The State Board of Education (SBOE) adopts new §§112.41-112.45, concerning Texas Essential Knowledge and Skills (TEKS) for science. New §112.41 is adopted without changes to the proposed text as published in the October 9, 2020 issue of the *Texas Register* (45 TexReg 7125) and will not be republished. New §§112.42-112.45 are adopted with changes to the proposed text as published in the October 9, 2020 issue of the *Texas Register* (45 TexReg 7125) and will be republished. The new sections provide updated standards for Biology, Chemistry, Physics, and Integrated Physics and Chemistry to ensure they remain current.

REASONED JUSTIFICATION: In accordance with statutory requirements that the SBOE by rule identify the essential knowledge and skills of each subject in the required curriculum, the SBOE follows a board-approved cycle to review and revise the essential knowledge and skills for each subject.

At the September 2019 meeting, SBOE members were asked to designate content advisors for the review and revision of the science TEKS. In December 2019, applications to serve on science TEKS review work groups were posted on the Texas Education Agency (TEA) website. Additionally in December 2019, TEA distributed a survey to collect information from educators regarding the review and revision of the science TEKS. TEA staff provided applications for the science review work groups to SBOE members on a monthly basis from December 2019 to June 2020. At the January 2020 SBOE meeting, the SBOE provided specific guidance for the TEKS review work groups.

Also in January 2020, science TEKS review content advisors met in a face-to-face meeting to develop consensus recommendations regarding revisions to the science TEKS to share with future work groups. At that time, the content advisors met with representatives from Work Group A to discuss the consensus recommendations. Work Group A convened in February 2020 to review survey results, content advisor consensus recommendations, and the SBOE's guidance to work groups to develop recommendations for how science TEKS review work groups can address these areas. Work Group B was convened virtually in June and July 2020 to develop recommendations for four high school science courses: Biology, Chemistry, Physics, and Integrated Physics and Chemistry. Additionally, in July 2020, members from Work Group B met with Work Group C to discuss vertical alignment of the high school and middle school TEKS. Work Group C continued to meet virtually in August, September, and October 2020.

The new sections introduce revised standards for Biology, Chemistry, Physics, and Integrated Physics and Chemistry as well as related implementation language. The revised standards ensure that the requirements for these courses remain current. The new sections will be implemented beginning with the 2023-2024 school year.

At adoption, the following changes were made.

The student expectation in §112.42(c)(4)(C) was amended by replacing the phrase "connections between grade level appropriate concepts and" with the phrase "resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a" and by inserting the phrase "field in order to investigate STEM" before the word "careers."

The student expectation in §112.42(c)(6)(A) was amended by inserting the phrase "an overview of the" before the phrase "stages of the cell cycle."

The student expectation in §112.42(c)(7)(D) was amended by replacing the phrase "describe the function" with the phrase "discuss the importance."

The student expectation in §112.42(c)(10)(D) was amended by inserting the phrase "and their effect" before the phrase "on the gene pool."

The student expectation in §112.42(c)(11)(A) was amended by inserting the word "the" before the phrase "chemical equations" and by inserting the phrase "for these processes" after the phrase "chemical equations."

The student expectation in §112.42(c)(11)(B) was amended by deleting the phrase "identify and" and by inserting the phrase "and explain" after the word "investigate."

The student expectation in §112.42(c)(12)(B) was amended by inserting the phrase "interactions that occur among systems that perform" before the word "functions."

The student expectation in §112.43(c)(4)(C) was amended by replacing the phrase "connections between grade level appropriate concepts and" with the phrase "resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a" and by inserting the phrase "field in order to investigate STEM" before the word "careers."

The student expectation in §112.43(c)(11)(C) was amended by replacing the phrase "factors that influence" with the word "how," replacing the phrase "such as" after the phrase "gas solubilities" with the phrase "are influenced by," by inserting the word "how" before the phrase "rates of dissolution," and by replacing the phrase "such as" after the phrase "rates of dissolution" with the phrase "are influenced by."

The student expectation in §112.43(c)(11)(D) was amended by inserting the phrase "the solubility of" after the word "predict."

The student expectation in §112.44(c)(4)(C) was amended by replacing the phrase "connections between grade level appropriate concepts and" with the phrase "resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a" and by inserting the phrase "field in order to investigate STEM" before the word "careers."

The student expectation in §112.45(c)(4)(C) was amended by replacing the phrase "connections between grade level appropriate concepts and" with the phrase "resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a" and by inserting the phrase "field in order to investigate STEM" before the word "careers."

The student expectation in §112.45(c)(6)(C) was amended by replacing the word "der" with the word "de" in the phrase "Van de Graaf generators."

The student expectation in §112.45(c)(8)(A) was amended by inserting the phrase "masses on" before the phrase "springs and pendulums" and inserting the phrase "pulses in" before the word "ropes."

The SBOE approved the proposed new sections for first reading and filing authorization at its September 11, 2020 meeting and for second reading and final adoption at its November 20, 2020 meeting.

In accordance with TEC, §7.102(f), the SBOE approved the new sections for adoption by a vote of two-thirds of its members to specify an effective date earlier than the beginning of the 2021-2022 school year. The earlier effective date will enable districts to begin preparing for implementation of the revised high school science TEKS. The effective date is 20 days after filing as adopted with the *Texas Register*.

SUMMARY OF COMMENTS AND RESPONSES: The public comment period on the proposal began October 9, 2020, and ended November 13, 2020. The SBOE also provided an opportunity for registered oral and written comments at its November 2020 meeting in accordance with the SBOE board operating policies and procedures. Following is a summary of the public comments received and corresponding responses.

Comment. A teacher expressed concern that the additional high school science courses have not yet been included in the TEKS review process.

Response. The SBOE provides the following clarification. The current TEKS for additional high school science courses will be revised on a different timeline and are expected to be adopted in 2021.

Comment. A teacher indicated that the majority of science credits earned by students are in career and technical education (CTE) courses because many of the current science courses no longer meet the needs of the student demographic. The commenter recommended adding independent research and special topics courses for science similar to courses offered in social studies.

Response. This comment is outside the scope of the proposed rulemaking.

Comment. A representative from an institution of higher education suggested that student expectations with the word "including" be considered for State of Texas Assessments of Academic Readiness (STAAR®) items whereas student expectations with "such as" not be considered for STAAR® items.

Response. This comment is outside the scope of the proposed rulemaking.

Comment. Six teachers and five administrators recommended replacing the verb "relate" with the verb "identify" in the proposed student expectation in §112.42(c)(5)(A). The commenters stated that the verb "relate" may result in very complex assessments that are not grade-level appropriate and would result in more time spent teaching this concept.

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in §112.42(c)(5)(A) is appropriate as proposed.

Comment. An administrator and 10 instructional coaches recommended including enzymes as a type of biomolecule in the proposed student expectation in §112.42(c)(5)(A) to read, "including carbohydrates, lipids, proteins (including enzymes), and nucleic acids."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in §112.42(c)(5)(A) is appropriate as proposed.

Comment. A teacher recommended adding the term "endosymbiont theory" to the proposed student expectation in §112.42(c)(5)(B) for specificity.

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in §112.42(c)(5)(B) is appropriate as proposed.

Comment. An administrator and 10 instructional coaches stated that proposed §112.42(c)(5)(B) is wordy and should be split into two parts. The commenters recommended revising §112.42(5)(B) to read, "compare and contrast prokaryotic and eukaryotic cells, including their complexity" and a new §112.42(5)(C) should be added to read, "evaluate endosymbiotic theory as an explanation for cellular complexity."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in §112.42(c)(5)(B) is appropriately worded as proposed.

Comment. A teacher recommended adding more specificity to the proposed student expectation in §112.42(c)(5)(C) about the types of cellular transport and how they relate to homeostasis.

Response. The SBOE disagrees that the suggested change is necessary and has determined that the level of specificity in the student expectation in §112.42(c)(5)(C) is appropriate as proposed.

Comment. A teacher expressed concern about the removal of viral reproduction from the proposed student expectation in §112.42(c)(5)(D). The commenter stated that viral reproduction helps explain how viruses spread.

Response. The SBOE disagrees and has determined that the student expectation in §112.42(c)(5)(D) is appropriate as proposed.

Comment. An administrator and 10 instructional coaches recommended the deletion of the proposed student expectation in §112.42(c)(6)(A) because, as written, the student expectation will lead to the memorization of the cell cycle which adds nothing to student understanding of this knowledge and skills statement.

Response. The SBOE disagrees with the recommendation to delete the student expectation in §112.42(c)(6)(A). However, in response to this and other comments, the SBOE took action to amend the student expectation in §112.42(c)(6)(A) to read, "explain the importance of the cell cycle to the growth of organisms, including an overview of the stages of the cell cycle and deoxyribonucleic acid (DNA) replication models."

Comment. Two teachers and two community members expressed concern regarding the insertion at first reading of the phrase "stages of the cell cycle" in the proposed student expectation in §112.42(c)(6)(A) because the stages are rote facts and no rigor is added by memorizing them. The commenters recommended reverting back to the language proposed by the work group to read, "explain the importance of the cell cycle to the growth of organisms, including DNA replication using models."

Response. The SBOE disagrees with the suggested change and has determined that amendment to the student expectation in §112.42(c)(6)(A) at first reading was appropriate. In response to other comments, however, the SBOE took action to amend the student expectation in §112.42(c)(6)(A) to read, "explain the importance of the cell cycle to the growth of organisms, including an overview of the stages of the cell cycle and deoxyribonucleic acid (DNA) replication models."

Comment. A teacher recommended revising the proposed student expectation in §112.42(c)(6)(A) to read, "explain the importance of the cell cycle to the growth of organisms, including stages of the cell cycle and the steps and significance of deoxyribonucleic acid (DNA) replication in the cell cycle." The commenter stated that the significance of DNA replication could be revisited in other processes including protein synthesis and mutations and viral replication.

Response. The SBOE disagrees with the suggested rewording. In response to other comments, however, the SBOE took action to amend the student expectation in §112.42(c)(6)(A) to read, "explain the importance of the cell cycle to the growth of organisms, including an overview of the stages of the cell cycle and deoxyribonucleic acid (DNA) replication models."

Comment. A teacher stated that the student expectations in §112.34(c)(6)(B) and (C) from the current Biology course should be included in the proposed new Biology TEKS because they are essential to understanding how organisms could have evolved from one another.

Response. The SBOE disagrees that §112.34(c)(6)(B) and (C) from the current Biology course are essential and has determined that they were appropriately eliminated from the TEKS. The SBOE also provides the following clarification. The concepts of transcription and translation, which are currently addressed in §112.34(c)(6)(C) have been incorporated into the new proposed student expectation in §112.45(c)(7)(A).

Comment. A teacher recommended adding gene expression to the proposed student expectation in §112.42(c)(6)(B).

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.42(c)(6)(B) is appropriate as proposed.

Comment. Six teachers and five administrators expressed concern regarding the proposed student expectation in §112.42(c)(6)(B). The commenters stated that focusing on process and environmental factors is beyond the scope of a freshman biology course and would require excessive time to teach. The commenters recommended revising the student expectation to read, "explain the importance of cell specialization and cell differentiation in multicellular organisms."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.42(c)(6)(B) is appropriate for a high school biology course as proposed.

Comment. Six teachers and five administrators expressed concern that the wording in the proposed student expectation in §112.42(c)(7)(A) may lead to the misconception that sugar and phosphate are relevant to the coding of genes. The commenters recommended revising the student expectation to read, "explain how the DNA structure, specifically the nitrogen base sequence, determines some traits of an organism, and examine scientific explanations for the origin of DNA."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.42(c)(7)(A) is appropriately clear as proposed.

Comment. A teacher recommended including in the proposed student expectation in §112.42(c)(7)(A) a specific experiment related to the origin of DNA such as Miller Urey.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.42(c)(7)(A) is appropriate as proposed.

Comment. An individual from out of state stated that explanations for the origin of DNA in the proposed student expectation in §112.42(c)(7)(A) should include both materialistic and teleological hypotheses. The commenter explained that there is nothing in the proposed TEKS regarding an explanation for the origin of life, which is an important topic and should not be ignored.

Response. The SBOE disagrees and has determined that the student expectation in §112.42(c)(7)(A) appropriately provides opportunities for students to examine a variety of scientific explanations of the origin of DNA.

Comment. A teacher recommended connecting the proposed student expectation in §112.42(c)(7)(B) to gene expression.

Response. The SBOE disagrees and has determined that gene expression is already appropriately addressed in §112.42(c)(7)(B) as proposed.

Comment. Six teachers and five administrators recommended that the proposed student expectation in §112.42(c)(7)(B) be revised for clarity to read, "use models to explain protein synthesis and the significance of gene expression."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in §112.42(c)(7)(B) is sufficiently clear as proposed.

Comment. A teacher recommended reinstating in the proposed student expectation in §112.42(c)(7)(D) the topic of biotechnology, which was removed when Biology was streamlined in 2017.

Response. The SBOE disagrees that reinserting biotechnology in Biology is necessary. However, in response to other comments the SBOE took action to amend §112.42(c)(7)(D) to read, "discuss the importance of molecular technologies such as polymerase chain reaction (PCR), gel electrophoresis, and genetic engineering that are applicable in current research and engineering practices."

Comment. A teacher recommended that the SBOE reinstate the term "gene modification" in proposed new §112.42(c)(7)(D).

Response. The SBOE disagrees that the suggested change is necessary. However, in response to other comments the SBOE took action to amend §112.42(c)(7)(D) to read, "discuss the importance of molecular technologies such as polymerase chain reaction (PCR), gel electrophoresis, and genetic engineering that are applicable in current research and engineering practices."

Comment. A teacher expressed concern regarding potential funding issues to implement the proposed student expectations in §112.42(c)(1)(D) and (7)(D) due to tools such as gel electrophoresis and polymerase chain reaction (PCR) apparatuses, microcentrifuges, water baths, and incubators that are listed.

