~ explain ~~and apply~~ ~~concepts of two-dimensional~~ ~~equations using~~ projectile and circular motion using two-dimensional equations or ~~with~~ vectors and apply the concepts to an investigation such as testing a catapult or carousel;

Comment[18](G)(~~E)~~ explain ~~and apply~~ ~~the concepts of equilibrium and inertia as represented by~~ Newton's first law of motion and apply the concepts of equilibrium and inertia to investigations using relevant real-world examples such as rockets, satellites, and automobile safety devices;

Comment[19](H)(~~F)~~ conduct investigations that include calculations and free body diagrams to observe the effect of forces on objects, including tension, friction, normal force, gravity, centripetal force, and applied force, using ~~free body diagrams and~~ the relationship between force, mass, and acceleration as represented by Newton's second law of motion;

[11] To streamline
[12] To streamline and clarify SE
[13] Removed because it does not address the K&S focus
[14] Split this SE into three
[15] Split one dimensional equations out
[16] Split graphical vector addition out
[17] Separated out the verbs
[18] Clarified meaning of SE
[19] Added language to increase accuracy

(I)(G) conduct or design investigations such as those that involve rockets, tug-of-war, or balloon cars to illustrate and analyze the simultaneous forces between two objects as represented in Newton's third law of motion using free body diagrams;

Comment[20](J)(H) design a model such as one that involves planetary motion based on Newton's law of universal gravitation between two or more objects to determine the relationships between how the magnitude of force between two objects, depends on their masses, and the distance between their centers and predict the effects on objects in linear and orbiting systems using Newton's law of universal gravitation; and

Comment[21](K)(I) apply engineering practices to conservation of momentum and impulse concepts to design, evaluate, and refine a device that uses the concepts of impulse and conservation of momentum to minimize the net force on objects during collisions such as those that occur during vehicular accidents, sports activities, or the dropping of personal electronic devices.

Comment[22](L)(J)describe and calculate the mechanical energy of the power generated within, the impulse applied to, and the momentum of a physical system.

(10) The student describes the nature of forces in the physical world. The student is expected to:

(A) predict how the magnitude of the electric force between two objects depends on their charges and the distance between their centers using Coulomb's law;

(B) build models such as generators, motors, and transformers that show how electric, magnetic, and electromagnetic forces and fields work in everyday life;

(C) test a variety of materials to determine conductive or insulative properties based on their electric properties;

Comment[23](D) use engineering principles to design, evaluate, and refine series and parallel circuits using schematics, digital resources, or and materials such as switches, wires, resistors, lightbulbs, batteries, multimeters, voltmeters, and ammeters; and

Comment[24](E) construct both series and parallel circuits and use Ohm's Law to calculate current, potential difference, resistance, and power of various real-world series and parallel circuits such as models of in-home wiring, automobile wiring, and simple electrical devices.

(11) The student describes and applies the laws of the conservation of energy. The student is expected to:

Comment[25](A) describe the transformations among transformational process between work, potential energy, and kinetic energy using the (work-energy theorem);

Comment[26] (B) analyze and calculate the relationships between work, power, kinetic energy, and potential energy using examples;

Comment[27](C) identify, describe, and give real-world examples of simple machines such as levers, pulleys, wheel and axles, wedges, screws, and inclined planes;

[20] Split into 11(J) and 11(K) to clarify the meaning of the standards
[21] Clarified SE
[22] Deleted – redundant to other SEs
[23] Streamlined SE
[24] Clarified SE
[25] Clarified language
[26] Streamlined SE
[27] Added content to TEKS; Science CCRS I.D.2; Science CCRS V.C.1.a; Science CCRS VIII.D.1.a; Science CCRS VIII.D.1.b; Science CCRS VIII.D.2.a

Comment[28](D) calculate mechanical advantage of simple machines; and

Comment[29] (E)~~(C)~~ ~~describe and~~ apply the laws of conservation of energy to a physical system using simple machines such as a Rube Goldberg machine.

