Guidelines for Content Advisor Feedback

Please review the proposed revisions to the Texas Essential Knowledge and Skills (TEKS) for

- the four high school courses: Biology, Chemistry, Integrated Physics and Chemistry (IPC), and Physics, and
- scientific process for kindergarten–grade 12 (scientific and engineering practices).

Use the following questions to develop feedback for the State Board of Education regarding revisions to the standards.

There is no specific format required for your feedback. When referencing specific portions of the TEKS, please indicate the course and specific letter/number of the standard and course to which you are referring, as appropriate. Feedback may be limited to specific courses; however, please specify in comments which course(s) is addressed.

Guiding Questions- High School Courses

1. Does each course follow a complete and logical development of science concepts presented? If not, what suggestions do you have for improvement?

Yes, I believe that the courses follow and very comprehensive and logical set of concepts and are organized in a sensible order.

2. Do the standards for the course(s) adequately address scientific concepts? If not, please give examples of how the standards might be improved.

Yes, the standards contain a very high level of expectancy from students and teachers. The concepts covered are extremely deep and broad. The successful high school students that have completed these courses will be well-prepared for university science curriculum.

4. Are there any gaps or concepts missing that should be addressed? Are there specific areas that need to be updated to reflect current research?

I have noted this with comments in the document, but I would suggest addressing whole genome sequencing and/or metagenomics in biology.

5. Do the high school courses course(s) sufficiently prepare students for postsecondary success? If not, please provide suggestions for improving the standards.

Yes, I am confident in that. As previously stated, the curriculum is extremely robust, and I believe it will prepare high school students very well for university science curriculum.

6. Does each course include sufficient standards focused on laboratory and field investigation?

Yes, there is a strong emphasis on experiential learning through demonstration and laboratory exercises.

7. Are the student expectations clear and specific? If not, please give examples of how the language might be improved.

The language is sufficient, but the support of TEK and teaching guides will be critical to provide examples and guidance.

8. Are there student expectations that are not essential or unnecessarily duplicative and can be eliminated? If so, please identify by course and student expectation number, e.g., Physics 4.B.

I did not identify any glaring incidences of redundancy. The course seem to be complimentary with minimal overlap.

Guiding Questions- Scientific and engineering practices

1. Are the student expectations in the science and engineering practices clear and specific? If not, please give examples of how the language might be improved.

   Yes, for the most part, the text is clear and specific. I (Woerner) have noted in the pdf document the minor exceptions.

2. Do the science and engineering practices sufficiently prepare students to engage in investigative and engineering design processes? If not, please provide suggestions for improving the standards.

   Yes, I believe that these practices prepare students beyond adequacy in the areas of scientific and engineering practices.

3. Are there any gaps or practices missing that should be addressed?

   None.

Submitted by Dale Woerner

Final Recommendations
Texas Essential Knowledge and Skills (TEKS)
Scientific and Engineering Practices, Kindergarten–High School

This document reflects final recommendations from the State Board of Education's TEKS work group for scientific and engineering practices and indicates the changes from the previous draft completed in June 2020. Proposed deletions are shown in red font with strikethroughs (~~deletions~~). Text proposed to be moved from its original proposed location is shown in purple italicized font with strikethrough (~~*moved text*~~) and is shown in the proposed new location in purple italicized font with underlines (*new text location*). Additions are shown in green font with underlines (additions).

The Scientific and Engineering Practices Work Group is in agreement with the recommendation from Work Group A and the content advisors to integrate scientific and engineering practices into the process skills in the current TEKS. Additionally, the work group is in agreement with the recommendation to rename the strand as "Scientific and engineering practices." The decision to call the strand scientific and engineering practices stems from the need to emphasize to teachers these are actual experiences we want students to have in their K-12 science education. Using the word "practices" encourages exploration and promotes hands on experiences as opposed to only following a prescriptive process. Students, although making connections between science and engineering, must engage in the practice of investigating and designing in order to answer questions and solve problems. An alternative strand name that would be acceptable to the workgroup would be "Scientific processes and engineering practices."

The work group reorganized the structure of the knowledge and skills statements and student expectations in the current Scientific Processes strand to reflect key domains of the scientific and engineering process: designing investigations, evaluating data, and developing explanations and solutions. The organization of the scientific and engineering practices strand coincides with practices in which a scientist or engineer would engage to answer a question or solve a problem. The current TEKS (process skills) include many of these practices, however, the workgroup wanted to ensure each step of the scientific process was well-defined and in an order that is most applicable for teachers. The work group maintained student expectations specific to issues related to science and society to give a context to science and engineering.

Using the K-12 Framework for Science Education, the workgroup made an effort to maintain as much of the language in the current TEKS as possible. The additional language serves to further define certain processes (example: New SE (1)(E) "quantitative and qualitative data"). Some SEs reference both the scientific practice as well as the engineering practice with differing language, however, since there are multiple ways science and engineering overlap, it would be misleading to have "separate" TEKS just for engineering.

To support vertical alignment the work group developed student expectations for K-12, using common vocabulary, phrases, and numbering. In addition, the work group recommends keeping SEs consistent within each grade band. This allows for teachers to deepen their knowledge and understanding of the TEKS and for students to work to gain mastery of those skills and practices over multiple years, increasing in rigor as the content rigor increases. The SEs concerning tools and representations of data, however, should be differentiated based on grade-level content or appropriateness.

The work group maintained the requirement for percentage of instructional time for investigations for grades 6-12 (40%) within the knowledge and skills statements. The work group recommends maintaining the percentage of instructional time for investigations that is recommended for K-5 and including it in the introduction. The work group recommends moving current SEs (2)(A), (B), and (C) from Biology, Chemistry, and Physics into the introduction for all high school courses. These student expectations are definitions which are more appropriately presented in the introduction. The student expectation (2)(D) in Biology and Chemistry is an applicable, measurable practice; therefore, the work group recommends maintaining its inclusion in the student expectations for grades 6-12.

Number: 1 Author: dwoerner Subject: Sticky Note Date: 8/20/2020 9:31:20 PM

I would concur that this strand name provides greater clarity for science and engineering. Technically the 2 strand names are the same, but this options leaves no room for misinterpretation.

Submitted by Dale Woerner

<table>
<tr>
<td colspan="2">1. Scientific and engineering practices. The student asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, ~~seek answers,~~ explain phenomena, or design solutions using appropriate tools and models.</td>
<td colspan="2">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, ~~seek answers,~~ explain phenomena, or design solutions using appropriate tools and models.</td>
<td>Current TEKS address the planning and implementation in one SE; KS 1 introduces the planning and implementation process and the SEs breakdown the process into steps.

Adds clarity and specificity for teachers so they can address each component of the process.

“Phenomena” is a term used in the scientific community. Use of this term in the TEKS builds teacher’s depth of knowledge and gives them the correct scientific language to describe objects or events occurring in the natural world which inspire curiosity from students. Including the term in the student expectations can help foster connections to those phenomena present in the content standards (organisms, objects, and events observed in the natural world) to the practices used in exploring them.</td>
</tr>
<tr>
<th>Kindergarten-Grade 2</th>
<th>Grades 3-5</th>
<th>Grades 6-8</th>
<th>High school</th>
<th>Comments</th>
</tr>
<tr>
<td>A. ask questions and define problems based on observations or information from text, phenomena, models, or investigations</td>
<td>A. ask questions and define problems based on observations or information from text, phenomena, models, or investigations</td>
<td>A. ask questions and define problems based on observations or information from text, phenomena, models, or investigations</td>
<td>A. ask questions and define problems based on observations or information from text, phenomena, models, or investigations</td>
<td>Specific and grade-appropriate phenomena can be addressed in the content and TEKS Guide.