Response. This comment is outside the scope of the proposed rulemaking.

Comment. A teacher expressed support for the proposed student expectation in §112.42(c)(7)(D) related to genetic engineering.

Response. The SBOE agrees. In response to other comments the SBOE took action to amend §112.42(c)(7)(D) to read, "discuss the importance of molecular technologies such as polymerase chain reaction (PCR), gel electrophoresis, and genetic engineering that are applicable in current research and engineering practices."

Comment. An administrator and 10 instructional coaches expressed concern regarding changes made at first reading to the proposed student expectation in §112.42(c)(7)(D). The commenters stated that "describe the function" is very low rigor and recommended replacing it with the phrase "discuss the importance" to read, "discuss the importance of molecular technologies such as polymerase chain reaction (PCR), gel electrophoresis, and genetic engineering that are applicable in current research and engineering practices."

Response. The SBOE agrees and took action to amend §112.42(c)(7)(D) to read, "discuss the importance of molecular technologies such as polymerase chain reaction (PCR), gel electrophoresis, and genetic engineering that are applicable in current research and engineering practices."

Comment. A teacher recommended that the proposed student expectation in §112.42(c)(7)(D) be moved to the scientific and engineering practices student expectations.

Response. The SBOE disagrees and has determined that the student expectation in §112.42(c)(7)(D) is appropriately placed. In response to other comments, however, the SBOE took action to amend the student expectation to read, "discuss the importance of molecular technologies such as polymerase chain reaction (PCR), gel electrophoresis, and genetic engineering that are applicable in current research and engineering practices."

Comment. Three teachers recommended replacing the phrase "describe the significance of genetic engineering" in the proposed student expectation in §112.42(c)(7)(D) with "explain the effects of genetic modification."

Response. The SBOE disagrees with the suggested change. However, in response to other comments the SBOE took action to amend the student expectation in §112.42(c)(7)(D) to read, "discuss the importance of molecular technologies such as polymerase chain reaction (PCR), gel electrophoresis, and genetic engineering that are applicable in current research and engineering practices."

Comment. Six teachers and five administrators recommended replacing the word "function" with the word "purpose" in the proposed student expectation in §112.42(c)(7)(D).

Response. The SBOE agrees that the word "function" should be replaced but disagrees with the suggested replacement. In response to other comments the SBOE took action to replace the phrase "describe the function" with the phrase "discuss the importance" in the student expectation in §112.42(c)(7)(D).

Comment. A teacher recommended merging the student expectations under the proposed knowledge and skills statements in §112.42(c)(7) and (8).

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.42(c)(7) and (8) are appropriate as separate knowledge and skills statements.

Comment. An administrator and 10 instructional coaches expressed concern regarding changes made to the proposed student expectation in §112.42(c)(8)(B). The commenters explained that including dihybrid crosses does not increase the rigor of the student expectation because dihybrid crosses are very algorithmic and can be taught absent of biology. The commenters recommended reverting to the student expectation as originally proposed at first reading to read, "predict possible outcomes of various genetic combinations including monohybrid crosses, incomplete dominance, codominance, sex-linked traits, and multiple alleles."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.42(c)(8)(B) is appropriate as proposed.

Comment. Three teachers recommended removing dihybrid genetics problems from the proposed student expectation in §112.42(c)(8)(B). The commenters explained that the concept requires too much time to master.

Response. The SBOE disagrees and has determined that dihybrid genetics problems are appropriately included in the student expectation in §112.42(c)(8)(B).

Comment. Four teachers, five administrators, and four community members expressed concern regarding the inclusion of "dihybrid crosses" and "non-Mendelian" in the proposed student expectation in §112.42(c)(8)(B). The commenters recommended reverting back to the language originally proposed by the work group.

Response. The SBOE disagrees and has determined that the terms "dihybrid crosses" and "non-Mendelian" are appropriately included in the student expectation in §112.42(c)(8)(B).

Comment. A teacher proposed adding the analysis of graphs to the proposed student expectation in §112.42(c)(9)(B) for more specificity.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.42(c)(9)(B) is appropriate as proposed.

Comment. An administrator and 10 instructional coaches expressed concern regarding the proposed student expectation in §112.42(c)(9)(B). The commenters recommended reverting to the student expectation as written by the work group because it specifies what students are expected to examine.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.42(c)(9)(B) is appropriate as proposed.

Comment. An individual from out of state stated that proposed student expectations related to biological evolution in §112.42(c)(10)(A)-(D) deal with microevolution (small scale change within a species). The commenter added that mutation/natural selection mechanism applies to microevolution, not macroevolution (large scale change with new body parts and plans). The commenter recommended that the possible role of intentional design (teleology) should be included.

Response. The SBOE disagrees and has determined that speciation is appropriately addressed in the student expectations in §112.42(c)(10)(A)-(D) as proposed.

Comment. A teacher expressed concern regarding the choice of verbs in the proposed student expectations in §112.42(c)(10)(A)-(D). The commenter explained that a lower level of Bloom's taxonomy is more appropriate because Biology is the first time students are exposed to evolution concepts at this level of detail.

Response. The SBOE disagrees that the suggested change is necessary and has determined that the choice of verbs in the student expectations in §112.42(c)(10)(A)-(D) is appropriate as proposed. In response to other comments, however, the SBOE took action to amend §112.42(c)(10)(D) to read, "analyze evolutionary mechanisms other than natural selection, including genetic drift, gene flow, mutation, and genetic recombination, and their effect on the gene pool of a population."

Comment. Five administrators, ten teachers, and two community members expressed concern regarding the grade-level appropriateness of the verbs "analyze and evaluate" in the proposed student expectation in §112.42(c)(10)(A) because analyzing and evaluating natural selection requires extensive background knowledge. The commenters recommended reverting back to the verb "explain."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the verbs in the student expectation in §112.42(c)(10)(A) are appropriate as proposed.

Comment. Five administrators, thirteen teachers, and two community members expressed concern regarding the grade-level appropriateness of the verbs "analyze and evaluate" in the proposed student expectation in §112.42(c)(10)(B) because analyzing and evaluating natural selection requires extensive background knowledge. The commenters recommended reverting back to the verbs "explain and analyze."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the verbs in the student expectation in §112.42(c)(10)(B) are appropriate as proposed.

Comment. An administrator and 10 instructional coaches expressed concern that changes at first reading to the proposed student expectation in §112.42(c)(10)(A), (B), and (D) were not reviewed by the work group. The commenters recommended reverting back to the wording proposed by the work group.

Response. The SBOE disagrees with the recommendation and has determined that the student expectations in §112.42(c)(10)(A), (B), and (D) are appropriate as proposed. However, in response to other comments the SBOE took action to amend §112.42(c)(10)(D) to read, "analyze evolutionary mechanisms other than natural selection, including genetic drift, gene flow, mutation, and genetic recombination, and their effect on the gene pool of a population."

Comment. Six teachers and five administrators expressed concern that the proposed student expectation in §112.42(c)(10)(D) is not developmentally appropriate for the typical high school freshman or in a first biology course because it requires too much prior knowledge and excessive time to teach. The commenters recommended deleting the student expectation.

Response. The SBOE disagrees that §112.42(c)(10)(D) should be deleted. However, in response to other comments the SBOE took action to amend §112.42(c)(10)(D) to read, "analyze evolutionary mechanisms other than natural selection, including genetic drift, gene flow, mutation, and genetic recombination, and their effect on the gene pool of a population."

Comment. A teacher recommended the inclusion of the carbon cycle in the proposed student expectation in §112.42(c)(11)(A).

Response. The SBOE disagrees that the suggested change is necessary. In response to other comments, however, the SBOE took action to amend §112.42(c)(11)(A) to read, "explain how matter is conserved and energy is transferred during photosynthesis and cellular respiration using models, including the chemical equations for these processes."

Comment. An administrator and 10 instructional coaches expressed concern regarding the proposed student expectation in §112.42(c)(11)(A) and recommended editing the student expectation to read, "explain how matter is conserved and energy is transferred during photosynthesis and cellular respiration using models."

Response. The SBOE disagrees that the suggested change is necessary. In response to this and other comments, however, the SBOE took action to amend §112.42(c)(11)(A) to read, "explain how matter is conserved and energy is transferred during photosynthesis and cellular respiration using models, including the chemical equations for these processes."

Comment. A teacher recommended listing specific cellular processes such as DNA replication and cell cycle to make a connection to cell processes addressed in the proposed student expectation in §112.42(c)(11)(B).

Response. The SBOE disagrees that the suggested change is necessary. In response to other comments, however, the SBOE took action to amend §112.42(c)(11)(B) to read, "investigate and explain the role of enzymes in facilitating cellular processes."

Comment. A teacher recommended that enzymes may fit better under DNA and protein synthesis than in the student expectation in §112.42(c)(11)(B) regarding cellular processes.

Response. The SBOE disagrees that the suggested change is necessary and has determined that enzymes are appropriately included in the student expectation in §112.42(c)(11)(B) as proposed.

Comment. An administrator, ten instructional coaches, two teachers, and two community members expressed concern that changes made at first reading to the verbs in the proposed student expectation in §112.42(c)(11)(B) decrease the rigor of the student expectation. The commenters suggest reverting back to the verbs "investigate and explain."

Response. The SBOE agrees and took action to amend §112.42(c)(11)(B) to read, "investigate and explain the role of enzymes in facilitating cellular processes."

Comment. An administrator and 10 instructional coaches expressed concern that the cognitive level expected for the proposed student expectation in §112.42(c)(12)(A), related to animals, is much higher than the proposed student expectation in §112.42(c)(12)(B), related to plants, and seems to imply that plants are not important. The commenters recommended revising §112.42(c)(12)(B) to read, "analyze the interactions that occur among systems that perform the functions of transport, reproduction, and response in plants that are facilitated by their structures."

Response. The SBOE disagrees and has determined that §112.42(c)(12)(A) and (B) give equal importance to plants and animals. However, in response to other comments the SBOE took action to amend §112.42(c)(12)(B) to read, "explain how the interactions that occur among systems that perform functions of transport, reproduction, and response in plants are facilitated by their structures."

Comment. Six teachers and five administrators expressed concern regarding the clarity of the proposed student expectation in §112.42(c)(12)(B). The commenters recommended revising the student expectation to read, "explain how the structures in plants facilitate the functions of transport, reproduction, and response."

Response. The SBOE disagrees that the suggested change is necessary. However, in response to other comments the SBOE took action to amend §112.42(c)(12)(B) to read, "explain how the interactions that occur among systems that perform functions of transport, reproduction, and response in plants are facilitated by their structures."

Comment. Three teachers recommended changing the verbs in the proposed student expectation in §112.42(c)(13)(A) from "investigate and evaluate" to "analyze."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the verbs in §112.42(c)(13)(A) are appropriate as proposed.

Comment. Six teachers and five administrators expressed concern regarding the verbs "investigate and evaluate" in the proposed student expectation in §112.42(c)(13)(A). The commenters explained that it is dangerous to "investigate" predatory, parasitic, competitive, and symbiotic relationships and People for the Ethical Treatment of Animals (PETA) would find it unacceptable to engage in these investigations. The commenters recommended substituting the verb "explain."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the verbs in the student expectation in §112.42(c)(13)(A) are appropriate as proposed.

Comment. Six teachers and five administrators expressed concern regarding the clarity of the proposed student expectations in §112.42(c)(13)(B) and (C). The commenters recommended deleting the student expectation in §112.42(c)(13)(C) and revising the student expectation in §112.42(c)(13)(B) to read, "use models to analyze ecosystem stability and the effects of disruptions in cycling of matter (including nitrogen and carbon) and flow of energy."

Response. The SBOE disagrees that the suggested changes are necessary and has determined that the student expectations in §112.42(c)(13)(B) and (C) are sufficiently clear as proposed.

Comment. A teacher recommended specifying the models students should use such as food webs, food chains, and food pyramids in the proposed student expectation in §112.42(c)(13)(B).

Response. The SBOE disagrees that the suggested examples of models are necessary and has determined that the student expectation in §112.42(c)(13)(B) is appropriate as proposed.

Comment. Two teachers and two community members stated that adding human activity to the proposed student expectation in §112.42(c)(13)(D) is a step in the right direction but does not specifically address climate change. The commenters recommended revising the student expectation to read, "explain how environmental change, including climate change due to human activity, affects biodiversity and analyze how changes in biodiversity impact ecosystem stability."

Response. The SBOE disagrees that the suggested change is necessary and has determined that environmental changes due to human activity are appropriately addressed in §112.42(c)(13)(D) as proposed.

Comment. Six teachers and five administrators expressed concern regarding the clarity of the proposed student expectation in §112.42(c)(13)(D). The commenters recommended revising the student expectation to read, "explain and analyze how environmental change affects biodiversity and ecosystem stability."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.42(c)(13)(D) is sufficiently clear as proposed.

Comment. A parent stated that there should be no reference to creationism in the state curriculum because superstition isn't science.

Response. The SBOE agrees that the Biology TEKS should be based on science and has determined that the language in the standards is appropriate. Additional changes were made in response to other comments.

Comment. An individual from out of state stated that because the term "evolution" has multiple meanings, the TEKS should identify which definition is being used.

Response. The SBOE disagrees and has determined that the standards in which evolution is addressed are sufficiently clear.

Comment. A community member expressed concern that the only theory listed in the proposed Biology TEKS is evolutionary theory. The commenter suggested that the TEKS specifically list other theories or at least acknowledge that other theories exist.

Response. The SBOE agrees that the study of scientific theory is important and provides the following clarification. Scientific theories are addressed in the four proposed high school science courses by including them in the introduction and scientific and engineering practices in §§112.42(c)(1)(H), 112.43(c)(1)(H), 112.44(c)(1)(H), and 112.45(c)(1)(H).

Comment. A teacher questioned whether Chemistry should be a prerequisite for enrollment in Biology.