(12) The student analyzes the concept of thermal energy. The student is expected to:

(A) explain the laws of thermodynamics and how they relate to systems such as engines, heat pumps, refrigeration, solar, and heating and air conditioning;

(B) investigate and demonstrate the movement of thermal energy through various states of matter by convection, conduction, and radiation through environmental and man-made systems; and

Comment[30](C) ~~apply engineering principles to~~ design, construct, and test a device or system that either minimizes or maximizes thermal energy consumption and perform a cost-benefit analysis such as comparing materials and energy sources that are renewable and nonrenewable.

(13) The student analyzes the properties of wave motion and optics. The student is expected to:

(A) examine and describe oscillatory motion using pendulums 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;

Comment[31](D) compare the characteristics and behaviors of transverse waves to longitudinal waves, including electromagnetic waves and ~~the electromagnetic spectrum, and longitudinal waves, including~~ sound waves;

Comment[32](E) describe how the differences in wavelength and frequency within the electromagnetic spectrum impact real-world technologies such as radio, x-rays, and microwaves;

(F)~~(E)~~ investigate and explain behaviors of waves, including reflection, refraction, diffraction, interference, resonance, polarization, and the Doppler effect; and

(G)~~(F)~~ describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens.

[28] Added content to TEKS; Science CCRS I.D.2; Science CCRS II.A.6.f; Science CCRS VIII.D.1.a; Science CCRS VIII.D.1.b; Science CCRS VIII.D.2.a
[29] Streamlined SE; Science CCRS I.D.2; Science CCRS VIII.D.1.a; Science CCRS VIII.D.1.b; Science CCRS VIII.D.2.a
[30] Streamlined SE
[31] Clarified SE and separated out EM Spectrum
[32] Highlighted practical applications of EM Spectrum

This document reflects the CTE TEKS work group final recommendations as of January 2024.

§127.796. Scientific Research and Design (One Credit), Adopted 2024.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2025-2026 school year.

(b) General requirements. This course is recommended for students in Grades 11 and 12. Prerequisite: Biology, and one credit of the following: Applied Physics and Engineering, Chemistry, Integrated Physics and Chemistry (IPC), or Physics. 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. Students may take this course with different course content for a maximum of three credits.

(c) 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.

Comment[1](2) The Engineering Career Cluster focuses on ~~The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on~~ the planning, designing, testing, building, and maintaining of machines, structures, materials, systems, and processes using empirical evidence and science, technology, and math principles. ~~managing, and providing scientific research and professional and technical services, including laboratory and testing services, and research and development services.~~

Comment[2](3) Scientific Research and Design is ~~a broad-based course~~ designed to allow districts and schools flexibility to develop local curriculum to supplement a program of study or coherent sequence. The course has the components of any rigorous scientific or career and technical education (CTE) program of study, including ~~from~~ problem identification, investigation design, data collection, data analysis, formulation, and presentation of conclusions. These ~~All of these~~ components are integrated with the CTE emphasis of helping students gain entry-level employment in high-skill, high-wage jobs and/or continue their education.

(4) 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.

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

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

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

(6) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are

[1] Paragraph matches the proposed career cluster for Engineering
[2] Tightened up language

manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified.

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

(B) Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models.

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

(8) Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested, while models allow for boundary specification and provide tools for understanding the ideas presented. 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.

(9) Students are encouraged to participate in extended learning experiences such as career and technical student organizations, other leadership or extracurricular organizations, or practical, hands-on activities or experiences through which a learner interacts with industry professionals in a workplace, which may be an in-person, virtual, or simulated setting. Learners prepare for employment or advancement along a career pathway by completing purposeful tasks that develop academic, technical, and employability skills.

(10) 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.