Current 3-8 (2)(A) and high school (2)(E) combine asking questions with implementing an investigation. These have been broken up into multiple SEs.</td>
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</table>

This page contains no comments

Submitted by Dale Woerner

Kindergarten-Grade 2	Grades 3-5	Grades 6-8	High school	Comments
B. use scientific practices to plan and conduct simple descriptive investigations and use engineering practices to *design* ~~develop~~ solutions to ~~*design*~~ problems	B. use scientific practices to plan and conduct descriptive investigations and use engineering practices to *design* ~~develop~~ solutions to ~~*design*~~ problems (Grades 3-4) B. use scientific practices to plan and conduct descriptive and simple experimental investigations and use engineering practices to *design* ~~develop~~ solutions to ~~*design*~~ problems (Grade 5)	B. use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to *design* ~~develop~~ solutions to ~~*design*~~ problems	B. apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to *design* ~~develop~~ solutions to ~~*design*~~ problems	Current TEKS use “implement” versus “conduct” but the expectation is the same. The investigations listed are consistent with the current TEKS with the exception of adding descriptive investigations to the grade 5 SE. Designing solutions includes the creation of end products to engineering tasks. End products could be physical devices, prototypes, models, drawings, or processes. It should be noted the content standards can offer more direction for specific products students should develop based on the student expectations for the course.
C. identify, describe, and demonstrate safe practices during classroom and field investigations as outlined in Texas Education Agency-approved safety standards	C. demonstrate safe practices and the use of safety equipment during classroom and field investigations as outlined in Texas Education Agency-approved safety standards	**C.** use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency approved safety standards	C. use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency approved safety standards	For K-5 TEKS the specific measures in the current TEKS were deleted to allow for choice based on the needs of the investigation. Recommend linking to the cohesive safety standards to the TEA approved safety standard.

This page contains no comments

Submitted by Dale Woerner

Kindergarten-Grade 2	Grades 3-5	Grades 6-8	High school	Comments
D. use tools to observe, measure, test, and compare to make observations and design solutions to problems, including (grade-level work group will list tools based on standards)*	D. use tools to observe, measure, test, and analyze information to make observations and design solutions to problems, including (grade-level work group will list tools based on standards)*	D. use appropriate tools, such as including (list should be grade-level specific)*	D. use appropriate tools such as use appropriate tools such as	The current TEKS address appropriate tools. For K-5, it's important to introduce and scaffold an understanding of tools and the context in which they are selected and used.
			Biology— microscopes, slides, Petri dishes, laboratory glassware, metric rulers, digital balances, pipets, filter paper, micropipettes, gel electrophoresis and 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	
			IPC— data-collecting probes, apps, 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, diagrams and the internet	
			Chemistry— 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, pipets, graduated cylinders, volumetric flasks, and burettes	

*Future K-8 work groups will develop recommendations for grade-level specific SEs

Number: 1 Author: dwoerner Subject: Sticky Note Date: 8/20/2020 9:40:12 PM

The word "including" should also be struck out.

Number: 2 Author: dwoerner Subject: Sticky Note Date: 8/20/2020 9:43:28 PM

Suggest the addition of acid/base chemistry tools (i.e. litmus paper or pH probe)

Submitted by Dale Woerner

Kindergarten-Grade 2	Grades 3-5	Grades 6-8	High school	
			D. (continued) use appropriate tools such as **Physics—** 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, dynam ics 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/string, scientific calculators, stopwatches, springs, spring scales, switches, tuning forks, wave generators, and/or other equipment and materials that will produce the same results	
E. collect observations and measurements as evidence ~~to answer questions, explain phenomena, or test design solutions~~	E. collect observations and measurements as evidence ~~to answer questions, explain phenomena, or test design solutions~~	E. collect quantitative data using the International System of Units (SI) and qualitative data as evidence ~~to answer questions, explain phenomena, or test design solutions~~	E. collect quantitative data using the International System of Units (SI) and qualitative data as evidence ~~to answer questions, explain phenomena, or test design solutions~~	The current TEKS address collection of data. For K-5 it's helpful to scaffold for teachers that observations and measurements are data. For high school, aligned the SEs related to the types of data that is collected across the courses. The purpose for collecting data (to answer questions, explain phenomena, or design solutions) is more appropriate in the KS because it applies to all of SEs in this section. (streamlining).

This page contains no comments

Submitted by Dale Woerner

Kindergarten-Grade 2	Grades 3-5	Grades 6-8	High School	Comments
F. record and organize data using pictures, numbers, words, and simple graphs (insert grade-level appropriate graphs)*	F. construct appropriate simple tables, graphs, maps, and charts to organize data (insert grade-level appropriate graphs)*	F. construct appropriate tables, graphs, maps, and charts using repeated trials and means, to organize data (insert grade-level appropriate graphs)*	F. organize qualitative and quantitative data using	The current TEKS address organization of data. The revisions reinforce the alignment with grade-level math TEKS. For high school, aligned the SEs related to organization of data that is collected across the courses.
			Biology— scatter plots, line graphs, bar graphs, charts, data tables, digital tools, diagrams, scientific drawings, and student-prepared models	
			IPC— labeled drawings and diagrams, graphic organizers, charts, tables, and graphs	
			Chemistry— oral or written lab reports, labeled drawings, particle diagrams, charts, tables, graphs, journals, summaries, or technology-based reports	
			Physics— bar charts, line graphs, scatter plots, data tables, labeled diagrams, and conceptual mathematical relationships	

*Future K-8 work groups will develop recommendations for grade-level specific SEs

Number: 1 Author: dwoerner Subject: Sticky Note Date: 8/20/2020 9:45:21 PM

Statement is incomplete.

Submitted by Dale Woerner

Kindergarten-Grade 2	Grades 3-5	Grades 6-8	High school	Comments
G. develop and use a models to conceptually represent phenomena, objects, and processes and tools or design a prototype for a solution to a problem	G. develop and use a models to represent phenomena, objects, and processes for tools, objects, and things that cannot be experienced or or design a prototype for a solution to a problem	G. develop and use models to represent phenomena, systems, or processes, or solutions to engineering problems in order to answer questions or to refine designs	G. develop and use models to represent phenomena, systems, and processes, or solutions to engineering problems in order to answer questions or to refine designs	The current K-2 TEKS do not include models. For grades 3- 8 and high school, using or evaluating models are addressed but developing models is only in grade 5. The types of models can be addressed in the TEKS Guide and left open for teachers to select. Developing a model can be an end product in designing a solution.
		H. distinguish between scientific hypotheses, theories, and laws	H. distinguish between scientific hypotheses, theories, and laws	Scientific hypotheses and theories are not addressed in the current TEKS for every high school course. The revisions aligns the SE across high school courses and adds the SE to 6-8.

This page contains no comments

Submitted by Dale Woerner

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:			**Comment:** Current TEKS address the evaluation and analysis of data; however, KS 2 breaks the process down into steps that are clearer and more specific for teachers. The SEs in this KS emphasize the importance of evaluating and analyzing data in scientific and engineering practices.	
Kindergarten-Grade 2	**Grades 3-5**	**Grades 6-8**	**High school**	**Comments**
A. identify basic advantages and limitations of models such as their size, scale, properties, and materials	A. identify advantages and limitations of models such as their size, scale, properties, and materials	A. identify advantages and limitations of models such as their size, scale, properties, and materials	A. identify advantages and limitations of models such as their size, scale, properties, and materials	Limitation of models are in the current TEKS with the exception of K-2. For high school, aligned the SEs related to limitations of models across the courses and added what the limitations are. The complexity of models and their limitations increase across grade-levels and courses and are dependent on the content.
B. analyze data by identifying significant features and patterns	B. analyze data by identifying any significant features, ~~and~~ patterns, ~~and take into account~~ or sources of error ~~or limitations~~	B. analyze data by identifying any significant descriptive statistical features, ~~and~~ patterns, ~~apply statistics and probability, and take into account~~ sources of error, or limitations	B. analyze data by identifying any significant statistical features, ~~and~~ patterns, ~~apply statistics and probability, and take into account~~ sources of error, and ~~or~~ limitations	The current TEKS require students to analyze data in grades 3-12. Students in K-2 have the ability to analyze data and are already expected to do so in the current TEKS, e.g., using seasonal and weather data to make choices. Students in grades 3-5 also have the ability to identify errors in sources of data such as why an experiment didn't work. Recommend providing grade-level appropriate examples of statistical and descriptive statistical features of data, sources of error, and limitations in the TEKS Guide.

This page contains no comments

Submitted by Dale Woerner

Kindergarten-Grade 2	Grades 3-5	Grades 6-8	High school	Comments
C. ~~explain and compare numerical representations of data and patterns to explore scientific questions and engineering problems~~ C. use mathematical concepts to compare two objects with common attributes	C. ~~explain and compare numerical representations of data and patterns to explore scientific questions and engineering problems~~ C. use mathematical calculations to compare patterns and relationships	C. use mathematical calculations ~~concepts and processes~~ to assess quantitative relationships in data ~~patterns or correlations while investigating scientific questions and engineering problems~~.	C. use mathematical calculations ~~concepts and processes~~ to assess ~~patterns or correlations and apply~~ quantitative relationships in data ~~while investigating scientific questions and engineering problems~~	The current TEKS include mathematical concepts and calculations. The revisions reinforce the alignment with grade-level math TEKS. For high school, aligned the SEs related to mathematical concepts and calculations across the courses
D. evaluate a design or object using criteria to determine if it works as intended	D. evaluate a design or object using criteria ~~to refine a problem statement or solution~~ (Grades 3-4) D. evaluate experimental and engineering designs (Grade 5)	D. evaluate experimental and engineering designs	D. evaluate experimental and engineering designs	Currently process skills do not have students evaluating a design. Clarify in the TEKS Guide that designs can include end products but also drawings, models, and processes.