Response. The SBOE disagrees and has determined that completion of Chemistry is not necessary for students to be successful in Biology.

Comment. A teacher expressed concern regarding the removal of the current knowledge and skills statement in §112.42(c)(3) regarding using critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The commenter stated that this statement gives room for a broad range of connections to 21st century skills and other disciplines.

Response. The SBOE agrees that using critical thinking, scientific reasoning, and problem solving to make informed decisions is important and has determined that these skills are appropriately included in the introduction in §112.42(b)(1) with the phrase, "By the end of Grade 12, students are expected to gain sufficient knowledge of the scientific and engineering practices across the disciplines of science to make informed decisions using critical thinking and scientific problem solving."

Comment. A teacher stated that the proposed new TEKS for §112.42, Biology, are very well written and provide an overall focus for many of the concepts in the course.

Response. The SBOE agrees. Additional changes were made in response to other comments.

Comment. A teacher expressed support for addressing theory in the content student expectations for Biology.

Response. The SBOE agrees that the inclusion of scientific theory in the Biology TEKS is appropriate. Additional changes were made in response to other comments.

Comment. A teacher requested that the SBOE identify sections of proposed §112.42, Biology, that would not need to be taught so that educators could go deeper into the content.

Response. The SBOE disagrees and has determined that the scope of the proposed new TEKS for Biology are appropriate and permit teachers to go into sufficient depth of content. The SBOE also provides the following clarification. In accordance with 19 TAC §74.1(b), a school district must provide instruction in all of the TEKS for the appropriate grade levels and/or courses in the required curriculum. A school district may add elements at its discretion but must not delete or omit instruction.

Comment. A teacher stated that the proposed new TEKS for Biology cover more content than can be thoroughly taught in one year. The commenter requested that consideration be given for how much students are required to learn in a course.

Response. The SBOE disagrees and has determined that the scope of the proposed new TEKS for Biology are appropriate in scope and can be sufficiently taught in an instructional year.

Comment. Three teachers and five administrators recommended revising the proposed student expectation in §112.43(c)(6)(A) to read, "use models and experimental design to explain Dalton's Postulates, Thomson's discovery of electron properties, Rutherford's nuclear atom, Bohr's nuclear atom, and Heisenberg's Uncertainty Principle, and how they have lead to the modern atomic theory." The commenters stated that adding experimental designs addresses the issue that all of the examples in the student expectation can be captured in a model.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(6)(A) is appropriate as proposed.

Comment. Three teachers and five administrators recommended eliminating the student expectation in §112.43(c)(6)(D) and adding isotopes to the proposed student expectation in §112.43(c)(6)(B) to support conceptional chemistry.

Response. The SBOE disagrees that the suggested changes are necessary and has determined that §112.43(c)(6)(B) and (D) are appropriate as proposed.

Comment. Three teachers and five administrators expressed disagreement with the proposed student expectation in §112.43(c)(6)(C). The commenter recommended reverting to the student expectation proposed by the work group which focused on chemistry rather than mathematics to read, "investigate the quantized energy emitted by electron movement of various elements and relate the emissions to the electromagnetic spectrum."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(6)(C) is appropriate as proposed.

Comment. A representative from an institution of higher education expressed concern that the addition of the phrase "and relate it to the quantization of energy in the emission spectrum" in the proposed student expectation in §112.43(c)(6)(C) extends the student expectation into the realm of physics and will add additional weeks of instructional time to an already full course. The commenter recommended revising the student expectation to read, "investigate the energy emitted by electron movement of various elements and relate the emissions to the various elements of atomic emission spectra."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(6)(C) is appropriate as proposed.

Comment. A teacher recommended removing the phrase "the mathematical relationship" from the proposed student expectation in §112.43(c)(6)(C) and reverting back to the original wording proposed by the work group to read, "investigate the quantized energy emitted by electron movement of various elements and relate the emissions to the electromagnetic spectrum."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(6)(C) is appropriate as proposed.

Comment. Three teachers and five administrators expressed concern regarding the clarity of the proposed student expectation in §112.43(c)(6)(E). The commenters recommended revising the student expectation to read, "construct electron configurations and Lewis dot structures to express the arrangement of electrons in atoms."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(6)(E) is sufficiently clear as proposed.

Comment. Three teachers and five administrators recommended deleting the proposed student expectation in §112.43(c)(7)(C) and stated that most Chemistry students have not completed Geometry; therefore, the student expectation is not accessible to them.

Response. The SBOE disagrees that the suggested deletion is necessary and has determined that §112.43(c)(7)(C) is appropriate as proposed.

Comment. Three teachers and five administrators recommended revising the proposed student expectation in §112.43(c)(7)(A) to read, "predict bonding between elements using the periodic trends associated with electronegativity." The commenters explained that the wording as proposed lacks the clarity teachers would need in planning for assessments and activities.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(7)(A) is sufficiently clear as proposed.

Comment. A teacher stated that something about determining molecular polarity should be added to the Chemistry TEKS because students will need the skill to fully understand intermolecular forces (IMF) theory in §112.43(c)(7)(D). The commenter added that the skill also supports understanding of the unique properties of water, the reason that water is polar, and concepts in solubility.

Response. The SBOE disagrees and has determined that there is sufficient background for students to fully understand the student expectation in §112.43(c)(7)(D).

Comment. Three teachers and five administrators expressed concern regarding changes to the student expectation in §112.43(c)(9)(A) and recommended reverting to the language proposed by the work group.

Response. The SBOE disagrees and has determined that §112.43(c)(9)(A) is appropriate as proposed.

Comment. A teacher questioned the meaning of "interpret chemical equations," in the proposed student expectation in §112.43(c)(9)(A). The commenter stated that it is unclear whether students should be able to identify the type of chemical reaction by looking at the chemical equation or if they should be able to predict the products of different types of equations.

Response. The SBOE disagrees and has determined that §112.43(c)(9)(A) is sufficiently clear as proposed.

Comment. Three teachers and five administrators recommended keeping all types of chemical reactions together in the proposed student expectation in §112.43(c)(9)(B) by revising the student expectation to read, "classify the reactions as synthesis, decomposition, single replacement, double replacement, and combustion reactions and differentiate among acid-base reactions, precipitation reactions, and oxidation-reduction reactions."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(9)(B) is appropriate as proposed.

Comment. A teacher stated that the proposed student expectation in §112.43(c)(9)(B) is unnecessary and should be deleted. The commenter explained that acid-base reactions are addressed in §112.43(c)(12)(D), precipitation

reactions are addressed in §112.43(c)(11)(D), and electrochemistry (oxidation-reduction reactions) is not covered in Chemistry and does not support students' ability to master the other student expectations.

Response. The SBOE disagrees with the suggested deletion and has determined that §112.43(c)(9)(B) is appropriate as proposed.

Comment. A representative from an institution of higher education expressed concern that the proposed student expectation in §112.43(c)(11)(C) might be confusing to teachers because it contains two "such as" statements. The commenter recommended revising the student expectation to read, "investigate factors that influence solid and gas solubilities using solubility curves and rates of dissolution such as temperature, agitation, and surface area."

Response. The SBOE agrees that the language of the student expectation as proposed could use refinement and took action to amend §112.43(c)(11)(C) to read, "investigate how solid and gas solubilities are influenced by temperature using solubility curves and how rates of dissolution are influenced by temperature, agitation, and surface area."

Comment. A teacher expressed support for the addition of bases to the proposed student expectation in §112.43(c)(12)(A) because it aligns the student expectation with the knowledge and skills statement.

Response. The SBOE agrees and has determined that the student expectation and knowledge and skills statement are appropriately aligned.

Comment. Five teachers and five administrators expressed concern about the addition of the phrase "and bases" to the proposed student expectation in §112.43(c)(12)(A). The commenters recommended the deletion of the phrase because bases do not have their own naming rules.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(12)(A) is appropriate as proposed.

Comment. Three teachers and five administrators recommended deleting the student expectation in §112.43(c)(12)(C) and revising §112.43(c)(12)(B) to read, "classify acids and bases based on the presence and concentration of hydrogen ions (protons) using the pH scale" to give students a better real world understanding of acids and bases that would be more relevant to how students might use their knowledge of acids and bases beyond the classroom.

Response. The SBOE disagrees that the suggested changes are necessary and has determined that §112.43(c)(12)(B) and (C) are appropriate as proposed.

Comment. Three teachers and five administrators expressed concern that the proposed student expectation in §112.43(c)(12)(D) duplicates part of the student expectation in §112.43(c)(9)(A) because a reaction of an acid and base to form water is a double-replacement reaction. The commenters recommended revising the student expectation to read, "describe how acids and bases neutralize each other and how this applies to solving real world issues such as heart burn, soil balance in gardens, and pool maintenance" to incorporate real world chemistry.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(12)(D) is appropriate as proposed.

Comment. Three teachers and five administrators expressed concern regarding the proposed student expectation in §112.43(c)(12)(E). The commenters explained that this student expectation focuses too much on complex calculations that lack a connection to how pH is used in real-world problem solving. The commenters recommended editing the student expectation to read, "test solutions to classify as acids or bases."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(12)(E) is appropriate as proposed.

Comment. Four teachers and five administrators expressed concern regarding the grade-level appropriateness of the proposed student expectation in §112.43(c)(13)(A). The commenter stated that thermodynamics is more appropriate for Physics or an upper level chemistry course.

Response. The SBOE disagrees and has determined that thermodynamics is appropriately included in the student expectation in §112.43(c)(13)(A).

Comment. Two teachers recommended deleting or rewriting the proposed student expectation in §112.43(c)(13)(A) because the laws of thermodynamics require knowledge students would not have if they have not taken Physics. The commenters stated that portions of the laws can be taught in Chemistry; however, a true understanding of concepts related to thermodynamics such as entropy are beyond the scope of a high school course.

Response. The SBOE disagrees and has determined that thermodynamics is appropriately included in the student expectation in §112.43(c)(13)(A).

Comment. Two teachers recommended amending the proposed student expectation in §112.43(c)(13)(A) to include everyday examples of only the first and second laws of thermodynamics because the third and fourth laws are difficult to understand and not as relevant for high school students.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(13)(A) is appropriate as proposed.

Comment. A teacher recommended changing the verb from "explain" to "identify" in the student expectation in §112.43(c)(13)(A) to make the student expectation more attainable.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(13)(A) is appropriate as proposed.

Comment. Three teachers and five administrators recommended moving the proposed student expectations in §112.43(c)(14)(A) and (B) to the Earth and Space Science and Astronomy courses since the elements are formed in stars and the student expectation is beyond the scope of Chemistry.

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectations in §112.43(c)(14)(A) and (B) are appropriate as proposed.

Comment. Three teachers and five administrators recommended moving the proposed student expectation in §112.43(c)(14)(C) to proposed §112.45, Physics.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.43(c)(14)(C) is appropriate as proposed.

Comment. A teacher expressed concern that the proposed new TEKS for §112.43, Chemistry, will be much more difficult for students due to the deletion of basic concepts (such as states of matter and the comparison of substances and mixtures) and the addition of more difficult concepts (such as electronegativity and intramolecular and intermolecular forces). The commenter explained that these changes will force many schools to offer Chemistry as a junior-level class because very few underclassmen have the logical reasoning for abstract concepts.

Response. The SBOE disagrees and has determined that the new TEKS for Chemistry are appropriate as proposed. Additional changes were made in response to other comments.

Comment. A teacher expressed support for not including physical and chemical changes and properties, states of matter, pure substances and mixtures, and energy and its forms in the proposed new Chemistry TEKS because they are planned to be covered in Grade 8.

Response. The SBOE agrees and has determined the new TEKS for Chemistry are appropriate as proposed. Additional changes were made in response to other comments.

Comment. A teacher expressed concern regarding the lack of content regarding dimensional analysis or significant digits in proposed §112.43, Chemistry. The commenter explained that, since measurements are uncertain, only numbers that are meaningful should be used and knowing how to perform dimensional analysis will help students be more successful and see the purpose of performing calculations.

Response. The SBOE disagrees and has determined that dimensional analysis and significant digits are unnecessary in the TEKS for Chemistry.

Comment. An administrator recommended the addition of the following statement to the prerequisites for the proposed Chemistry TEKS, "It is recommended that students taking Chemistry in 10th grade made an 80 or higher in Algebra I; otherwise, it is recommended they take Chemistry in 11th grade."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the prerequisites for Chemistry are appropriate as proposed.

Comment. Four teachers and six administrators stated that there is not sufficient time to teach the quantity of student expectations in the proposed new Chemistry course.

Response. The SBOE disagrees and has determined that the scope of the proposed new TEKS for Chemistry are appropriate in scope and can be sufficiently taught in an instructional year.

Comment. A teacher recommended the addition of the following concepts to proposed new §112.44, Integrated Physics and Chemistry (IPC), to prepare students for Chemistry or Physics: basic atomic structure; atomic theory and models; ionic versus covalent bonding properties; kinetic molecular theory as it relates to states of matter; work versus energy; and an overview of Newton's laws.

Response. The SBOE disagrees that the suggested additions are necessary and has determined that the topics addressed in the new IPC TEKS are appropriate as proposed.

Comment. A teacher expressed concern regarding the lack of continuity in proposed §112.44, the IPC course. The commenter recommended revising the TEKS so that connections can be made within each knowledge and skills statement, making it easier for teachers to support student learning.

Response. The SBOE disagrees that the suggested changes are necessary and has determined that §112.44 included connections to support student learning as appropriate.

Comment. A teacher recommended adding distance and displacement to clarify position in the proposed student expectation in §112.44(c)(5)(A).

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(5)(A) is appropriate as proposed.

Comment. A teacher recommended removing impulse from the proposed student expectation in §112.44(c)(5)(C). The commenter recommended concentrating on momentum.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(5)(C) is appropriate as proposed.