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

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

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

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

Comment[3](D) use appropriate tools such as measurement and data collection tools, software, sensors, probes, microscopes, cameras, and glassware~~, etc.~~;

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

(F) organize quantitative and qualitative data using notebooks, journals, graphs, charts, tables, spreadsheets, and drawings and models;

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

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

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

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

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

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

(D) evaluate experimental and engineering designs.

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

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

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

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

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

(A) analyze, evaluate, and critique scientific explanations and solutions by using empirical evidence, logical reasoning, and experimental and observational testing so as to encourage critical thinking by the student;

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

Comment[4](C) research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors ~~employed in a STEM field in order~~ to investigate STEM careers.

(6) The student develops a proposal that centers around a scientific or engineering topic or~~,~~ problem~~, or area of interest~~ within a specific program of study or area of interest. The student is expected to:

[3] Cleaned up grammar
[4] Changed to address focus

Comment[5](A) ~~brainstorm current and past events to~~ establish a rationale and preliminary set of ideas for a research question or questions using organizational tools, collaboration, or research;

(B) perform a literature review and evaluate several examples related to the project;

Comment[6](C) refine a research question by interacting ~~and collaborate~~ with professionals in the field of study ~~such as scientific researchers and other industry professionals~~ and document the conversation;

(D) distinguish between descriptive, comparative, or experimental research design methodologies;

(E) develop a research question or questions that are testable and measurable;

(F) justify in writing the significance and feasibility of the project;

(G) generate a materials list and propose a cost analysis; and

Comment[7](H) use the citation style appropriate to the field of study ~~American Psychological Association (APA) style~~ throughout the documentation.

Comment[8](7) The student formulates hypotheses to guide experimentation and data collection independently or in a team that centers around a scientific or engineering topic or problem within a specific program of study or area of interest. The student is expected to:

(A) perform background research on the selected investigative problem;

(B) examine hypotheses generated to guide a research process by evaluating the merits and feasibility of the hypotheses; and

Comment[9](C) *identify the control, independent variable, and dependent variable within the research and justify the purpose of each*.~~;~~

~~identify within the project the dependent and independent variables.~~

Comment[10] (8) The student develops, implements, and collects data for their investigative designs that centers around a scientific or engineering topic or problem within a specific program of study or area of interest. The student is expected to:

comment[11](A) ~~*identify the control, independent variable, and dependent variable within the research and justify the purpose of each;*~~

(A)~~(B)~~ write the procedure of the experimental design including ~~with~~ a schematic of the lab, materials, set up, ethical considerations, and safety protocols;

Comment[12](B)~~(C)~~ conduct the experiment with the independent and dependent variables ~~in place~~;

Comment[13](C)~~(E)~~ *acquire data using appropriate equipment and technology*~~, following the rules of significant digits.~~;and

[5] Clarified SE
[6] Improved observability and measurability
[7] Revised to provide flexibility
[8] Making all K&S after SEPs consistent
[9] Moved from 8.A (original 7.C deleted due to redundancy)
[10] Making all K&S after SEPs consistent
[11] Moved to 7.C
[12] Streamlining language
[13] Moved from original 8(E) to 8(C) for sequencing

Comment[14](D) record observations as they occur within an investigation, including qualitative and quantitative observations such as journals, photographic evidence, logs, and tables, and charts.; and

~~(E) acquire data using appropriate equipment and technology, following the rules of significant digits.~~

Comment[15] (9) The student organizes and evaluates qualitative and quantitative data obtained through experimentation that centers around a scientific or engineering topic or problem within a specific program of study or area of interest. The student is expected to:

(A) manipulate *data by constructing charts, data tables, or graphs using technology to organize information collected in an experiment* ~~and analyze data using appropriate equipment and technology, following the rules of significant digits~~;

Comment[16]~~(B) construct charts, data tables, and graphs using technology to organize information collected in an experiment~~;

(B)~~(C)~~ identify sources of random error and systematic error and differentiate between both types of error;

Comment[17] (C)~~(D)~~ report error of a set of measured data in various formats, such as ~~including~~ standard deviation and percent error; and

Comment[18] (D)~~(E)~~ analyze ~~evaluate~~ data using statistical methods to recognize patterns, trends, and proportional relationships.