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Number: 1 Author: dwoerner Subject: Sticky Note Date: 8/20/2020 9:53:30 PM

I am struggling to understand how identifying statistical features (B) is different from using mathematical calculations (C). I would suggest that these be combined or explained further to delineate the intended differentiation between the 2.

Submitted by Dale Woerner

3. Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions.			**Comment:** In the current TEKS students are developing and communication explanations. The proposed KS and SEs in this section are organized into three parts: developing explanations and proposing solutions; communicating explanations and solutions; and engaging in scientific argumentation to encourage critical thinking.	
Kindergarten-Grade 2	**Grades 3-5**	**Grades 6-8**	**High school**	**Comments**
A. develop explanations and propose solutions supported by data and models	A. develop explanations and propose solutions supported by data and models	A. develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories	A. develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories	Proposing a solution is an engineering practice. At the early grade levels students are already providing reasons for explanations using student-generated data in the current TEKS. (1.2.E)
B. communicate explanations and solutions individually and collaboratively in a variety of settings and formats	B. communicate explanations and solutions individually and collaboratively in a variety of settings and formats	B. communicate explanations and solutions individually and collaboratively in a variety of settings and formats	B. communicate explanations and solutions individually and collaboratively in a variety of settings and formats	In the current TEKS, students communicate explanations (valid conclusions). The proposed SEs build 21st century skills used in science and engineering practices which includes collaborations and communication. Designing solutions is an engineering practice and this SE requires students to communicate about their solutions. The complexity of explanations increase across grade-levels and courses and are dependent on the content.

This page contains no comments

Submitted by Dale Woerner

Kindergarten-Grade 2	Grades 3-5	Grades 6-8	High school	Comments
C. listen actively to others' explanations to identify important ~~relevant~~ evidence and engage respectfully in scientific discussion ~~argumentation~~	C. listen actively to others' explanations to identify relevant evidence and engage respectfully in scientific discussion ~~argumentation~~	C. engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence	C. engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence	Current SEs do not include argumentation. Scientific argumentation is a process of supporting claims with evidence based data. Scientists and engineers are required to defend their process and explanations and questions other claims, processes, and explanations Argumentation is a 21st Century skill that supports critical thinking and literacy in reading, writing, listening, and speaking skills while encouraging the "soft" skills of listening to others and questioning others' claims respectfully.

g

This page contains no comments

Submitted by Dale Woerner

4. Scientific and engineering practices. The students knows the contributions of scientists and recognizes the importance of scientific research and innovation on society.				
Kindergarten-Grade 2	**Grades 3-5**	**Grades 6-8**	**High school**	**Comments**
A. ~~B.~~ make informed decisions when reviewing promotional materials for products and services	A. ~~B.~~ make informed decisions when reviewing informational resources and promotional materials for products and services	A. ~~B.~~ make informed decisions by evaluating evidence from multiple appropriate sources to assess the credibility, accuracy, and methods used	~~A. make informed decisions by evaluating evidence from multiple appropriate sources to assess the credibility, accuracy, and methods used~~ 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*	Returning current TEKS 3A to high school while maintaining vertical alignment with earlier grades.
B. ~~A.~~ explain how science or an innovation can help others	B. ~~A.~~ explain how scientific discoveries and innovative solutions to problems impact science and society	B. ~~A.~~ relate the impact of past and current research on scientific thought and society, including the process of science and contributions of diverse scientists as related to the content	B. ~~A.~~ relate the impact of past and current research on scientific thought and society, including research methodology, ethics, and contributions of diverse scientists as related to the content	Current TEKS focus on historical scientific discoveries and scientists. The proposed SEs expand the concept to include current research and innovation and modern scientists. This SE also includes the connection between science and society.

This page contains no comments

Submitted by Dale Woerner

Kindergarten-Grade 2	Grades 3-5	Grades 6-8	High school	Comments
C. identify what a scientist or engineer is and explore what different scientists and engineers do	C. research and explore connections (connect) between grade-level appropriate science concepts and STEM careers	C. research and explore connections between grade-level appropriate science concepts and STEM careers	C. research and explore connections between grade-level appropriate science concepts and STEM careers	Current TEKS in K-5 had a science career focus. The workgroup opted to divide the original history of science SE into two components: (4B) is history and current research while (4C) focuses on STEM careers. This SE was not part of all high school courses but is being added for alignment purposes.
			~~*D. 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*~~	Moved to proposed new (4)(A)

This page contains no comments

Submitted by Dale Woerner

Final Recommendations
Texas Essential Knowledge and Skills (TEKS)
Science, High School Courses

The document reflects revisions to the science Texas Essential Knowledge and Skills (TEKS) that have been recommended by the State Board of Education's TEKS work group for Biology, Chemistry, Integrated Physics and Chemistry, and Physics. Proposed deletions are shown in red font with strikethroughs (~~deletions~~). Text proposed to be moved from its current student expectation is shown in purple italicized font with strikethrough (*~~moved text~~*) and is shown in the proposed new location in purple italicized font with underlines (*new text location*). Additions are shown in green font with underlines (additions). Numbering for the knowledge and skills statements in the document will be finalized when the proposal is prepared to file with the *Texas Register*.

Comments in the right-hand column provide explanations for the proposed changes. The following notations were used as part of the explanations:

MV—multiple viewpoints from within the work group

VA—information added, changed, or deleted to increase vertical alignment

Science TABLE OF CONTENTS

This page contains no comments

Submitted by Dale Woerner

§112.34. Biology, Adopted 2017.		
	TEKS with edits	Work Group Comments
(a)	**General requirements.** Students shall be awarded one credit for successful completion of this course. Prerequisites: none. This course is recommended for students in Grade 9, 10, or 11.	
(b)	**Introduction.**	
(1)	Biology. By the end of 12th grade, 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. 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. ~~In Biology, students conduct laboratory and field investigations, use scientific practices during investigations, and make informed decisions using critical thinking and scientific problem solving. Students in Biology study a variety of topics that include: structures and functions of cells and viruses; growth and development of organisms; cells, tissues, and organs; nucleic acids and genetics; biological evolution; taxonomy; metabolism and energy transfers in living organisms; living systems; homeostasis; and ecosystems and the environment.~~	This language is the same across courses. The purpose is to capture the goals of learning science based on the K12 Framework and combine it with what the TEKS already has.
(2)	Nature of science. According to the National Science Teaching Association (NSTA), the "nature of science is a critical component of scientific literacy that enhances students' understandings of science concepts and enables them to make informed decisions about scientifically-based personal and societal issues." ~~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.	Used a quotation for nature of science as opposed to a definition of science. The new definition emphasizes literacy.
(3)	Scientific hypotheses and theories. Students are expected to know that:	Added SEs 2.B and 2.C as recommended by the scientific and engineering practices work group. Deleted 2.A. because the content was already addressed above in 2. Definitions help teachers have a shared understanding of these terms.
(A)	otheses 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	

Number: 1 Author: dwoerner Subject: Sticky Note Date: 8/21/2020 7:21:43 AM

Capitalize.

Submitted by Dale Woerner

(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) ~~(3)~~	Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are ~~experimental,~~ descriptive, ~~or~~ comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations is as follows: descriptive investigations involve collecting data and recording observations without making comparisons; comparative investigations involve collecting data with variables that are manipulated to compare results; and experimental investigations involve processes similar to comparative investigations, but a control is identified.	Changed order for consistency and intentional ordering of "hierarchy" or types of investigations. Defined types of investigations and scientific and engineering practices as recommended by Work Group A.
(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) ~~(4)~~	Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Social [1] justice applies the concept of social responsibility to determine if something is ethical. Students should be able to distinguish between scientific decision-making methods (scientific and engineering practices ~~methods~~) and the use of ethics ~~ethical~~ and social justice to make decisions that involve ~~science (~~the application of scientific information~~)~~ and engineering design.	Better defined social ethics. Modernized language by incorporating engineering
(6) ~~(5)~~	Scientific cross-cutting concepts. Science is a series of cross cutting concepts such as ~~Science~~ systems, ~~and~~ models, and patterns. ~~A system is a collection of cycles, structures, and processes that interact~~. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested, while models allow for boundary specification and 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.	To clarify language around systems, define the cross-cutting concepts, and include additional specificity regarding scalability of models.
(7) ~~(6)~~	Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.	