Comment. A teacher recommended the phrase "describe the nature of the four fundamental forces" should be clarified in the proposed student expectation in §112.44(c)(5)(D).

Response. The SBOE disagrees that additional clarification is necessary and has determined that §112.44(c)(5)(D) is appropriate as proposed.

Comment. A teacher recommended that the proposed student expectation in §112.44(c)(5)(D) should focus on nuclear forces.

Response. The SBOE disagrees that the student expectation should focus on nuclear forces and has determined that §112.44(c)(5)(D) is appropriate as proposed.

Comment. A teacher recommended dividing the proposed student expectation in §112.44(c)(5)(D) into separate student expectations because it is difficult to assess the mastery level needed as written. The commenter added that clarification on mass-energy equivalency is also needed to determine mastery level.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(5)(D) is appropriate as proposed.

Comment. A teacher and five administrators expressed concern that concepts in the proposed student expectation in §112.44(c)(5)(D) are not appropriate for the average student enrolled in an IPC course. The commenters recommended revising the student expectation to read, "conduct an experiment that shows the relationship between the kinetic and potential energy of objects that are in motion and at rest." The commenters added that this revision would also better align with the knowledge and skills statement.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(5)(D) is appropriate as proposed.

Comment. Two teachers and one representative from an institution of higher education recommended deleting the proposed student expectation in §112.44(c)(5)(D) due to the advanced nature of the topic. The commenters stated that mass-energy equivalency is too abstract and complex for general education students and is more appropriate for Advanced Placement Chemistry or college-level chemistry and beyond.

Response. The SBOE disagrees that the topic is too advanced for the revised IPC course and has determined that §112.44(c)(5)(D) is appropriate as proposed.

Comment. A teacher and five administrators recommended replacing the proposed student expectation in §112.44(c)(5)(E) with a new student expectation to read "define and calculate work in a mechanical system." The commenters stated that as currently proposed, the student expectation would take excessive time to teach and the suggested revision would better prepare students for the student expectation in §112.44(c)(6)(C).

Response. The SBOE disagrees that the suggested revision is necessary and has determined that §112.44(c)(5)(E) is appropriate as proposed.

Comment. A teacher recommended replacing "and" with "or" in the proposed student expectation in §112.44(6)(A) regarding series and parallel circuits.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(6)(A) is appropriate as proposed.

Comment. A teacher expressed concern that the level of difficulty increased substantially in the proposed student expectation in §112.44(c)(6)(B).

Response. The SBOE disagrees that the level of difficulty increased substantially in the student expectation and has determined that §112.44(c)(6)(B) is appropriate as proposed.

Comment. A teacher and five administrators recommended adding a real-world approach to the proposed student expectation in §112.44(c)(6)(B) by revising it to read, "analyze various ways to generate electricity by investigating mechanical generators, chemical cells, including batteries and fuel cells, and photovoltaic cells (solar panels)."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(6)(B) is appropriate as proposed.

Comment. A teacher and five administrators recommended revising the proposed student expectation in §112.44(c)(6)(C) to read, "define and calculate efficiency as it relates to energy conserved and energy transferred out of the system." The commenters stated that it is difficult for students to create a closed system which shows that energy is conserved.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(6)(C) is appropriate as proposed.

Comment. A teacher recommended clarifying the kinds of energy, such as potential and kinetic, expected in the proposed student expectation in §112.44(c)(6)(C).

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(6)(C) is appropriate as proposed.

Comment. A representative from an institution of higher education expressed concern that the proposed student expectation in §112.44(c)(6)(E), which calls for conducting an investigation, would be challenging for most schools given the equipment required. The commenter recommended revising the student expectation to read, "analyze data to evaluate the transfer of energy or information through different materials by different types of waves such as wireless signals, ultraviolet radiation, and microwaves."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(6)(E) is appropriate as proposed.

Comment. A teacher and five administrators recommended revising the proposed student expectation in §112.44(c)(6)(E) to read, "model the process through which electromagnetic waves are propagated and describe how the characteristics of waves can be manipulated to transfer energy and information in everyday items such as AM/FM radio, wireless telephones, photographic equipment, x-rays, and microwave ovens." The commenters stated that planning and investigating waves such as wireless signals exceeds the scope of the course.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(6)(E) as proposed is appropriate for the scope of the revised course.

Comment. A teacher expressed concern that since there was no proposed student expectation on fundamentals of wave characteristics, students could not be expected to plan and conduct an investigation to evaluate the transfer of energy by different types of waves in the proposed student expectation in §112.44(c)(6)(F).

Response. The SBOE disagrees and has determined that the fundamentals of wave characteristics are addressed appropriately in other student expectations for the course.

Comment. A teacher and five administrators recommended revising the proposed student expectation in §112.44(c)(7)(A) to read, "model basic atomic structure and relate an element's atomic structure to its bonding, reactivity, and placement on the Periodic Table." The commenters stated that reactivity is a chemical property and already covered in the proposed student expectation in §112.44(c)(7)(B).

Response. The SBOE is unable to agree or disagree with this comment as it is unclear what the commenters wish to change. The language recommended in the comment matches the language of the student expectation as proposed.

Comment. Two teachers recommended clarifying the proposed student expectation in §112.44(c)(7)(A) by specifying what needs to be included on the model of an atom such as the placement of protons, neutrons, and electrons or the atom's charge and relative size and then separating the phrase "relate an element's atomic structure" to form a new student expectation.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(7)(A) is appropriate as proposed.

Comment. A teacher recommended clarifying the type of model described in the proposed student expectation in §112.44(c)(7)(A) as a Bohr model.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(7)(A) is appropriate as proposed.

Comment. A teacher stated that the content in the proposed student expectation in §112.44(c)(7)(D) is already covered in the proposed TEKS for Chemistry. The commenter recommended either deleting the student expectation or adjusting the level of mastery by changing the verb "explain" to "describe."

Response. The SBOE disagrees that the content is duplicative as many students will not take both courses. The SBOE has determined that §112.44(c)(7)(D) is appropriate as proposed.

Comment. A representative from an institution of higher education recommended deleting the proposed student expectation in §112.44(c)(7)(D) because it exceeds the scope of the knowledge and skills statement in §112.44(c)(7).

Response. The SBOE disagrees and has determined that §112.44(c)(7)(D) is appropriately included in IPC and does not exceed the scope of the knowledge and skills statement.

Comment. A teacher stated that the content in the proposed student expectation in §112.44(c)(7)(D) is already covered in Chemistry. The commenter recommended either deleting the student expectation or adjusting the level of mastery by changing the verb "explain" to "describe."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(7)(D) is appropriate as proposed.

Comment. An administrator expressed concern about the proposed student expectation in §112.44(c)(7)(D) because the concepts are inappropriate for an introductory level science course.

Response. The SBOE disagrees and has determined that §112.44(c)(7)(D) is appropriate as proposed for the revised IPC course.

Comment. An administrator expressed concern that concepts such as how atomic energy levels and emission spectra present evidence for wave particle duality in proposed §112.43(c)(7)(E) are highly inappropriate for IPC and are usually taught in Physics.

Response. The SBOE disagrees that the suggested concepts are inappropriate for the revised IPC course and has determined that §112.44(c)(7)(E) is appropriate as proposed.

Comment. A teacher and five administrators recommended deleting the proposed student expectation in §112.44(c)(7)(E) related to wave particle duality because IPC students do not have the prior knowledge needed to understand this content.

Response. The SBOE disagrees and has determined that wave particle duality is appropriately included in §112.44(c)(7)(E).

Comment. Three teachers and one representative from an institution of higher education recommended deleting the proposed student expectation in §112.44(c)(7)(E). The commenters stated that wave duality is already covered in Physics and students taking IPC spend most of the instructional time trying to grasp that waves are a transference of energy and to apply the mathematical models.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.44(c)(7)(E) was appropriately included in the revised IPC course.

Comment. A teacher expressed concern with regard to the placement of the proposed student expectation in §112.44(c)(7)(F) because the student expectations under knowledge and skills statement §112.44(c)(7) don't build on each other.

Response. The SBOE disagrees and has determined that the student expectation in §112.44(c)(7)(F) is appropriately placed under the knowledge and skills statement in §112.44(c)(7).

Comment. A teacher expressed concern regarding the proposed student expectation in §112.44(c)(8)(A). The commenter explained that students do not have sufficient background in this topic to master the concept of chemical reactions. The commenter stated that the current student expectation is better.

Response. The SBOE disagrees that the topic is inappropriate for the revised IPC course and has determined that §112.44(c)(8)(A) is appropriate as proposed.

Comment. Two teachers, one parent, four community members, and two representatives from institutions of higher education stated that climate change should be addressed in the science TEKS.

Response. The SBOE agrees that the concept of climate change should be appropriately addressed in the TEKS in relevant courses. In response to this and other comments, the SBOE took action to amend §112.44(c)(8)(D) to read, "construct and communicate an evidence-based explanation of the environmental impact of the end-products of chemical reactions such as those that may result in degradation of water, soil, air quality, and global climate change."

Comment. Two teachers, four administrators, three community members, one representative from an institution of higher education, and ten instructional coaches recommended that the SBOE delay adoption of the proposed TEKS to provide work groups adequate time to respond to public comments.

Response. The SBOE disagrees that additional time is necessary and has determined that the adoption of proposed §§112.42-112.45 shall proceed as planned.

Comment. An administrator expressed concern that, by adopting high school standards first, the lower grades may be forced to incorporate content that is not cognitively appropriate or compress too many standards into particular grade levels. The commenter recommended putting the adoption of the high school science TEKS on hold; finalizing the elementary TEKS, followed by the middle school TEKS; and then allowing a brief period of revision for the high school TEKS to ensure vertical alignment.

Response. The SBOE disagrees that the delay of adoption of the high school science TEKS is necessary and has determined that the adoption of proposed §§112.42-112.45 shall proceed as planned.

Comment. Two teachers expressed concern that teachers have not had time to appropriately review and give feedback on the proposed changes to the science TEKS. The commenter added that teachers need to review proposed middle school science TEKS to make an appropriate decision on high school science TEKS.

Response. The SBOE disagrees that teachers have not had sufficient time to comment and that the middle school TEKS were necessary prior to adoption of the TEKS for the four high school courses. The SBOE determined that the adoption of proposed §§112.42-112.45 shall proceed as planned.

Comment. Two teachers expressed concern that teachers need to review proposed revisions to the middle school science TEKS to make an appropriate decision on high school science TEKS.

Response. The SBOE disagrees that the middle school TEKS were necessary prior to adoption of the TEKS for the four high school courses. The SBOE determined that the adoption of proposed §§112.42-112.45 shall proceed as planned.

Comment. An administrator expressed concern with the lack of inclusion of the contributions of female scientists and scientists of color in the proposed science TEKS.

Response. The SBOE disagrees and has determined that the proposed science TEKS include the contributions of scientists as appropriate for the content and reflect what is essential in each course.

Comment. An administrator and 10 instructional coaches stated that the proposed TEKS for the core high school science courses will not prepare students for the future of Texas. The commenters stated that science education should not be focused around learning facts, but about how to do science and recommended drastically reducing the number of student expectations so students have time to learn science through inquiry and to make sense of the world around us.

Response. The SBOE disagrees and has determined that the proposed TEKS for the four high school science courses will adequately prepare students.

Comment. A teacher stated that the proposed TEKS for Biology, Chemistry, IPC, and Physics are comprehensive and add a new layer of inquiry and scientific discovery that are critical for students.

Response. The SBOE agrees and took action to approve proposed new TEKS for Biology, Chemistry, IPC, and Physics. The SBOE also took action to approve additional changes to respond to other comments.

Comment. A teacher expressed concern regarding the lack of any mention of inferences in the proposed TEKS for Biology, Chemistry, IPC, and Physics. The commenter explained that inferencing skills aid with the writing evidence-based arguments and support connections with other subjects.

Response. The SBOE disagrees that the TEKS for the four high school courses must include references of inferencing.

Comment. A community member requested the SBOE include only facts in the science TEKS.

Response. The SBOE agrees and has determined that the science TEKS appropriately address scientific facts.

Comment. A community member stated that the TEKS should address the lack of education and awareness of light pollution.

Response. The SBOE disagrees and has determined that inclusion of light pollution would not be appropriate in one of the four courses currently under consideration, but may be more appropriate in another science course or grade level.

Comment. An individual from out-of-state recommended that a distinction be made between current science and historical science with regard to theories and hypotheses. The commenter explained that hypotheses and theories concerning origin or historical science are not testable and should not be considered science in the current sense.

Response. The SBOE disagrees and has determined that a distinction between current science and historical science with regard to theories and hypotheses is not necessary.

Comment. An administrator expressed concern that the science high school TEKS should not attempt to compress whatever content is left after Kindergarten-Grade 8 to meet arbitrary college-level expectations or college readiness ideals created with little to no reference to child development and cognitive appropriateness. The commenter stated that this philosophy has created standards with too much content to cover, and students leave high school with a plethora of science facts that are easily dismissed instead of a real understanding of how science works.

Response. The SBOE agrees and has determined that the TEKS for the four high school science courses appropriately address essential knowledge and skills and foster a real understanding of how science works.

Comment. A teacher expressed concern that significant figures are not included in the proposed TEKS for the four high school courses. The commenter stated that understanding how significant digits are used when measuring and

when rounding a number in an answer is very important because it prevents scientific data from being misunderstood and manipulated.

Response. The SBOE disagrees and has determined that the suggested change is not necessary.

Comment. Two teachers recommended adding data science and computational thinking as tools where appropriate in the high school courses. The commenter further recommended adding a statement to the general requirements to regarding computational thinking and programming to read, "The desire to achieve educational excellence is the driving force behind the TEKS for mathematics, guided by the college and career readiness standards. By embedding statistics, probability, and finance, while focusing on computational thinking, mathematical fluency and solid understanding, Texas will lead the way in mathematics education and prepare all Texas students for the challenges they will face in the 21st century."