Comment[19] (10) The student knows how to synthesize valid conclusions from qualitative and quantitative data that centers around a scientific or engineering topic or problem within a specific program of study or area of interest. The student is expected to:

Comment[20](A) justify conclusions that are supported by research data;

(B) consider and summarize alternative explanations for observations and results; and

(C) identify limitations within the research process and provide recommendations for additional research.

Comment[21] (11) The student communicates conclusions clearly and concisely to an audience of professionals that centers around a scientific or engineering topic or problem within a specific program of study or area of interest. The student is expected to:

Comment[22]~~(A) construct charts, tables, and graphs using technology in order to facilitate data analysis and communicate experimental results clearly and effectively, including oral presentation of original findings of a research project, to an audience of peers and professionals;~~

Comment[23] (A)~~(D)~~ *develop a plan of action on how to present to a target audience;*

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[14] Responded to ESC feedback, maintained such as because the examples are illustrative for new teachers
[15] Making all K&S after SEPs consistent
[16] Added language to increase specificity and incorporated into 9(A)
[17] Responding to staff feedback, used "such as" because not every project requires percent error and standard deviation
[18] Responding to staff feedback
[19] Making all K&S after SEPs consistent
[20] Clarified SE
[21] Making all K&S after SEPs consistent
[22] Removed the first part due to redundance and moved the second part to 11.F
[23] Moved from 11(D) to be 11(A), the first SE of a sequence in this K&S

Comment[24] (B)~~(F)~~ *review artifacts used in the communication of the presentation for errors, grammar professional standards, and citations.*

Comment[25](C) develop a professional collection or portfolio of work that includes artifacts such as a journal, ~~the~~ proposal, written procedures, methodology, iterations, interviews and check ins with professionals, changes within the experiment, and photographic evidence;

Comment[26](D)~~(E)~~ *practice a professional presentation with peers and* ~~other~~ *educators using a rubric to measure content, skill, and performance*; ~~and~~

Comment[27](E)~~(B)~~ incorporate feedback ~~suggest alternative explanations from observations or trends evident within the data or from prompts~~ *provided by a review panel* to document for future improvements or changes;

Comment[28] *(F) communicate* data analysis and *experimental results* ~~clearly and effectively, including oral presentation~~ *of original findings of a research project* clearly~~,~~ *to an audience of* ~~peers and~~ *professionals*;

Comment[29]~~(B)~~ ~~*suggest alternative explanations from observations or trends evident within the data or from prompts provided by a review panel*~~;

Comment[30]~~(D)~~ ~~*develop a plan of action on how to present to a target audience;*~~

Comment[31]~~(E)~~ ~~*practice a professional presentation with peers and other educators using a rubric to measure content, skill, and performance; and*~~

Comment[32]~~(F)~~ ~~*review artifacts used in the communication of the presentation for errors, grammar professional standards, and citations.*~~

[24] Moved from 11(F) to be 11(B), the second SE of a sequence in this K&S
[25] Responded to ESC feedback and maintained "such as" because the examples are illustrative for new teachers
[26] Moved from 11(E) to 11(D) for sequencing and clarified SE language
[27] Moved from 11(B) to 11(E) for sequencing and clarified SE language
[28] Moved the second half from 11(A) to 11(F) for sequencing and clarified language, removed peers because the K&S specifies presenting to professionals
[29] Moved from 11(B) to 11(E) for sequencing
[30] Moved from 11(D) to be 11(A), the first SE of a sequence in this K&S
[31] Moved from 11(E) to 11(D) for sequencing
[32] Moved from 11(F) to be 11(B), the second SE of a sequence in this K&S