Number: 1 Author: dwoerner Subject: Sticky Note Date: 8/21/2020 7:27:42 AM

I think the addition of science ethics is outstanding in a time where misinformation is extraordinarily abundant; however, it will be critical for teachers to have the appropriate resources to ensure that this happens in the way that it is intended. Perhaps TEKS guides should provide the exact scenerios used in the classroom.

Submitted by Dale Woerner

(c)	**Knowledge and skills.**	
(1)	Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:	A separate **Scientific and Engineering Practices** Work Group developed recommendations for revisions to the current process skills for K-12. Recommendations from the **Scientific and Engineering Practices** Work Group for proposed new (1)-(4) are posted on the Science TEKS Review Drafts web page.
(A)	demonstrate safe practices during laboratory and field investigations; and	
(B)	demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.	
(2)	Scientific processes. The student uses scientific practices and equipment during laboratory and field investigations. The student is expected to:	
(A)	know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;	
(B)	know that hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories;	
(C)	know 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;	
(D)	distinguish between scientific hypotheses and scientific theories;	
(E)	plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology;	
(F)	collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as data-collecting probes, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, balances, gel electrophoresis apparatuses, micropipettes, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures;	
(G)	analyze, evaluate, make inferences, and predict trends from data; and	

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(H)	~~communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.~~	
(3)	~~Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:~~	
(A)	~~analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student;~~	
(B)	~~communicate and apply scientific information extracted from various sources such as current events, published journal articles, and marketing materials;~~	
(C)	~~draw inferences based on data related to promotional materials for products and services;~~	
(D)	~~evaluate the impact of scientific research on society and the environment;~~	
(E)	~~evaluate models according to their limitations in representing biological objects or events; and~~	
(F)	~~research and describe the history of biology and contributions of scientists.~~	
(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 ~~cells are the basic structures of all living things with specialized parts that perform specific functions and that viruses are different from cells.~~ The student is expected to:**	
(A)	relate ~~compare~~ the functions of different types of biomolecules including carbohydrates, lipids, proteins, and nucleic acids to the structure and function of a cell;	Rationale: revised to place emphasis on how biomolecules are important to cell structure and function. (9)(A)
(B)	compare and contrast prokaryotic and eukaryotic cells, including their complexity, and compare and contrast scientific explanations for cellular complexity;	(4)(A)
(C)	investigate homeostasis through the cellular transport of molecules; and ~~investigate and explain cellular processes, including homeostasis and transport of molecules; and~~	Rationale: focus on the big idea of homeostasis. (4)(B)

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Will this or should this be related to human nutrition, health and well-being?

(D)	compare the structures of viruses to cells and explain how viruses spread and cause disease.~~, describe viral reproduction~~, ~~and describe the role of viruses in causing diseases such as human immunodeficiency virus (HIV) and influenza.~~	Rationale: viral reproduction (lytic vs. lysogenic cycles) is too much detail; students need to know what viruses are, how they are different from cells, and how they can cause disease. (4)(C)
(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 DNA replication using models ~~describe the stages of the cell cycle, including deoxyribonucleic acid (DNA) replication and mitosis, and the importance of the cell cycle to the growth of organisms;~~	Rationale: increase rigor with explain; emphasize the big picture of cell cycle importance (5)(A)
(B)	explain the process of cell specialization through cell differentiation including the role of environmental factors; and ~~describe the roles of DNA, ribonucleic acid (RNA), and environmental factors in cell differentiation; and.~~	Rationale: increase rigor with explain and focus on big picture of cell differentiation and specialization (5)(B)
(C)	relate ~~recognize that~~ disruptions of the cell cycle ~~lead~~ to the development of diseases such as cancer.	Rationale: to increase rigor by changing verb from low-level "recognize" and emphasize the idea of cause-and-effect (5)(C)
(7)	**Science concepts--mechanisms of genetics. The student knows ~~the mechanisms of genetics such as~~ the role of nucleic acids in gene expression ~~and the principles of Mendelian and non-Mendelian genetics.~~ The student is expected to:**	
(A)	identify components of DNA, explain how the nucleotide sequence specifies the traits of an organism ~~identify how information for specifying the traits of an organism is carried in the DNA~~, and examine scientific explanations for the origin of DNA;	Rationale: revised to clarify the connection between traits of an organism and the nucleotide sequences in DNA (6)(A)

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(B)	describe the significance of gene expression and explain the ~~purpose and~~ process of protein synthesis ~~transcription and translation~~ using models of DNA and RNA;	Rationale: revised to place emphasis on the big - picture process of protein synthesis. Gene expression (moved from 6D) is the purpose of protein synthesis. (6)(C)
(C)	identify and illustrate changes in DNA and evaluate the significance of these changes;	(6)(E)
(D)	investigate molecular technologies such as PCR, gel electrophoresis, and gene modification that are applicable in current research and engineering practices 1	Rationale: Provides students the opportunity to apply biological concepts to real-world events and current research that has an impact on their lives. A similar standard was deleted during streamlining in 2017. Also incorporates engineering applications of science. (6)(H)
(8)	**Science concepts--mechanisms of genetics. The student knows ~~the mechanisms of genetics such as the role of nucleic acids and~~ the principles of inheritance and variation of traits ~~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 ~~recognize the significance of meiosis to sexual reproduction.~~	Rationale: strengthen verb to make more rigorous; specify significance by identifying three aspects of meiosis; and tie concepts to the diversity of populations. (6)(G)
(B)	predict possible outcomes of various genetic combinations including ~~such as~~ monohybrid crosses, ~~dihybrid crosses,~~ incomplete dominance, codominance, sex-linked traits, and multiple alleles. ~~and non-Mendelian inheritance; and~~	Rationale: change from "such as" to "including" to make emphasis very clear; delete dihybrid crosses as a requirement for all students; specify the types of non-Mendelian inheritance expected to be taught (6)(F)

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Suggest the mention of whole genome sequence and/or metagenomics.

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(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:**	Rationale: recommendation is to break the SEs into two K&S to distinguish between the evidences of evolution and the mechanisms. Workgroup would be OK if these were all maintained under a single K&S as currently written.
(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	(7)(A)
(B)	examine gradualism and punctuated equilibrium as scientific explanations of abrupt appearance and stasis in the fossil record.;	Rationale: workgroup is okay with keeping as is but would like to add more specificity for clarity (7)(B)
(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)	explain analyze and evaluate how natural selection produces change in populations, and not in individuals;	Rationale: change verbs to match the level of knowledge expected (7)(C)
(B)	explain and 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;	Rationale: for most students, this will be the first introduction to these ideas and they will lack the necessary background knowledge to evaluate natural selection. It is more appropriate for students to apply the principles of natural selection that are being introduced by explaining how they work. (7)(D)
(C)	analyze and evaluate the relationship of natural selection to adaptation, speciation, and divergent evolution and to the development of diversity in and among species; and	Rationale: revised to clarify the expectation of what students should know about how diversity is achieved. (7)(E)

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(D)	analyze the effect of ~~other~~ evolutionary mechanisms other than natural selection, including genetic drift, gene flow, mutation, and genetic recombination on the gene pool of a population.	Rationale: revised to clarify that these mechanisms are in contrast to natural selection; added effects of mechanisms on populations of organisms. (7)(F)
(11)	**Science concepts--biological structures, functions, and processes. The student knows the significance of matter cycling, energy flow, and enzymes ~~various molecules involved in metabolic processes and energy conversions that occur~~ in living organisms. The student is expected to:**	
(A)	explain how matter and energy are conserved during photosynthesis and cellular respiration using models, including chemical equations; and ~~compare the reactants and products of photosynthesis and cellular respiration in terms of energy, energy conversions, and matter; and~~	Rationale: emphasis should be on cycling of matter and transfer of energy (9)(B)
(B)	~~identify and~~ investigate and explain the role of enzymes in facilitating cellular processes.	Rationale: increase rigor and focus on big picture of enzymes as necessary facilitators of cellular processes (9)(C)
(12)	**Science concepts--biological structures, functions, and processes. The student knows that multicellular organisms ~~biological systems~~ are composed of multiple systems that interact to perform complex functions ~~levels~~. The student is expected to:**	
(A)	~~describe~~ 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	Rationale: change verb to increase rigor (10)(A)
(B)	explain how the functions of transport, reproduction, and response in plants are facilitated by their structures. ~~describe the interactions that occur among systems that perform the functions of transport, reproduction, and response in plants; and~~	Rationale: to place emphasis on functions and the big picture of how structure and function support each other. (10)(B)