Response. The SBOE disagrees and has determined that the suggested language is not appropriate for the high school science general requirements.

Comment. A teacher stated that proposed revisions to the science TEKS for Biology, Chemistry, IPC, and Physics appear to have added additional content and depth. The commenter expressed concern that ensuring mastery of the current TEKS within the suggested time frame is already a challenge, and that adding content would only further rush the process of preparing students for the STAAR®.

Response. The SBOE disagrees and has determined that the proposed revisions to the science TEKS for Biology, Chemistry, IPC, and Physics are appropriate in scope. Additionally, the SBOE provides the follow clarification. The only high school science course with a required STAAR® exam is Biology.

Comment. A representative from an institution of higher education recommended that explanations should be defined in the introductions for the four proposed high school courses in §§112.42(b)(3), 112.43(b)(3), 112.44(b)(3), and 112.45(b)(3). The commenter proposed the wording to read, "explanations are statements based on evidence from observations of facts or a series of events that describe the natural or physical world."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the language in the introductions of §§112.42(b)(3), 112.43(b)(3), 112.44(b)(3), and 112.45(b)(3) is appropriate as proposed.

Comment. A representative from an institution of higher education stated that the introduction of the proposed four high school courses should contain fundamental scientific and engineering definitions and ideas for better literacy and critical thinking that business and industry value for improving the economy.

Response. The SBOE agrees and has determined that scientific and engineering practices are appropriately defined in the introduction as proposed. The SBOE also agrees that literacy and critical thinking skills are highly valued by business and industry; however, the SBOE disagrees that additional changes to the introduction are necessary.

Comment. A representative from an institution of higher education recommended addressing inferences in the introductions for the four proposed high school courses in §§112.42(b)(3), 112.43(b)(3), 112.44(b)(3), and 112.45(b)(3). The commenter recommended amending the language to read, "Scientific observations, inferences, hypotheses, theories, and laws" and adding new §§112.42(b)(3)(C), 112.43(b)(3)(C), 112.44(b)(3)(C), and 112.45(b)(3)(C) to read, "inferences are predictions or conclusions about past or future events based on observations."

Response. The SBOE disagrees that the suggested changes are necessary. The SBOE has determined that addressing scientific hypotheses and theories in §§112.42(b)(3), 112.43(b)(3), 112.44(b)(3), and 112.45(b)(3) is sufficient and the introduction is appropriate as proposed.

Comment. A representative from an institution of higher education recommended that observations should be defined in the introductions for the proposed four high school courses in §§112.42(b)(3), 112.43(b)(3), 112.44(b)(3), and 112.45(b)(3). The commenter proposed amending the language to read, "observations are facts from obtaining

qualitative information of natural or physical phenomena using direct experience that can be drawings/diagrams, words, or numbers and play a role in scientific explanations."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §§112.42(b)(3), 112.43(b)(3), 112.44(b)(3), and 112.45(b)(3) are appropriate as proposed.

Comment. A representative from an institution of higher education recommended editing the introductions for the four proposed high school courses in §§112.42(b)(4), 112.43(b)(4), 112.44(b)(4), and 112.45(b)(4) to read, "Scientific inquiry and engineering problem solving. Scientific inquiry is the planned and deliberate investigation of the natural or physical world using scientific practices. Scientific methods of investigation are descriptive, correlative, comparative, or experimental designs. 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; correlative investigations which involve predicting a relationship between variables; comparative investigations, which involve predicting a relationship between group means; and experimental investigations, which involve predicting a treatment effect and a control is identified. Engineering involves identifying a problem and designing a solution."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §§112.42(b)(4), 112.43(b)(4), 112.44(b)(4), and 112.45(b)(4) are appropriate as proposed.

Comment. A representative from an institution of higher education recommended defining scientific laws of matter in the introductions for the four proposed high school courses in §§112.42(b)(3), 112.43(b)(3), 112.44(b)(3), and 112.45(b)(3). The commenter proposed adding the statement, "scientific laws of matter are the same in all parts of the universe and over any period of time which describe natural and physical phenomena."

Response. The SBOE disagrees that the suggested change is necessary. The SBOE has determined that the inclusion of definitions of scientific hypotheses and theories in §§112.42(b)(3), 112.43(b)(3), 112.44(b)(3), and 112.45(b)(3)is sufficient and the introduction is appropriate as proposed.

Comment. A representative from an institution of higher education recommended adding a sentence to the definition of scientific theories in the introductions for the four proposed high school courses in §§112.42(b)(3)(B), 112.43(b)(3)(B), 112.44(b)(3)(B), and 112.45(b)(3)(B) that states, "Theories do not become laws or facts." The commenter stated that this sentence should be inserted to address a common misconception.

Response. The SBOE disagrees that the suggested change is necessary and has determined that the definition of scientific theories is sufficiently clear in §§112.42(b)(3)(B), 112.43(b)(3)(B), 112.44(b)(3)(B), and 112.45(b)(3)(B) as proposed.

Comment. A representative from an institution of higher education recommended that the introductions for the four proposed high school courses in §§112.42(b)(4)(A), 112.43(b)(4)(A), 112.44(b)(4)(A), and 112.45(b)(4)(A) should be edited because the information contained in these subsections is incomplete guidance for teachers, particularly those who lack adequate scientific research experience or professional development.

Response. The SBOE disagrees and has determined that §§112.42(b)(4)(A), 112.43(b)(4)(A), 112.44(b)(4)(A), and 112.45(b)(4)(A) are appropriate as proposed.

Comment. A representative from an institution of higher education recommended that the SBOE amend the introductions for the four proposed high school courses in §§112.42(b)(4)(B), 112.43(b)(4)(B), 112.44(b)(4)(B), and 112.45(b)(4)(B) to read, "Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models and research relevant information."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §§112.42(b)(4)(B), 112.43(b)(4)(B), 112.44(b)(4)(B), and 112.45(b)(4)(B) are appropriate as proposed.

Comment. A teacher stated that the introductions for the four high school science courses in §§112.42(b)(4)(B), 112.43(b)(4)(B), 112.44(b)(4)(B), and 112.45(b)(4)(B) should be revised to read "students should be able to identify problems, design and communicate solutions using appropriate tools and models."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §§112.42(b)(4)(B), 112.43(b)(4)(B), 112.44(b)(4)(B), and 112.45(b)(4)(B) are appropriate as proposed.

Comment. A representative from an institution of higher education recommended that the SBOE add a new subparagraph to the introductions for the four proposed high school courses in §§112.42(b)(4)(B), 112.43(b)(4)(B), 112.44(b)(4)(B), and 112.45(b)(4)(B) that states, "Scientific practices. Students should be able to design and conduct a descriptive investigation by forming a research question, select subject or group and type of observations, make the observations, repeat observations, calculate data summaries (sample size, mean and standard deviation)."

Response. The SBOE disagrees that the suggested addition is necessary and has determined that scientific practices are appropriately addressed in §§112.42(b)(4), 112.43(b)(4), 112.44(b)(4), and 112.45(b)(4) as proposed.

Comment. A representative from an institution of higher education recommended that the SBOE add a new subparagraph to the introductions for the four proposed high school courses in §§112.42(b)(4)(C), 112.43(b)(4)(C), 112.44(b)(4)(C), and 112.45(b)(4)(C) that states, "Scientific practices. Students should be able to design and conduct a correlative investigation by developing a hypothesis that predicts a natural pattern and a relationship between variables, select a representative group, measure variables relevant to the hypothesis across subjects in one of more groups, quantify the correlation."

Response. The SBOE disagrees that the suggested addition is necessary and has determined that scientific practices are appropriately addressed in §§112.42(b)(4), 112.43(b)(4), 112.44(b)(4), and 112.45(b)(4) as proposed.

Comment. A representative from an institution of higher education recommended that the SBOE add a new subparagraph to the introductions for the four proposed high school courses in §§112.42(b)(4)(C), 112.43(b)(4)(C), 112.44(b)(4)(C), and 112.45(b)(4)(C) that states, "Engineering practices. Students should be able to test and evaluate the possible solutions using mathematical and computational representations of established relationships and principles integral to the design; use a systematic process to design a solution by using reasoning and argument, clearly communicate the advantages of their design and critique competing design solutions based upon agreed design criteria."

Response. The SBOE disagrees that the suggested addition is necessary and has determined that engineering practices are appropriately addressed in §§112.42(b)(4), 112.43(b)(4), 112.44(b)(4), and 112.45(b)(4) as proposed.

Comment. A representative from an institution of higher education recommended that the SBOE add a new subparagraph to the introductions for the four proposed high school courses in §§112.42(b)(4)(D), 112.43(b)(4)(D), 112.44(b)(4)(D), and 112.45(b)(4)(D) that states, "Scientific practices. Students should be able to design and conduct a comparative investigation by developing a hypothesis that predicts a natural pattern and a relationship between representative groups, measure response variables relevant to the hypothesis across groups, compare group means, and determine if the response variables consist of counts (discrete data) or measurements (continuous data) and use appropriate statistical tests."

Response. The SBOE disagrees that the suggested addition is necessary and has determined that scientific practices are appropriately addressed in §§112.42(b)(4), 112.43(b)(4), 112.44(b)(4), and 112.45(b)(4) as proposed.

Comment. A representative from an institution of higher education recommended that the SBOE add a new subparagraph to the introductions for the four proposed high school courses in §§112.42(b)(4)(E), 112.43(b)(4)(E), 112.44(b)(4)(E), and 112.45(b)(4)(E) that states, "Scientific practices. Students should be able to design and conduct an experimental investigation by selecting a treatment effect, developing a hypothesis that predicts a treatment effect, select representative subjects, measure the response variables relevant to the hypothesis on members of different treatment groups, compare treatment means."

Response. The SBOE disagrees that the suggested addition is necessary and has determined that scientific practices are appropriately addressed in §§112.42(b)(4), 112.43(b)(4), 112.44(b)(4), and 112.45(b)(4) as proposed.

Comment. A representative from an institution of higher education recommended deleting "(scientific methods)" from the introductions for the four proposed high school courses in §§112.42(b)(5), 112.43(b)(5), 112.44(b)(5), and 112.45(b)(5). The commenter stated that using this term misleads teachers into the incorrect idea that there is only one scientific method and that there a set of steps that must be followed.

Response. The SBOE disagrees and has determined that the term "scientific methods" is appropriately included in §§112.42(b)(5), 112.43(b)(5), 112.44(b)(5), and 112.45(b)(5) as proposed.

Comment. A teacher expressed concern about the incorporation of the term "social ethics" in the introductions of the four proposed high school courses in §§112.42(b)(5), 112.43(b)(5), 112.44(b)(5), and 112.45(b)(5). The commenter recommended removing the language or revising it to provide more clarity because it is unclear how social ethics would be taught and instruction could become politicized.

Response. The SBOE disagrees and has determined that the term "social ethics" is appropriately included in §§112.42(b)(5), 112.43(b)(5), 112.44(b)(5), and 112.45(b)(5) in the introductions as proposed.

Comment. Four community members stated that the term "social justice" should be eliminated from the proposed science TEKS. The commenters stated that the term is not adequately defined, has been recently maligned as meaning promoting lesbian, gay, bisexual, transexual, and queer (LGBTQ) advocacy, and has no place in science courses.

Response. The SBOE provides the following clarification. The term "social justice" does not appear in the proposed new TEKS as proposed. This language was amended at first reading.

Comment. A representative from an institution of higher education suggested adding the phrase "to problems" after design solutions in the knowledge and skills statement for scientific and engineering practices in the four high school courses in §§112.42(c)(1), 112.43(c)(1), 112.44(c)(1), and 112.45(c)(1). The commenter stated the phrase as written is incomplete because engineers design solutions to problems.

Response. The SBOE disagrees that the suggested change is necessary and has determined that knowledge and skills statement in the proposed TEKS for the four high school courses in §§112.42(c)(1), 112.43(c)(1), 112.44(c)(1), and 112.45(c)(1) is appropriate as proposed.

Comment. A community member expressed concern about the wording of the four proposed high school courses in §§112.42(c)(1)(B), 112.43(c)(1)(B), 112.44(c)(1)(B), and 112.45(c)(1)(B) because students will not usually do both the scientific and the engineering practices in the same activity or lesson. The commenter suggested replacing the word "and" with "and/or" in the phrase to read, "apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations, and/or use engineering practices to design solutions to problems."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the language in the four high school courses in §§112.42(c)(1)(B), 112.43(c)(1)(B), 112.44(c)(1)(B), and 112.45(c)(1)(B) is appropriate as proposed.

Comment. A representative from an institution of higher education suggested amending the proposed student expectation in the scientific and engineering practices for the four proposed high school courses in §§112.42(c)(1)(B), 112.43(c)(1)(B), 112.44(c)(1)(B), and 112.45(c)(1)(B) to read, "apply scientific practices to plan and conduct descriptive, correlative, comparative and experimental investigations; and apply engineering practices to design solutions to problems."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in the scientific and engineering practices for the four high school courses in §§112.42(c)(1)(B), 112.43(c)(1)(B), 112.44(c)(1)(B), and 112.45(c)(1)(B) is appropriate as proposed.

Comment. A representative from an institution of higher education suggested amending the proposed student expectation in the scientific and engineering practices for the four proposed high school courses in §§112.42(c)(1)(H), 112.43(c)(1)(H), 112.44(c)(1)(H), and 112.45(c)(1)(H) to read, "distinguish among scientific observations, inferences, explanations, hypotheses, theories, and laws."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in the scientific and engineering practices for the four high school courses in §§112.42(c)(1)(H), 112.43(c)(1)(H), 112.44(c)(1)(H), and 112.45(c)(1)(H) is appropriate as proposed.