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(13)	**Science concepts--interdependence within environmental systems. The student knows that ~~interdependence and~~ interactions at various levels of organization occur within an ecosystem ~~environmental system~~ to maintain stability. The student is expected to:**	
(A)	investigate and evaluate how ecological relationships ~~interpret relationships~~, including predation, parasitism, commensalism, mutualism, and competition, influence ecosystem stability ~~among organisms~~;	Rationale: revised to expand on learning in earlier grades and relate concepts to broader ecological systems (12)(A)
(B)	analyze how ecosystem stability is affected by disruptions to the cycling of matter and flow of energy through trophic levels using models; ~~analyze the flow of matter and energy through trophic levels using various models, including food chains, food webs, and ecological pyramids;~~	Rationale: revised to add on to and go deeper than the learning on this topic in middle school. (12)(C)
(C)	explain the significance of the carbon and nitrogen cycles to ecosystem stability and analyze the consequences of disrupting these cycles; and ~~describe the flow of matter through the carbon and nitrogen cycles and explain the consequences of disrupting these cycles; and~~	Rationale: revised to focus on the impacts of carbon and nitrogen cycles on ecosystems. (12)(D)
(D)	explain how environmental change affects biodiversity and analyze how changes in biodiversity impact ecosystem stability. ~~describe how environmental change can impact ecosystem stability.~~	Rationale: revised to relate biodiversity to environmental stability and connect to environmental changes. Also increases rigor with explain and analyze as verbs. (12)(E)

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§112.35. Chemistry (One Credit), Adopted 2017.		
	TEKS with edits	Work Group Comments
(a)	**General requirements.** Students shall be awarded one credit for successful completion of this course. Required prerequisites: one unit of high school science and Algebra I. Suggested prerequisite: completion of or concurrent enrollment in a second year of mathematics. This course is recommended for students in Grade 10, 11, or 12.	
(b)	**Introduction.**	
(1)	Chemistry. By the end of 12th grade, 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. 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, ~~and~~ chemical bonding, chemical stoichiometry, gas laws, solution chemistry, acid-base chemistry, thermochemistry, and nuclear chemistry. Students will investigate how chemistry is an integral part of our daily lives.	Work group split out acids and bases from solutions.
(2)	Nature of science. According to the National Science Teaching Association (NSTA), the "nature of science is a critical component of scientific literacy that enhances students' understandings of science concepts and enables them to make informed decisions about scientifically-based personal and societal issues." ~~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.	Used a quotation for nature of science as opposed to a definition of science. The new definition emphasizes literacy.

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Equipment list needs to be updated to include the ability to measure acid/base chemistry.

(3)	Scientific hypotheses and theories. Students are expected to know that:	Added SEs 2.B and 2.C as recommended by the scientific and engineering practices work group. Deleted 2.A. because the content was already addressed above in 2. Definitions help teachers have a shared understanding of these terms.
(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) ~~(3)~~	Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods ~~practices~~ of investigation are ~~can be experimental,~~ descriptive, ~~or~~ comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations is as follows: descriptive investigations involve collecting data and recording observations without making comparisons; comparative investigations involve collecting data with variables that are manipulated to compare results; experimental investigations involve processes similar to comparative investigations, but a control is identified.	Consider how engineering practices can be integrated with scientific inquiry. Changed order for consistency and intentional ordering of “hierarchy” or types of investigations. Defined types of investigations and scientific and engineering practices as recommended by Work Group A.
(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.	

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(5)(4)	Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Social justice applies the concept of social responsibility to determine if something is ethical. Students should be able to distinguish between scientific decision-making methods (scientific and engineering practices) and the use of ethics ethical and social justice to make decisions that involve the application of scientific information and engineering design. 1	Better defined social ethics. Modernized language by incorporating engineering
(6) (5)	Scientific cross-cutting concepts. Science is a series of cross cutting concepts such as systems, models, and patterns. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested while models allow for boundary specification and 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.	To clarify language around systems, define the cross-cutting concepts, and include additional specificity regarding scalability of models.
(7) (6)	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 processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:**	A separate **Scientific and Engineering Practices** Work Group developed recommendations for revisions to the current process skills for K-12. Recommendations from the **Scientific and Engineering Practices** Work Group for proposed new (1)–(4) are posted on the Science TEKS Review Drafts web page.
(A)	demonstrate safe practices during laboratory and field investigations, including the appropriate use of safety showers, eyewash fountains, safety goggles or chemical splash goggles, as appropriate, and fire extinguishers;	
(B)	know specific hazards of chemical substances such as flammability, corrosiveness, and radioactivity as summarized on the Safety Data Sheets (SDS); and	
(C)	demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.	
(2)	**Scientific processes. The student uses scientific practices to solve investigative questions. The student is expected to:**	
(A)	know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;	

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These are outstanding concepts and are essential life skills, but I really struggle with ensuring the preparedness of high school teachers to appropriately address these topics. Extremely good support tools will be needed to accomplish this.

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~~(B)~~	~~know that scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories;~~	
~~(C)~~	~~know that scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well-established and highly reliable explanations, but may be subject to change as new areas of science and new technologies are developed;~~	
~~(D)~~	~~distinguish between scientific hypotheses and scientific theories;~~	
~~(E)~~	~~plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting equipment and technology, including 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;~~	
~~(F)~~	~~collect data and make measurements with accuracy and precision;~~	
~~(G)~~	~~express and manipulate chemical quantities using scientific conventions and mathematical procedures, including dimensional analysis, scientific notation, and significant figures;~~	
~~(H)~~	~~organize, analyze, evaluate, make inferences, and predict trends from data; and~~	
~~(I)~~	~~communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphs, journals, summaries, oral reports, and technology-based reports.~~	
~~(3)~~	**~~Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:~~**	
~~(A)~~	~~analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student;~~	
~~(B)~~	~~communicate and apply scientific information extracted from various sources such as current events, published journal articles, and marketing materials;~~	
~~(C)~~	~~draw inferences based on data related to promotional materials for products and services;~~	
~~(D)~~	~~evaluate the impact of research on scientific thought, society, and the environment;~~	
~~(E)~~	~~describe the connection between chemistry and future careers; and~~	
~~(F)~~	~~describe the history of chemistry and contributions of scientists.~~	

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~~(4)~~	~~**Science concepts. The student knows the characteristics of matter and can analyze the relationships between chemical and physical changes and properties. The student is expected to:**~~	Recommend deletion based on survey responses and framework; physical changes and properties covered in K-5; grade 6 (6)(A) physical properties, (6)(C) density; grade 8 (5)(A) atom structure, (5)(B) chemical properties; IPC (6)(A) physical properties, (6)(B) physical properties, (6)(C) analyze properties; rather deepen knowledge around bonding and intermolecular forces. IPC and Chemistry are in agreement that these properties should be mastered by the end of middle school. Not necessarily terminal standards; work group explained that physical and chemical properties were addressed in conjunction with other concepts and did not need to be explicitly called out in a separate KS, such as in (4)(A) and new (6)(D) of their revisions.
~~(A)~~	~~differentiate between physical and chemical changes and properties;~~	
~~(B)~~	~~identify extensive properties such as mass and volume and intensive properties such as density and melting point;~~	
~~(C)~~	~~compare solids, liquids, and gases in terms of compressibility, structure, shape, and volume; and~~	
~~(D)~~	~~classify matter as pure substances or mixtures through investigation of their properties.~~	
(4) ~~(5)~~	**Science concepts. The student understands the ~~historical~~ development of the Periodic Table and applies ~~can apply~~ its predictive power. The student is expected to:**	The development of the Periodic Table is dynamic and ongoing.
(A)	construct explanations to communicate ~~explain the use of chemical and physical properties in~~ the ~~historical~~ development of the Periodic Table over time using evidence such as ~~explain the use of~~ chemical and physical properties;	"construct explanations to communicate" addresses science practices and is more rigorous; "historical" to "over time" connects to revised KS
(B)	predict the properties of elements in ~~identify and explain the properties of~~ chemical families, including alkali metals, alkaline earth metals, halogens, noble gases, and transition metals, based on the patterns of valence electrons using the Periodic Table; and	Patterns are part of cross-cutting concepts; "predict" elevates rigor and connects more directly to the KS

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(C)	analyze and interpret elemental data ~~*periodic trends*~~, including atomic radius, atomic mass, electronegativity, ~~and~~ ionization energy, and reactivity to discover trends in ~~using~~ the Periodic Table.	MV: not all agreed on inclusion of atomic mass "Reactivity" pulled from grade 8 (5)(B)
(5) ~~(6)~~	**Science concepts. The student ~~knows and~~ understands the ~~historical~~ development of atomic theory and applies it to real-world phenomena. The student is expected to:**	KS as written did not fully encompass SEs
(A)	construct models using ~~describe the experimental design and conclusions used in *the development of modern atomic theory*, including~~ Dalton's Postulates, Thomson's discovery of electron properties, Rutherford's nuclear atom, ~~and~~ Bohr's nuclear atom, and Heisenberg's Uncertainly Principle to show *the development of modern atomic theory* over time;	Fits with cross-cutting; more measurable student outcome; pulls in quantum concepts (modern); new verb integrates science and engineering practices
(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;	Atomic theory is part of the HS framework; pulled from grade 8, (5)(A) and added ions; recommend that grade 8 delete (5)(A) and (B) MV: lacks science and engineering practices; cross-cutting concepts
(C) ~~(B)~~	investigate the quantized energy emitted by electron movement of various elements and relate the emissions to ~~describe the mathematical relationships between energy, frequency, and wavelength of light using~~ the electromagnetic spectrum;	
(D) ~~(C)~~	calculate average atomic mass of an element using isotopic composition; and	
(E) ~~(D)~~	construct models to express the arrangement of electrons in atoms of representative elements using electron configurations and Lewis ~~valence electron~~ dot structures.	MV: not all agreed on addition Important to address in PD-- developing and using models is part of doing science; distinguish between scientific and engineering models
(6) ~~(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;	Connects ideas of this KS to KS(5) via periodic trends

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(B) ~~(A)~~	name and *write the chemical formulas* for ionic and *covalent* compounds ~~containing main group or transition metals,~~ ~~*covalent*~~ ~~compounds,~~ ~~*acids*~~~~, and bases~~ using International Union of Pure and Applied Chemistry (IUPAC) nomenclature rules;	Not in framework; however in CCRS: "know formulas for ionic compounds and molecular compounds"; students need comfort with encountering scientific terms in real world applications; acids moved to new KS (12)
~~(B)~~	~~*write the chemical formulas* of ionic compounds containing representative elements, transition metals and common polyatomic ions, covalent compounds, and acids and bases;~~	Combined with (B)
~~(C)~~	~~construct *electron dot* formulas to illustrate ionic and covalent bonds;~~	Combined into new (C)
~~(D)~~	~~describe metallic bonding and explain metallic properties such as thermal and electrical conductivity, malleability, and ductility; and~~	Combined into new (D)
(C) ~~(E)~~	classify and draw *electron dot* ~~molecular~~ structures for molecules with linear, bent, trigonal planar, trigonal pyramidal, and tetrahedral ~~electron pair~~ molecular geometries as explained by Valence Shell Electron Pair Repulsion (VSEPR) theory~~.~~; and	Lacked application; now addresses molecular geometries and intermolecular forces; clearer for first-year teachers
(D)	analyze the properties of ionic, covalent, and metallic substances in terms of intramolecular forces and intermolecular forces.	Delves deeper into the intramolecular forces and intermolecular forces which are both referenced in CCRS and framework; teachers requested IMF to be added in
(7) ~~(8)~~	**Science concepts. The student understands how matter is accounted for in ~~can quantify the changes that occur during~~ chemical substances ~~reactions~~. The student is expected to:**	Better alignment to student expectations now that the KS has been split.
(A)	define ~~and use the concept of a~~ mole and apply the concept of molar mass to convert between moles and grams;	Work group wanted to add application level to the concept of the mole
(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.~~;~~	Survey: some teachers wanted calculation empirical and molecular to be added; work group felt it was unnecessary
(8)	**Science concepts. The student understands how matter is accounted for in chemical reactions. The student is expected to:**	Split from previous KS; provides better context for new teachers.
(A) ~~(E)~~	write and balance chemical equations using the law of conservation of mass;	

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(B) ~~(F)~~	differentiate among double replacement reactions, including acid-base reactions and precipitation reactions, and oxidation-reduction reactions such as synthesis, decomposition, single replacement, and combustion reactions;	
(C) ~~(G)~~	perform stoichiometric calculations, including determination of mass relationships, ~~and~~ gas volume relationships ~~between reactants and products~~, and percent yield; and	Provides clarity in expectation, will assist new teachers in understanding expectation Survey: work group felt that on-level should be able to "perform calculations" and should not simply be conceptual
(D) ~~(H)~~	describe the concept of limiting reactants in a balanced chemical equation.	
(9)	**Science concepts. The student understands the principles of the *kinetic molecular theory* and~~,~~ ideal gas behavior ~~*kinetic molecular theory*, and the conditions that influence the behavior of gases~~. The student is expected to:**	There is a difference between real and ideal gasses. All the SEs are about ideal gas law and gasses.
(A) ~~(B)~~	describe the postulates of the kinetic molecular theory~~.~~;	
(B) ~~(A)~~	describe and calculate the relationships between volume, pressure, number of moles, and temperature for an ideal gas ~~as described by Boyle's law, Charles' law, Avogadro's law, *Dalton's law of partial pressure,* and the ideal gas law~~; and	Not all laws are included and are implied by stating the relationships between volume, pressure, number of moles, and temperature
(C)	define and apply *Dalton's law of partial pressure.*	This law is just about pressure; not appropriately grouped into previous SE
(10)	**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;	Recommend that middle school address properties of water to address conceptual gap
(B)	*distinguish among types of solutions such as electrolytes and nonelectrolytes;* and *unsaturated, saturated, and supersaturated solutions;* ~~and~~ ~~*strong and weak acids and bases;*~~	Acids and bases moved to new (11)(C) with other SEs related to that topic Work group felt this was a better arrangement of standards for knowledge progression.

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(C)	*investigate factors that influence solid and gas solubilities* such as temperature using solubility curves *and rates of dissolution such as temperature, agitation, and surface area;*	Work group felt this was a better arrangement o standards for knowledge progression Additional detail of solubility curves is helpful for new teachers; curves help contextualize the topic of solid and gas solubilities
(D)	investigate ~~apply~~ the general rules regarding solubility ~~through investigations~~ and ~~with aqueous solutions~~ predict the products of a double replacement reaction;	Work group felt adding prediction gave additional meaning to knowledge of solubility rules
(E) ~~(C)~~	calculate the concentration of solutions in units of molarity; and	
(F) ~~(D)~~	calculate the dilutions of solutions using molarity.~~;~~	
~~(E)~~	~~*distinguish among types of solutions such as electrolytes and nonelectrolytes; unsaturated, saturated, and supersaturated solutions; and strong and weak acids and bases;*~~	New (10)(B)
~~(F)~~	~~*investigate factors that influence solid and gas solubilities and rates of dissolution such as temperature, agitation, and surface area;*~~	New (10)(C)
(11)	**Science concepts. The student understands and applies various rules regarding acids and bases. The student is expected to:**	Work group felt the split out from solutions allowed them to add greater specificity to acid-base SEs. Survey: add titrations to acids and bases and red-ox; work group felt it might be outside scope of course[1]ome schools may lack equipment
(A)	name and write the chemical formulas *for acids* using IUPAC nomenclature rules;	Naming of acids moved from KS (7)
(B) ~~(G)~~	define acids and bases and distinguish between Arrhenius and Bronsted-Lowry definitions ~~and~~ ~~*predict products in acid-base reactions that form water*~~; ~~and~~	
(C)	differentiate between *strong and weak acids and bases;*	
(D)	*predict products in acid-base reactions that form water;* and	
(E) ~~(H)~~	define pH and calculate the pH of a solution using the hydrogen ion concentration.	

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I would agree with equipment limitations; however the ability to measure acid/base chemistry should be universal.