Comment. A teacher stated that the proposed knowledge and skills statement in the science and engineering practices for the four proposed high school courses in §§112.42(c)(2), 112.43(c)(2), 112.44(c)(2), and 112.45(c)(2) should be revised to add the phrase "client perspectives" to read, "the student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships, correlations, or client perspectives to develop evidence-based arguments or evaluate designs."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the knowledge and skills statement in the scientific and engineering practices for the four high school courses in §§112.42(c)(2), 112.43(c)(2), 112.44(c)(2), and 112.45(c)(2) is appropriate as proposed.

Comment. A representative from an institution of higher education stated that the proposed knowledge and skills statement in the science and engineering practices for the four proposed high school courses in §§112.42(c)(2), 112.43(c)(2), 112.44(c)(2), and 112.45(c)(2) should be revised to replace the word "correlations" with the phrase "discover relationships" to read, "The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships to develop evidence-based arguments or evaluate designs."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the knowledge and skills statement in the scientific and engineering practices for the four high school courses in §§112.42(c)(2), 112.43(c)(2), 112.44(c)(2), and 112.45(c)(2) is appropriate as proposed.

Comment. A teacher and a representative from an institution of higher education stated that in the proposed student expectation in the science and engineering practices for the four proposed high school courses in §§112.42(c)(2)(D), 112.43(c)(2)(D), 112.44(c)(2)(D), and 112.45(c)(2)(D), the phrase "based on design criteria and constraints" should be revised to read, "evaluate experimental and engineering designs based on design criteria and constraints."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in the scientific and engineering practices for the four high school courses in §§112.42(c)(2)(D), 112.43(c)(2)(D), 112.44(c)(2)(D), and 112.45(c)(2)(D) is appropriate as proposed.

Comment. A representative from an institution of higher education stated that the proposed knowledge and skills statement in the science and engineering practices for the four proposed high school courses in §§112.42(c)(4), 112.43(c)(4), 112.44(c)(4), and 112.45(c)(4) should be revised to read, "The student knows the contributions of diverse scientists and engineers and recognizes the importance of scientific and engineering research and innovation on society."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the knowledge and skills statement in the scientific and engineering practices for the four high school courses in §§112.42(c)(4), 112.43(c)(4), 112.44(c)(4), and 112.45(c)(4) is appropriate as proposed.

Comment. A representative from an institution of higher education suggested amending the student expectation in the science and engineering practices for the four proposed high school courses in §§112.42(c)(4)(A), 112.43(c)(4)(A), 112.44(c)(4)(A), and 112.45(c)(4)(A) to read, "analyze, evaluate, and critique scientific explanations and solutions by using empirical evidence, logical reasoning, and observations or experimental testing, so as to encourage critical thinking by the student because science does not test observationally."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in the scientific and engineering practices for the four high school courses in §§112.42(c)(4)(A), 112.43(c)(4)(A), 112.44(c)(4)(A), and 112.45(c)(4)(A) is appropriate as proposed.

Comment. A representative from an institution of higher education suggested adding a reference to engineers in the proposed student expectation in the science and engineering practices for the four proposed high school courses in §§112.42(c)(4)(B), 112.43(c)(4)(B), 112.44(c)(4)(B), and 112.45(c)(4)(B) to read, "relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists and engineers as related to the content."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in the scientific and engineering practices for the four high school courses in §§112.42(c)(4)(B), 112.43(c)(4)(B), 112.44(c)(4)(B), and 112.45(c)(4)(B) is appropriate as proposed.

Comment. An administrator recommended that the SBOE integrate the scientific and engineering practices into all grade levels and courses.

Response. The SBOE agrees that scientific and engineering practices are essential knowledge and skills and took action to approve scientific and engineering practices as proposed in the four high school courses in §§112.42(c)(1)-(4), 112.43(c)(1)-(4), 112.44(c)(1)-(4), and 112.45(c)(1)-(4). The SBOE also provides the following clarification. The grade level TEKS for Kindergarten-Grade 8 are outside the scope of the proposed rulemaking.

Comment. A parent and two community members expressed support for the inclusion of science, technology, engineering, and mathematics (STEM) and engineering in the proposed high school TEKS.

Response. The SBOE agrees that STEM and engineering knowledge and skills are essential and took action to adopt the scientific and engineering practices in the four proposed high school courses in §§112.42(c)(1)-(4), 112.43(c)(1)-(4), 112.44(c)(1)-(4), and 112.45(c)(1)-(4). In response to other comments, the SBOE took action to approve additional changes to the scientific and engineering practices.

Comment. Two teachers stated that, based on the depth and rigor of the proposed Physics TEKS, Algebra I should be a prerequisite because merely recommending a prerequisite or allowing the course as a corequisite would set students up for failure.

Response. The SBOE disagrees and has determined that Algebra I is appropriate as a recommended prerequisite corequisite to enrollment in Physics.

Comment. A teacher stated that proposed new §112.45, Physics, is well written and includes more details about how to teach the standards.

Response. The SBOE agrees and took action to adopt the new TEKS for the course. The SBOE also took action to approve additional changes to respond to other comments.

Comment. A teacher stated that the proposed new TEKS for §112.45, Physics, are a vast improvement because they are both streamlined for necessary content and less vague than student expectations in the current TEKS. The commenter stated that no further changes are necessary.

Response. The SBOE agrees that the proposed TEKS for §112.45, Physics, are appropriately streamlined and took action to adopt the new TEKS for the course. The SBOE also took action to approve additional changes to respond to other comments.

Comment. Two teachers expressed concern about the additional number of student expectations in proposed §112.45, Physics. The commenters suggested reducing the number of proposed student expectations so students can understand concepts at a deeper level.

Response. The SBOE disagrees and has determined that the scope of proposed §112.45, Physics is appropriate. The SBOE also took action to approve additional changes to respond to other comments.

Comment. Five administrators recommended deleting "hand graphing and" from the proposed student expectation in §112.45(c)(5)(A).

Response. The SBOE disagrees that the suggested change is necessary and has determined that hand graphing is appropriately included in §112.45(c)(5)(A) as proposed.

Comment. An administrator and 10 instructional coaches stated that the technology required by proposed §112.45(c)(5)(A) is too specific. The commenters recommended revising the student expectation to read, "investigate, analyze, and model motion in terms of position, velocity, acceleration, and time using tables, graphs, and mathematical relationships."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the specificity of §112.45(c)(5)(A) is appropriate as proposed.

Comment. Two teachers recommended deleting acceleration versus time graphs and rates of change of acceleration from the proposed student expectation in §112.45(c)(5)(A).

Response. The SBOE disagrees that the suggested change is necessary and has determined that 112.45(c)(5)(A) is appropriate as proposed.

Comment. Five administrators stated that the word "graphs" is missing from the proposed student expectation in §112.45(c)(5)(A) and should be added after the phrase "acceleration versus time."

Response. The SBOE disagrees that the suggested change is necessary and has determined that 112.45(c)(5)(A) is appropriate as proposed.

Comment. An administrator and 10 instructional coaches recommended deleting the proposed student expectation in §112.45(c)(5)(B) related to combining vectors because it is not a skill that will be used in other activities.

Response. The SBOE disagrees and has determined that the skill of combining vectors is appropriately included in §112.45(c)(5)(B) as proposed.

Comment. An administrator and 10 instructional coaches recommended that proposed §112.45(c)(5)(C) be deleted and the content be combined into §112.45(c)(5)(A) to read, "investigate, analyze, and model motion in terms of position, velocity, acceleration, and time using tables, graphs, and mathematical relationships."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.45(c)(5)(A) and (C) are appropriate as proposed.

Comment. Five administrators and one teacher stated that a comma is missing between the words "speed" and "velocity" in the student expectation in §112.45(c)(5)(C).

Response. The SBOE agrees. This and other comments have been addressed as technical edits.

Comment. An administrator and 10 instructional coaches recommended that proposed §112.45(c)(5)(D) be edited to read, "describe and analyze acceleration in uniform circular and horizontal projectile motion in two dimensions using motion graphs, tables and mathematical models."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.45(c)(5)(D) is appropriate as proposed.

Comment. A teacher expressed concern that the proposed student expectation in §112.45(c)(5)(E) does not include Newton's second and third laws.

Response. The SBOE disagrees that Newton's second and third laws are necessary in §112.45(c)(5)(E). The SBOE provides the following clarification. Newton's second law is appropriately addressed in §112.45(c)(5)(F) and Newton's third law is appropriately addressed in §112.45(c)(5)(G).

Comment. A teacher asked whether the new student expectation in §112.45(c)(5)(E) as proposed indicates that teachers are no longer expected to teach concepts related to projectiles shot at an angle.

Response. The SBOE provides the following clarification. The student expectation in §112.45(c)(5)(E) requires that students apply the concepts of equilibrium and inertia as represented by Newton's first law of motion using relevant real-world examples such as rockets, satellites, and automobile safety devices; however, the student expectation does not require that any of the real-world examples used must be shot at an angle.

Comment. Five administrators stated that the term "gravity" should be replaced with the term "gravitational" in the list of forces in the proposed student expectation in §112.45(c)(5)(F).

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in §112.45(c)(5)(F) is appropriate as proposed.

Comment. An administrator and 10 instructional coaches recommended replacing the verb "calculate" with the phrase "analyze data to explain" in the proposed student expectation in §112.45(c)(5)(F). The commenters explain that the revision will require students to look at more than just the math side of Newton's second law.

Response. The SBOE disagrees that the suggested change is necessary and has determined that the verb "calculate" in §112.45(c)(5)(F) is appropriate as proposed.

Comment. A teacher requested that the friction equation Ff = u * Fn be added to the old STAAR® reference sheet for Physics because the proposed student expectation in §112.45(c)(5)(F) requires students to calculate of the effects of friction.

Response. This comment is outside the scope of the proposed rulemaking.

Comment. Five administrators recommended revising the student expectation in §112.45(c)(5)(G) to read, "illustrate and analyze the simultaneous forces between two objects as represented in Newton's third law of motion" because free body diagrams are already covered in the student expectation in §112.45(c)(5)(F).

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.45(c)(5)(G) is appropriate as proposed.

Comment. Five administrators recommended revising the student expectation in §112.45(c)(5)(H) to read, "describe and calculate the magnitude of force between two objects and predict the effects on objects in linear and orbiting systems using Newton's law of universal gravitation."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.45(c)(5)(H) is sufficiently clear as proposed.

Comment. An administrator and 10 instructional coaches recommended that the proposed student expectation in §112.45(c)(5)(H) be moved to the knowledge and skills statement in §112.45(c)(6). The commenters explained that gravitational forces in §112.45(c)(5)(H) and electrical forces in §112.45(c)(6)(A) are very closely related in terms of force interactions; therefore, both belong in §112.45(c)(6).

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.45(c)(5)(H) is appropriately placed under the knowledge and skills statement in §112.45(c)(6) as proposed.

Comment. Five administrators recommended revising the student expectation in §112.45(c)(6)(A) to read, "calculate the magnitude of the electric force between two objects using Coulomb's law."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.45(c)(6)(A) is appropriate as proposed.

Comment. An administrator and 10 instructional coaches expressed concern that the proposed student expectations in §112.45(c)(6)(B)-(E) do not lead to a real-world understanding of electricity as it affects our daily lives. The commenters recommended that these student expectations be rewritten to focus on real-world understanding and application.

Response. The SBOE disagrees that the suggested changes are necessary and has determined that §112.45(c)(6)(B)-(E) are appropriate as proposed. In response to other comments, the phrase "Van der Graaf" in the student expectation in §112.45(c)(6)(C) was amended to read, "Van de Graaf."

Comment. A teacher stated that in the proposed student expectation in §112.45(c)(6)(C), the name of the "Van de Graaff" generator is misspelled as the "Van der Graaf" generator.

Response. The SBOE agrees and took action to amend the phrase "Van der Graaf" in the student expectation in §112.45(c)(6)(C) to read, "Van de Graaf."

Comment. Five administrators recommended revising the proposed student expectation in §112.45(c)(7)(A) to read, "calculate and explain work and power in one dimension and describe how work impacts a system."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.45(c)(7)(A) is sufficiently clear as proposed.

Comment. An administrator and 10 instructional coaches recommended that the proposed student expectation in §112.45(c)(7)(D) be revised to read "apply the concepts of momentum and impulse to design, evaluate, and refine a device to minimize or maximize the net force on objects during collisions such as those that occur during vehicular accidents, sports activities, or the dropping of personal electronic devices."

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.45(c)(7)(D) is appropriate as proposed.

Comment. A teacher expressed support for the separation of momentum from energy in the proposed student expectations in §112.45(c)(7)(C) and (D).

Response. The SBOE agrees and took action to approve the student expectations in §112.45(c)(7)(C) and (D) as proposed.

Comment. An administrator and 10 instructional coaches recommended that inelastic and elastic collisions be deleted from the proposed student expectation in §112.45(c)(7)(E) because they are unnecessary.

Response. The SBOE disagrees and has determined that inelastic and elastic collisions are appropriately included in §112.45(c)(7)(E) as proposed.

Comment. An administrator and 10 instructional coaches recommended reverting back to the original work group language for the proposed student expectation in §112.45(c)(8)(A) to read, "examine and describe simple harmonic motion, standing waves, and energy propagation in various types of media using examples such as springs, pendulums, surface waves on a body of water and ropes."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the wording in §112.45(c)(8)(A) is appropriate as proposed.

Comment. An administrator and 10 instructional coaches recommended revising the proposed student expectation in §112.45(c)(8)(C) to read, "investigate how the characteristics of waves are used in various technologies" to incorporate real world application into the characteristics of a wave and how they apply to or can impact technology.

Response. The SBOE disagrees that the suggested change is necessary and has determined that the characteristics of waves are appropriately addressed in the student expectation in §112.45(c)(8)(C) as proposed.

Comment. Five administrators recommended deleting the word "superposition" from the proposed student expectation in §112.45(c)(8)(D) to avoid duplication.

Response. The SBOE disagrees that the suggested change is necessary and has determined that the word "superposition" is appropriately included in the student expectation in §112.45(c)(8)(D) as proposed.

Comment. A teacher requested that resonance be reinserted in the proposed student expectation in §112.45(c)(8)(D).

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in §112.45(c)(8)(D) is appropriate as proposed.

Comment. An administrator and 10 instructional coaches recommended that the proposed student expectation in §112.45(c)(8)(E) be revised to read, "plan and conduct an investigation to evaluate the transfer of energy or information through different materials by different types of waves such as wireless signals, ultraviolet radiation, and microwaves."

Response. The SBOE disagrees that the suggested change is necessary and has determined that the student expectation in §112.45(c)(8)(E) is appropriate as proposed.

Comment. An administrator, ten instructional coaches, and two teachers recommended the deletion of the proposed student expectation in §112.45(c)(8)(F) because the concept of emission spectra is more appropriate for and included in the proposed new Chemistry course.

Response. The SBOE disagrees with the suggested deletion and has determined that the concept of emission spectra in §112.45(c)(8)(F) is appropriately included in Physics, §112.45, as proposed.

Comment. An administrator and 10 instructional coaches recommended deleting the proposed student expectation in §112.45(c)(8)(G) because the concepts take a lot of time to teach and do not add enough to an understanding of physics.

Response. The SBOE disagrees with the suggested deletion and has determined that the student expectation in §112.45(c)(8)(G) is sufficiently relevant to an understanding of physics and appropriately included in the Physics course as proposed.

Comment. A teacher expressed concern that the proposed student expectation in §112.45(c)(8)(G) does not include curved mirrors or concave lenses in addition to plane mirrors and thin convex lenses.

Response. The SBOE disagrees that the inclusion of curved mirrors or concave lenses is necessary and has determined that the student expectation in §112.45(c)(8)(G) is appropriate as proposed.

Comment. Two teachers recommended that the concept of the duality of light should be taught in relation to waves by adding a new student expectation in §112.45(c)(8)(H).

Response. The SBOE disagrees with the suggested change and has determined that the concept of duality of light is appropriately included in §112.45(c)(9)(C) as proposed.

Comment. Five teachers expressed concern about the inclusion of quantum phenomena in the proposed student expectations in §112.45(c)(9)(A)-(D). The commenters explained that including these standards increases the amount of content for the course by 20-25% and would exceed the level of quantum physics in AP Physics 1, AP Physics 2, and the College and Career Readiness Standards (CCRS).

Response. The SBOE disagrees and has determined that the inclusion of quantum phenomena in the proposed student expectations in §112.45(c)(9)(A)-(D) is appropriate in scope for the revised Physics TEKS.

Comment. Two teachers and two community members recommended replacing the student expectations in §112.45(c)(9)(A)-(D) with a new student expectation in §112.45(c)(8)(H) to read, "investigate and understand how quantum physics applies to the behavior of waves, including mass-energy equivalence, the photoelectric effect, and the dual nature of light."

Response. The SBOE disagrees that the suggested changes are necessary and has determined that the student expectations in §112.45(c)(9)(A)-(D) are appropriate as proposed.

Comment. An administrator and 10 instructional coaches recommended that the proposed student expectation in §112.45(c)(9)(A) be moved back into the knowledge and skills statement in §112.45(c)(8) related to the characteristics and behavior of waves.

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.45(c)(9)(A) is appropriately placed under the knowledge and skills statement in §112.45(c)(9).

Comment. A teacher requested that the dual nature of light, which is covered in the current Physics TEKS, be included in the proposed student expectation in §112.45(c)(9)(A).

Response. The SBOE disagrees that the suggested change is necessary and has determined that §112.45(c)(9)(A) is appropriate as proposed.

Comment. Three teachers and five administrators stated that Malus's Law is not appropriate for an on-level physics course. The commenters suggested deleting the student expectation in §112.45(c)(9)(B).

Response. The SBOE disagrees and has determined that Malus's Law is appropriately included in §112.45(c)(9)(B) as proposed.

Comment. A teacher expressed concern about the use of the verb "investigate" in the proposed student expectation in §112.45(c)(9)(B). The commenter questioned how Malus's Law could be investigated.

Response. The SBOE disagrees and has determined that the verb "investigate" is appropriate in §112.45(c)(9)(B) as proposed.

Comment. An administrator and a teacher expressed concern that the resources required to teach the proposed student expectations in §112.45(c)(9)(B) and (D) may be limited in low-income districts.

Response. This comment is outside the scope of the proposed rulemaking.

Comment. Five administrators recommended deleting the proposed student expectation in §112.45(c)(9)(C) because the concepts of superstition of quantum states and wave-particle duality of light are not grade-level appropriate.

Response. The SBOE disagrees with the suggestion to delete the student expectation in §112.45(c)(9)(C) and has determined that the student expectation is appropriate for an on-level physics course.

Comment. Two teachers stated that removing thermodynamics from Physics and adding it to Chemistry is a mistake as thermodynamics is fundamentally a physics concept, not a chemistry concept.

Response. The SBOE disagrees and has determined that thermodynamics is appropriately included in Physics as proposed.

STATUTORY AUTHORITY. The new sections are adopted under Texas Education Code (TEC), §7.102(c)(4), which requires the State Board of Education (SBOE) to establish curriculum and graduation requirements; TEC, §28.002(a), which identifies the subjects of the required curriculum; TEC, §28.002(c), which requires the SBOE to

by rule identify the essential knowledge and skills of each subject in the required curriculum that all students should be able to demonstrate and that will be used in evaluating instructional materials and addressed on the state assessment instruments; TEC, §28.002(j), which allows the SBOE to require laboratory instruction in secondary science courses and require a specific amount or percentage of time in a secondary science course that must be laboratory instruction; TEC, §28.002(n), which allows the SBOE to by rule develop and implement a plan designed to incorporate foundation curriculum requirements into the career and technical education curriculum required in TEC, §28.002; and TEC, §28.025(a), which requires the SBOE to by rule determine the curriculum requirements for the foundation high school graduation program that are consistent with the required curriculum under TEC, §28.002.

CROSS REFERENCE TO STATUTE. The new sections implement Texas Education Code, §§7.102(c)(4); 28.002(a), (c), (j), and (n); and 28.025(a).

<rule>

§112.41. Implementation of Texas Essential Knowledge and Skills for Science, High School, Adopted 2020.

(a) The provisions of §§112.42-112.45 of this subchapter shall be implemented by school districts.

(b) No later than July 31, 2022, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills for science as adopted in §§112.42-112.45 of this subchapter.

(c) If the commissioner makes the determination that instructional materials funding has been made available under subsection (b) of this section, §§112.42-112.45 of this subchapter shall be implemented beginning with the 2023-2024 school year and apply to the 2023-2024 and subsequent school years.

(d) If the commissioner does not make the determination that instructional materials funding has been made available under subsection (b) of this section, the commissioner shall determine no later than July 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that §§112.42-112.45 of this subchapter shall be implemented for the following school year.

(e) Sections 112.34, 112.35, 112.38, and 112.39 of this subchapter shall be superseded by the implementation of §§112.42-112.45 of this subchapter.

§112.42. Biology (One Credit), Adopted 2020.

(a) General requirements. Students shall be awarded one credit for successful completion of this course. This course is recommended for students in Grades 9-11.

(b) Introduction.

(1) Biology. Students in Biology focus on patterns, processes, and relationships of living organisms through four main concepts: biological structures, functions, and processes; mechanisms of genetics; biological evolution; and interdependence within environmental systems. By the end of Grade 12, students are expected to gain sufficient knowledge of the scientific and engineering practices across the disciplines of science to make informed decisions using critical thinking and scientific problem solving.

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

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

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

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

(4) 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.

(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.

(5) 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).

(6) 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 a tool 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.

(7) Statements containing 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) 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 microscopes, slides, Petri dishes, laboratory glassware, metric rulers, digital balances, pipets, filter paper, micropipettes, gel electrophoresis and polymerase chain reaction (PCR) apparatuses, microcentrifuges, water baths, incubators,

thermometers, hot plates, data collection probes, test tube holders, lab notebooks or journals, hand lenses, and models, diagrams, or samples of biological specimens or structures;

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

(F) organize quantitative and qualitative data using scatter plots, line graphs, bar graphs, charts, data tables, digital tools, diagrams, scientific drawings, and student-prepared models;

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

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

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

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

(B) analyze data by identifying 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.

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

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

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

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

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

(A) 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.

(5) Science concepts--biological structures, functions, and processes. The student knows that biological structures at multiple levels of organization perform specific functions and processes that affect life. The student is expected to:

(A) relate the functions of different types of biomolecules, including carbohydrates, lipids, proteins, and nucleic acids, to the structure and function of a cell;

(B) compare and contrast prokaryotic and eukaryotic cells, including their complexity, and compare and contrast scientific explanations for cellular complexity;

(C) investigate homeostasis through the cellular transport of molecules; and

(D) compare the structures of viruses to cells and explain how viruses spread and cause disease.

(6) Science concepts--biological structures, functions, and processes. The student knows how an organism grows and the importance of cell differentiation. The student is expected to:

(A) explain the importance of the cell cycle to the growth of organisms, including an overview of the stages of the cell cycle and deoxyribonucleic acid (DNA) replication models;

(B) explain the process of cell specialization through cell differentiation, including the role of environmental factors; and

(C) relate disruptions of the cell cycle to how they lead to the development of diseases such as cancer.

(7) Science concepts--mechanisms of genetics. The student knows the role of nucleic acids in gene expression. The student is expected to:

(A) identify components of DNA, explain how the nucleotide sequence specifies some traits of an organism, and examine scientific explanations for the origin of DNA;

(B) describe the significance of gene expression and explain the process of protein synthesis using models of DNA and ribonucleic acid (RNA);

(C) identify and illustrate changes in DNA and evaluate the significance of these changes; and

(D) discuss the importance of molecular technologies such as polymerase chain reaction (PCR), gel electrophoresis, and genetic engineering that are applicable in current research and engineering practices.

(8) Science concepts--mechanisms of genetics. The student knows the role of nucleic acids and the principles of inheritance and variation of traits in Mendelian and non-Mendelian genetics. The student is expected to:

(A) analyze the significance of chromosome reduction, independent assortment, and crossing-over during meiosis in increasing diversity in populations of organisms that reproduce sexually; and

(B) predict possible outcomes of various genetic combinations using monohybrid and dihybrid crosses, including non-Mendelian traits of incomplete dominance, codominance, sex-linked traits, and multiple alleles.

(9) Science concepts--biological evolution. The student knows evolutionary theory is a scientific explanation for the unity and diversity of life that has multiple lines of evidence. The student is expected to:

(A) analyze and evaluate how evidence of common ancestry among groups is provided by the fossil record, biogeography, and homologies, including anatomical, molecular, and developmental; and

(B) examine scientific explanations for varying rates of change such as gradualism, abrupt appearance, and stasis in the fossil record.

(10) Science concepts--biological evolution. The student knows evolutionary theory is a scientific explanation for the unity and diversity of life that has multiple mechanisms. The student is expected to:

(A) analyze and evaluate how natural selection produces change in populations and not in individuals;

(B) analyze and evaluate how the elements of natural selection, including inherited variation, the potential of a population to produce more offspring than can survive, and a finite supply of environmental resources, result in differential reproductive success;

(C) analyze and evaluate how natural selection may lead to speciation; and

(D) analyze evolutionary mechanisms other than natural selection, including genetic drift, gene flow, mutation, and genetic recombination, and their effect on the gene pool of a population.

(11) Science concepts--biological structures, functions, and processes. The student knows the significance of matter cycling, energy flow, and enzymes in living organisms. The student is expected to:

(A) explain how matter is conserved and energy is transferred during photosynthesis and cellular respiration using models, including the chemical equations for these processes; and

(B) investigate and explain the role of enzymes in facilitating cellular processes.

(12) Science concepts--biological structures, functions, and processes. The student knows that multicellular organisms are composed of multiple systems that interact to perform complex functions. The student is expected to:

(A) analyze the interactions that occur among systems that perform the functions of regulation, nutrient absorption, reproduction, and defense from injury or illness in animals; and

(B) explain how the interactions that occur among systems that perform functions of transport, reproduction, and response in plants are facilitated by their structures.

(13) Science concepts--interdependence within environmental systems. The student knows that interactions at various levels of organization occur within an ecosystem to maintain stability. The student is expected to:

(A) investigate and evaluate how ecological relationships, including predation, parasitism, commensalism, mutualism, and competition, influence ecosystem stability;

(B) analyze how ecosystem stability is affected by disruptions to the cycling of matter and flow of energy through trophic levels using models;

(C) explain the significance of the carbon and nitrogen cycles to ecosystem stability and analyze the consequences of disrupting these cycles; and

(D) explain how environmental change, including change due to human activity, affects biodiversity and analyze how changes in biodiversity impact ecosystem stability.

§112.43. Chemistry (One Credit), Adopted 2020.

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

(b) Introduction.

(1) Chemistry. In Chemistry, students conduct laboratory and field investigations, use scientific practices during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study a variety of topics that include characteristics of matter, use of the Periodic Table, development of atomic theory, chemical bonding, chemical stoichiometry, gas laws, solution chemistry, acid-base chemistry, thermochemistry, and nuclear chemistry. Students

investigate how chemistry is an integral part of our daily lives. By the end of Grade 12, students are expected to gain sufficient knowledge of the scientific and engineering practices across the disciplines of science to make informed decisions using critical thinking and scientific problem solving.

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

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

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

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

(4) 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 includes 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.

(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.

(5) 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).

(6) 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 a tool 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.

(7) Statements containing 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) 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 Safety Data Sheets (SDS), scientific or graphing calculators, computers and probes, electronic balances, an adequate supply of consumable chemicals, and sufficient scientific glassware such as beakers, Erlenmeyer flasks, pipettes, graduated cylinders, volumetric flasks, and burettes;

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

(F) organize quantitative and qualitative data using oral or written lab reports, labeled drawings, particle diagrams, charts, tables, graphs, journals, summaries, or technology-based reports;

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

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

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

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

(B) analyze data by identifying 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.