Submitted by Dale Woerner

(12) ~~(11)~~	**Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to:**	
~~(A)~~	~~describe energy and its forms, including kinetic, potential, chemical, and thermal energies;~~	Energy and it forms have been substantially covered in previous grade-level content: Grade 3 mechanical, light, sound, and thermal, Grade 5, (6)(A) thermal and sound; Grade 6 (8)(A) kinetic and potential; Grade 7 (7)(A) chemical energy in photosynthesis
(A) ~~(B)~~	describe and explain everyday examples that illustrate the four laws of thermodynamics;	Moved from Physics (6)(E); addresses entropy per survey
(B)	investigate ~~describe the law of conservation of energy and~~ the process~~es~~ of heat transfer in terms of calorimetry;	
(C)	differentiate processes ~~classify reactions~~ as exothermic or endothermic and represent energy changes that occur in chemical reactions using thermochemical equations or graphical analysis; and	Not all exothermic or endothermic examples are reactions; some are physical processes; change is more encompassing Survey: calculate enthalpy; Work group felt that this might be beyond scope of course and that teachers may add if time allows
(D)	perform calculations involving heat, mass, temperature change, and specific heat.	
(13) ~~(12)~~	**Science concepts. The student understands the basic processes of nuclear chemistry. The student is expected to:**	Survey: get rid of this altogether; add practical uses of nuclear chem; when it applies/real-world application Bringing over the SE from Physics addresses the application piece that survey respondents referred to.
(A)	describe the characteristics of alpha, beta, and gamma radioactive decay processes in terms of balanced nuclear equations; ~~*and*~~	
(B)	compare fission and fusion reactions~~.~~*; and*	

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(C)	give examples of applications of nuclear phenomena such as nuclear stability, radiation therapy, diagnostic imaging, solar cells, and nuclear power.	Brought SE over from Physics (8)(D) and eliminated refences to "atomic" and "quantum phenomena" as well as the "standard model" to help limit the burden of additional mathematics. Also, this Chemistry KS is limited to nuclear where Physics included both atomic and quantum.

This page contains no comments

Submitted by Dale Woerner

§112.38. Integrated Physics and Chemistry (One Credit), Adopted 2017.		
	TEKS with edits	Work Group Comments
(a)	**General requirements.** Students shall be awarded one credit for successful completion of this course. Prerequisites: none. This course is recommended for students in Grade 9 or 10.	
(b)	**Introduction.**	
(1)	Integrated Physics and Chemistry. By the end of 12th grade, 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. In Integrated Physics and Chemistry, students conduct laboratory and field investigations, 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.	This language is the same across courses. The purpose is to capture the goals of learning science based on the K12 Framework and combine it with what the TEKS already has.
(2)	Nature of science. According to the National Science Teaching Association (NSTA), the "nature of science is a critical component of scientific literacy that enhances students' understandings of science concepts and enables them to make informed decisions about scientifically-based personal and societal issues." ~~Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process."~~ This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable ~~by empirical science~~.	Used a quotation for nature of science as opposed to a definition of science. The new definition emphasizes literacy.
(3)	Scientific hypotheses and theories. Students are expected to know that:	Added SEs 2.B and 2.C as recommended by the scientific and engineering practices work group. Deleted 2.A. because the content was already addressed above in 2. Definitions help teachers have a shared understanding of these terms.
(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	

Number: 1 Author: dwoerner Subject: Sticky Note Date: 8/21/2020 8:40:24 AM

Suggest that students have taken or at least be concurrently enrolled in a 1st level high school mathematics course.

(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) ~~(3)~~	Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are ~~*experimental,*~~ descriptive, ~~*or*~~ comparative*, or experimental*. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations is as follows: descriptive investigations involve collecting data and recording observations without making comparisons; comparative investigations involve collecting data with variables that are manipulated to compare results; and experimental investigations involve processes similar to comparative investigations, but a control is identified.	Changed order for consistency and intentional ordering of "hierarchy" or types of investigations. Defined types of investigations and scientific and engineering practices as recommended by Work Group A.
(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) ~~(4)~~	Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Social justice applies the concept of social responsibility to determine if something is ethical. Students should be able to distinguish between scientific decision-making methods (scientific and engineering practices) and the use of ethics ~~ethical~~ and social justice to make decisions that involve ~~science (~~the application of scientific information~~)~~ and engineering design.	Better defined social ethics. Modernized language by incorporating engineering
(6) ~~(5)~~	Scientific cross-cutting concepts. Science is a series of cross cutting concepts such as ~~Science~~ systems, models, and patterns. ~~A system is a collection of cycles, structures, and processes that interact~~. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested, while models allow for boundary specification and 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.	To clarify language around systems, define the cross-cutting concepts, and include additional specificity regarding scalability of models.
(7) ~~(6)~~	Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.	

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(c)	**Knowledge and skills.**	
~~(1)~~	~~**Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:**~~	A separate **Scientific and Engineering Practices** Work Group developed recommendations for revisions to the current process skills for K-12. Recommendations from the **Scientific and Engineering Practices** Work Group for proposed new (1)-(4) are posted on the Science TEKS Review Drafts web page.
~~(A)~~	~~demonstrate safe practices during laboratory and field investigations, including the appropriate use of safety showers, eyewash fountains, safety goggles or chemical splash goggles, as appropriate, and fire extinguishers;~~	
~~(B)~~	~~know specific hazards of chemical substances such as flammability, corrosiveness, and radioactivity as summarized on the Safety Data Sheets (SDS); and~~	
~~(C)~~	~~demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.~~	
~~(2)~~	~~**Scientific processes. The student uses scientific practices during laboratory and field investigations. The student is expected to:**~~	
~~(A)~~	~~know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;~~	
~~(B)~~	~~plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting equipment and technology;~~	
~~(C)~~	~~collect data and make measurements with accuracy and precision;~~	
~~(D)~~	~~organize, analyze, evaluate, make inferences, and predict trends from data; and~~	
~~(E)~~	~~communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphs, journals, summaries, oral reports, and technology-based reports.~~	
~~(3)~~	~~**Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions. The student is expected to:**~~	
~~(A)~~	~~analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student;~~	
~~(B)~~	~~communicate and apply scientific information extracted from various sources such as current events, published journal articles, and marketing materials;~~	

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~~(C)~~	~~draw inferences based on data related to promotional materials for products and services;~~	
~~(D)~~	~~evaluate the impact of research on scientific thought, society, and the environment;~~	
~~(E)~~	~~describe connections between physics and chemistry and future careers; and~~	
~~(F)~~	~~research and describe the history of physics and chemistry and contributions of scientists.~~	
(4)	**Science concepts. The student knows the relationship between ~~concepts of~~ force and motion ~~evident~~ in everyday life. The student is expected to:**	
(A)	investigate, analyze, and model motion ~~describe and calculate an object's motion~~ in terms of position, velocity, acceleration, and time using tables, graphs, and mathematical relationships ~~displacement, speed, and acceleration~~;	Reorganization and changing the rigor to better bridge what is expected in Physics 4A and 4B versus what is traditionally taught in SE 6.8.C, 6.8.D, 8.6.A, and 8.6B. Increased specificity.
~~(B)~~	~~measure and graph distance and speed as a function of time;~~	Now is included in 4A.
~~(C)~~	~~investigate how an object's motion changes only when a net force is applied, including activities and equipment such as toy cars, vehicle restraints, sports activities, and classroom objects;~~	The current student expectation should be mastered in Grades 6-8 in 6.8B and 8.6A.
(B) ~~(D)~~	analyze data to explain the relationship between mass and acceleration in terms of the net force on an object, in one dimension, using free-body/force diagrams, tables, and graphs; ~~describe and calculate the relationship between force, mass, and acceleration using equipment such as dynamic carts, moving toys, vehicles, and falling objects;~~	Reorganization and changing the rigor to better bridge what is expected in Physics 4D versus what is traditionally taught in eighth grade 8.6C. Increased specificity.
(C) ~~(E)~~	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; and ~~explain the concept of conservation of momentum; using action and reaction forces;~~	Remove conservation of momentum because this the first introduction of momentum so the focus will be on impulse and momentum as it relates to forces. Design, evaluate and refine were chosen to integrate engineering practices.
(D) ~~(F)~~	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. ~~describe the gravitational attraction between objects of different masses at different distances; and~~	Combined 4F and 4G into one SE because gravitational forces and electrical forces behave similarly. This could be a conceptual explanation of the relationship.
~~(G)~~	~~examine electrical force as a universal force between any two charged objects.~~	Combined 4F and 4G into one SE because gravitational forces and electrical forces behave similarly.