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

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

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

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

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

(A) 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.

(5) Science concepts. The student understands the development of the Periodic Table and applies its predictive power. The student is expected to:

(A) explain the development of the Periodic Table over time using evidence such as chemical and physical properties;

(B) predict the properties of elements in chemical families, including alkali metals, alkaline earth metals, halogens, noble gases, and transition metals, based on valence electrons patterns using the Periodic Table; and

(C) analyze and interpret elemental data, including atomic radius, atomic mass, electronegativity, ionization energy, and reactivity to identify periodic trends.

(6) Science concepts. The student understands the development of atomic theory and applies it to real-world phenomena. The student is expected to:

(A) construct models using Dalton's Postulates, Thomson's discovery of electron properties, Rutherford's nuclear atom, Bohr's nuclear atom, and Heisenberg's Uncertainty Principle to show the development of modern atomic theory over time;

(B) describe the structure of atoms and ions, including the masses, electrical charges, and locations of protons and neutrons in the nucleus and electrons in the electron cloud;

(C) investigate the mathematical relationship between energy, frequency, and wavelength of light using the electromagnetic spectrum and relate it to the quantization of energy in the emission spectrum;

(D) calculate average atomic mass of an element using isotopic composition; and

(E) construct models to express the arrangement of electrons in atoms of representative elements using electron configurations and Lewis dot structures.

(7) Science concepts. The student knows how atoms form ionic, covalent, and metallic bonds. The student is expected to:

(A) construct an argument to support how periodic trends such as electronegativity can predict bonding between elements;

(B) name and write the chemical formulas for ionic and covalent compounds using International Union of Pure and Applied Chemistry (IUPAC) nomenclature rules;

(C) classify and draw electron dot structures for molecules with linear, bent, trigonal planar, trigonal pyramidal, and tetrahedral molecular geometries as explained by Valence Shell Electron Pair Repulsion (VSEPR) theory; and

(D) analyze the properties of ionic, covalent, and metallic substances in terms of intramolecular and intermolecular forces.

(8) Science concepts. The student understands how matter is accounted for in chemical substances. The student is expected to:

(A) define mole and apply the concept of molar mass to convert between moles and grams;

(B) calculate the number of atoms or molecules in a sample of material using Avogadro's number;

(C) calculate percent composition of compounds; and

(D) differentiate between empirical and molecular formulas.

(9) Science concepts. The student understands how matter is accounted for in chemical reactions. The student is expected to:

(A) interpret, write, and balance chemical equations, including synthesis, decomposition, single replacement, double replacement, and combustion reactions using the law of conservation of mass;

(B) differentiate among acid-base reactions, precipitation reactions, and oxidation-reduction reactions;

(C) perform stoichiometric calculations, including determination of mass relationships, gas volume relationships, and percent yield; and

(D) describe the concept of limiting reactants in a balanced chemical equation.

(10) Science concepts. The student understands the principles of the kinetic molecular theory and ideal gas behavior. The student is expected to:

(A) describe the postulates of the kinetic molecular theory;

(B) describe and calculate the relationships among volume, pressure, number of moles, and temperature for an ideal gas; and

(C) define and apply Dalton's law of partial pressure.

(11) Science concepts. The student understands and can apply the factors that influence the behavior of solutions. The student is expected to:

(A) describe the unique role of water in solutions in terms of polarity;

(B) distinguish among types of solutions, including electrolytes and nonelectrolytes and unsaturated, saturated, and supersaturated solutions;

(C) investigate how solid and gas solubilities are influenced by temperature using solubility curves and how rates of dissolution are influenced by temperature, agitation, and surface area;

(D) investigate the general rules regarding solubility and predict the solubility of the products of a double replacement reaction;

(E) calculate the concentration of solutions in units of molarity; and

(F) calculate the dilutions of solutions using molarity.

(12) Science concepts. The student understands and applies various rules regarding acids and bases. The student is expected to:

(A) name and write the chemical formulas for acids and bases using IUPAC nomenclature rules;

(B) define acids and bases and distinguish between Arrhenius and Bronsted-Lowry definitions;

(C) differentiate between strong and weak acids and bases;

(D) predict products in acid-base reactions that form water; and

(E) define pH and calculate the pH of a solution using the hydrogen ion concentration.

(13) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to:

(A) explain everyday examples that illustrate the four laws of thermodynamics;

(B) investigate the process of heat transfer using calorimetry;

(C) classify processes as exothermic or endothermic and represent energy changes that occur in chemical reactions using thermochemical equations or graphical analysis; and

(D) perform calculations involving heat, mass, temperature change, and specific heat.

(14) Science concepts. The student understands the basic processes of nuclear chemistry. The student is expected to:

(A) describe the characteristics of alpha, beta, and gamma radioactive decay processes in terms of balanced nuclear equations;

(B) compare fission and fusion reactions; and

(C) give examples of applications of nuclear phenomena such as nuclear stability, radiation therapy, diagnostic imaging, solar cells, and nuclear power.

§112.44. Integrated Physics and Chemistry (One Credit), Adopted 2020.

(a) General requirements. Students shall be awarded one credit for successful completion of this course. This course is recommended for students in Grades 9 and 10.

(b) Introduction.

(1) Integrated Physics and Chemistry. In Integrated Physics and Chemistry, students conduct laboratory and field investigations, use engineering practices, use scientific practices 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. By the end of Grade 12, students are expected to gain sufficient knowledge of the scientific and engineering practices across the disciplines of science to make informed decisions using critical thinking and scientific problem solving.

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

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

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

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

(4) 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.

(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.

(5) 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).

(6) 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 a tool 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.

(7) Statements containing 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) 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 data-collecting probes, software applications, the internet, standard laboratory glassware, metric rulers, meter sticks, spring scales, multimeters, Gauss meters, wires, batteries, light bulbs, switches, magnets, electronic balances, mass sets, Celsius thermometers, hot plates, an adequate supply of consumable chemicals, lab notebooks or journals, timing devices, models, and diagrams;

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

(F) organize quantitative and qualitative data using labeled drawings and diagrams, graphic organizers, charts, tables, and graphs;

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

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

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

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

(B) analyze data by identifying 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.

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

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

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

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

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

(A) 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.

(5) Science concepts. The student knows the relationship between force and motion in everyday life. The student is expected to:

(A) investigate, analyze, and model motion in terms of position, velocity, acceleration, and time using tables, graphs, and mathematical relationships;

(B) analyze data to explain the relationship between mass and acceleration in terms of the net force on an object in one dimension using force diagrams, tables, and graphs;

(C) apply the concepts of momentum and impulse to design, evaluate, and refine a device 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;

(D) describe the nature of the four fundamental forces: gravitation; electromagnetic; the strong and weak nuclear forces, including fission and fusion; and mass-energy equivalency; and

(E) construct and communicate an explanation based on evidence for how changes in mass, charge, and distance affect the strength of gravitational and electrical forces between two objects.

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

(A) design and construct series and parallel circuits that model real-world circuits such as in-home wiring, automobile wiring, and simple electrical devices to evaluate the transfer of electrical energy;

(B) design, evaluate, and refine a device that generates electrical energy through the interaction of electric charges and magnetic fields;

(C) plan and conduct an investigation to provide evidence that energy is conserved within a closed system;

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

(E) plan and conduct an investigation to evaluate the transfer of energy or information through different materials by different types of waves such as wireless signals, ultraviolet radiation, and microwaves;

(F) construct and communicate an evidence-based explanation for how wave interference, reflection, and refraction are used in technology such as medicine, communication, and scientific research; and

(G) evaluate evidence from multiple sources to critique the advantages and disadvantages of various renewable and nonrenewable energy sources and their impact on society and the environment.

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

(A) model basic atomic structure and relate an element's atomic structure to its bonding, reactivity, and placement on the Periodic Table;

(B) use patterns within the Periodic Table to predict the relative physical and chemical properties of elements;

(C) explain how physical and chemical properties of substances are related to their usage in everyday life such as in sunscreen, cookware, industrial applications, and fuels;

(D) explain how electrons can transition from a high energy level to a low energy state, emitting photons at different frequencies for different energy transitions;

(E) explain how atomic energy levels and emission spectra present evidence for the wave particle duality; and

(F) plan and conduct an investigation to provide evidence that the rate of reaction or dissolving is affected by multiple factors such as particle size, stirring, temperature, and concentration.

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

(A) investigate how changes in properties are indicative of chemical reactions such as hydrochloric acid with a metal, oxidation of metal, combustion, and neutralizing an acid with a base;

(B) develop and use models to balance chemical equations and support the claim that atoms, and therefore mass, are conserved during a chemical reaction;

(C) research and communicate the uses, advantages, and disadvantages of nuclear reactions in current technologies; and

(D) construct and communicate an evidence-based explanation of the environmental impact of the end-products of chemical reactions such as those that may result in degradation of water, soil, air quality, and global climate change.

§112.45. Physics (One Credit), Adopted 2020.

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Recommended prerequisite or corequisite: Algebra I. This course is recommended for students in Grades 9-12.

(b) Introduction.

(1) Physics. In Physics, students conduct laboratory and field investigations, use scientific practices 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, characteristics and behavior of waves, and electricity and magnetism. Students will apply conceptual knowledge and collaborative skills to experimental design, implementation, and interpretation. By the end of Grade 12, students are expected to gain sufficient knowledge of the scientific and engineering practices across the disciplines of science to make informed decisions using critical thinking and scientific problem solving.

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

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

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

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

(4) 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.

(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.

(5) 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).

(6) 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 a tool 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.

(7) Statements containing 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) 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 balances, ballistic carts or equivalent, batteries, computers, constant velocity cars, convex lenses, copper wire, discharge tubes with power supply (H, He, Ne, Ar), data acquisition probes and software, dynamics and force demonstration equipment, electrostatic generators, electrostatic kits, friction blocks, graph paper, graphing technology, hand-held visual spectroscopes, inclined planes, iron filings, lab masses, laser pointers, magnets, magnetic compasses, metric rulers, motion detectors, multimeters (current, voltage, resistance), optics bench, optics kit, photogates, plane mirrors, prisms, protractors, pulleys, resistors, rope or string, scientific calculators, stopwatches, springs, spring scales, switches, tuning forks, wave generators, 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;

(F) organize quantitative and qualitative data using bar charts, line graphs, scatter plots, data tables, labeled diagrams, and conceptual mathematical relationships;

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

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

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

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

(B) analyze data by identifying 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.

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

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

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

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

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

(A) 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.

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

(A) analyze different types of motion by generating and interpreting position versus time, velocity versus time, and acceleration versus time using hand graphing and real-time technology such as motion detectors, photogates, or digital applications;

(B) define scalar and vector quantities related to one- and two-dimensional motion and combine vectors using both graphical vector addition and the Pythagorean theorem;

(C) describe and analyze motion in one dimension using equations with the concepts of distance, displacement, speed, velocity, frames of reference, and acceleration;

(D) describe and analyze acceleration in uniform circular and horizontal projectile motion in two dimensions using equations;

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

(F) calculate the effect of forces on objects, including tension, friction, normal, gravity, centripetal, and applied forces, using free body diagrams and the relationship between force and acceleration as represented by Newton's second law of motion;

(G) illustrate and analyze the simultaneous forces between two objects as represented in Newton's third law of motion using free body diagrams and in an experimental design scenario; and

(H) describe and calculate, using scientific notation, 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.

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

(A) use scientific notation and 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) identify and describe examples of electric and magnetic forces and fields in everyday life such as generators, motors, and transformers;

(C) investigate and describe conservation of charge during the processes of induction, conduction, and polarization using different materials such as electroscopes, balloons, rods, fur, silk, and Van de Graaf generators;

(D) analyze, design, and construct series and parallel circuits using schematics and materials such as switches, wires, resistors, lightbulbs, batteries, voltmeters, and ammeters; and

(E) calculate current through, potential difference across, resistance of, and power used by electric circuit elements connected in both series and parallel circuits using Ohm's law.

(7) 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) calculate and explain work and power in one dimension and identify when work is and is not being done by or on a system;

(B) investigate and calculate mechanical, kinetic, and potential energy of a system;

(C) apply the concept of conservation of energy using the work-energy theorem, energy diagrams, and energy transformation equations, including transformations between kinetic, potential, and thermal energy;

(D) calculate and describe the impulse and momentum of objects in physical systems such as automobile safety features, athletics, and rockets; and

(E) analyze the conservation of momentum qualitatively in inelastic and elastic collisions in one dimension using models, diagrams, and simulations.

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

(A) examine and describe simple harmonic motion such as masses on springs and pendulums and wave energy propagation in various types of media such as surface waves on a body of water and pulses in ropes;

(B) compare the characteristics of transverse and longitudinal waves, including electromagnetic and sound waves;

(C) investigate and analyze characteristics of waves, including velocity, frequency, amplitude, and wavelength, and calculate using the relationships between wave speed, frequency, and wavelength;

(D) investigate behaviors of waves, including reflection, refraction, diffraction, interference, standing wave, the Doppler effect and polarization and superposition; and

(E) compare the different applications of the electromagnetic spectrum, including radio telescopes, microwaves, and x-rays;

(F) investigate the emission spectra produced by various atoms and explain the relationship to the electromagnetic spectrum; and

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

(9) Science concepts. The student knows examples of quantum phenomena and their applications. The student is expected to:

(A) describe the photoelectric effect and emission spectra produced by various atoms and how both are explained by the photon model for light;

(B) investigate Malus's Law and describe examples of applications of wave polarization, including 3-D movie glasses and LCD computer screens;

(C) compare and explain how superposition of quantum states is related to the wave-particle duality nature of light; and

(D) give examples of applications of quantum phenomena, including the Heisenberg uncertainty principle, quantum computing, and cybersecurity.