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(5)	**Science concepts. The student ~~recognizes multiple forms of energy and~~ knows the impact of energy transfer and energy conservation in everyday life. The student is expected to:**	
~~(A)~~	~~recognize and demonstrate that objects and substances in motion have kinetic energy such as vibration of atoms, water flowing down a stream moving pebbles, and bowling balls knocking down pins;~~	The current student expectation should be mastered in Grades 6-8 in SE 6.8A.
~~(B)~~	~~recognize and demonstrate common forms of potential energy, including gravitational, elastic, and chemical, such as a ball on an inclined plane, springs, and batteries;~~	The current student expectation should be mastered in Grades 6-8 in SE 6.8A.
(B) ~~(C)~~	design, evaluate, and refine a device that generates electrical energy through the interaction of electric charges and magnetic fields such as a generator, windmill, or other mechanically powered device; ~~demonstrate that moving electric charges produce magnetic forces and moving magnets produce electric forces;~~	Design, evaluate, and refine were chosen to integrate engineering practices. Wording was changed to add specificity and rigor, and to link how electrical and magnetic fields are used in society.
(C) ~~(D)~~	plan and conduct an investigation to provide evidence that energy is conserved within a closed system; ~~investigate the law of conservation of energy;~~	Added specificity and rigor and emphasized systems thinking approach. Added the verb plan to indicate students should be planning their own investigation.
(D) ~~(E)~~	~~investigate and demonstrate the movement of thermal energy through solids, liquids, and gases by convection, conduction, and radiation such as in weather, living, and mechanical systems;~~	The current student expectation should be mastered in Grades 6-8 in SE 6.9A.
(A) ~~(F)~~	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 ~~in series and parallel circuits and conductive materials~~;	Changed the wording to provide more specificity and the verb to allow for more real-world relevance.
(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;	Helps relate waves to technology and real-life applications.
(F) ~~(G)~~	construct and communicate an explanation based on evidence for how wave interference, reflection, and refraction are used in technology such as medicine, communication, and scientific research; and ~~explore the characteristics and behaviors of energy transferred by waves, including acoustic, seismic, light, and waves on water, as they reflect, refract, diffract, interfere with one another, and are absorbed by materials;~~	Allows a connection of wave properties to technology.
~~(H)~~	~~analyze energy transformations of *renewable and nonrenewable* resources; and~~	Moved to combine with 5(I).

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(G) ~~(I)~~	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.	Changed the verb to align with science and engineering practices. Combined with 5(H) for streamlining.
(6)	**Science concepts. The student knows that relationships exist between the structure and properties of matter. The student is expected to:**	
(A)	relate an element's atomic structure to its bonding, reactivity, and placement on the Periodic Table; ~~examine differences in physical properties of solids, liquids, and gases as explained by the arrangement and motion of atoms or molecules;~~	The deleted concepts are developmentally appropriate for middle school and should be moved to and mastered in Grades 6-8 such as in SE 7.6. IPC and Chemistry work group B members are in agreement that these properties should be mastered by the end of middle school.
(B)	use patterns within the Periodic Table to predict the relative physical and chemical properties of elements; ~~relate chemical properties of substances to the arrangement of their atoms;~~	Added to place an emphasis of the predictive capability of the Periodic Table.
(C)	explain how ~~analyze~~ physical and chemical properties of substances are related to their usage in everyday life such as in sunscreen, cookware, industrial applications, and fuels; and ~~elements and compounds such as color, density, viscosity, buoyancy, boiling point, freezing point, conductivity, and reactivity;~~	Changed the SE to emphasize the connection between properties and usage of substances and increase connections to everyday life.
~~(D)~~	~~relate the placement of an element on the Periodic Table to its physical and chemical behavior, including bonding and classification;~~	Re-wrote to emphasize the arrangement of electrons and the relationship to properties.
~~(E)~~	~~relate the structure of water to its function as a solvent; and~~	Eliminated – this concept is beyond the scope of IPC. It is covered in the proposed TEKS for Chemistry 10A.
(D) ~~(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. ~~investigate the properties of water solutions and factors affecting solid solubility, including nature of solute, temperature, and concentration.~~	Consolidated reaction rate with solutions. Students should be planning the investigations.
(7)	**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 an antacid; ~~changes of state as it relates to the arrangement of particles of matter and energy transfer;~~	The deleted concepts are developmentally appropriate for middle school and should be moved to and mastered in Grades 6-8. Reactions provided to increase specificity and application to everyday life.

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(B)	recognize that chemical changes can occur when substances react to form different substances and that these interactions are largely determined by the valence electrons;	The concepts are embedded within 6(A) & 7(A).
(B) (C)	develop and use models to balance chemical equations and support the claim that atoms, and therefore mass, are conserved during a chemical reaction; demonstrate that mass is conserved when substances undergo chemical change and that the number and kind of atoms are the same in the reactants and products;	The deleted concepts are developmentally appropriate for middle school and should be mastered in Grades 6-8 in SE 8.5E. The new standard builds on middle school concepts and adds complexity and rigor. Bridges the gap between middle school and chemistry.
(D)	classify energy changes that accompany chemical reactions such as those occurring in heat packs, cold packs, and glow sticks as exothermic or endothermic reactions;	Combined concepts with 7(A).
(C) (E)	research and communicate the uses, advantages, and disadvantages of nuclear reactions in current technologies; and describe types of nuclear reactions such as fission and fusion and their roles in applications such as medicine and energy production; and	Added rigor and made the content more applicable to student lives and future developments in technology.
(D) (F)	construct and communicate an explanation based on evidence for research and describe the environmental and economic impact of the end-products of chemical reactions such as those that may result in acid rain, degradation of water, soil, and air quality. and ozone depletion.	Changed the verb to better align with the new science and engineering practices, removed economic impact as it is beyond the level of IPC students in terms of their understanding of economies. Removed acid rain and ozone depletion and added soil degradation to allow teachers to focus on local issues in addition to more global issues that may arise.

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Submitted by Dale Woerner

§112.39. Physics (One Credit), Adopted 2017.		
	TEKS with edits	Work Group Comments
(a)	**General requirements.** Students shall be awarded one credit for successful completion of this course. Algebra I is suggested as a prerequisite or corequisite. This course is recommended for students in Grade 9, 10, 11, or 12.	
(b)	**Introduction.**	
(1)	Physics. By the end of 12th grade, 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. 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; ~~thermodynamics;~~ characteristics and behavior of waves; and electricity and magnetism. ~~and atomic, nuclear, and quantum physics.~~ Students who successfully complete Physics will be able to ~~acquire factual knowledge within a~~ apply conceptual knowledge and collaborative skills ~~framework, practice~~ to experimental design, implementation, and interpretation. ~~work collaboratively with colleagues, and develop critical-thinking skills.~~	Group suggested deleting topics of thermodynamics, and atomic, nuclear, and quantum physics, from the introduction because of suggested changes to student expectations. Changes to the last sentences were made to avoid redundancy, and emphasize application of basic principles rather than memorization of facts.
(2)	Nature of science. According to the National Science Teaching Association (NSTA), the "nature of science is a critical component of scientific literacy that enhances students' understandings of science concepts and enables them to make informed decisions about scientifically-based personal and societal issues." ~~Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process."~~ This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable ~~by empirical science~~.	Used a quotation for nature of science as opposed to a definition of science. The new definition emphasizes literacy.

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(3)	Scientific hypotheses and theories. Students are expected to know that:	Added SEs 2.B and 2.C as recommended by the scientific and engineering practices work group. Deleted 2.A. because the content was already addressed above in 2. Definitions help teachers have a shared understanding of these terms.
(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) ~~(3)~~	Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are ~~can be experimental,~~ descriptive, ~~or~~ comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations is as follows: descriptive investigations involve collecting data and recording observations without making comparisons; comparative investigations involve collecting data with variables that are manipulated to compare results; experimental investigations involve processes similar to comparative investigations, but a control is identified.	Changed order for consistency and intentional ordering of "hierarchy" or types of investigations. Defined types of investigations and scientific and engineering practices as recommended by Work Group A.
(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.	

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(B)	Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models.	
(5) ~~(4)~~	Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Social justice applies the concept of social responsibility to determine if something is ethical. Students should be able to distinguish between scientific decision-making methods (scientific and engineering practices) and the use of ethics ~~ethical~~ and social justice to make decisions that involve the application of scientific information and engineering design.	Better defined social ethics. Modernized language by incorporating engineering
(6) ~~(5)~~	Scientific cross-cutting concepts. Science is a series of cross cutting concepts such as systems, models and patterns. ~~A system is a collection of cycles, structures, and processes that interact~~. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested while models allow for boundary specification and 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.	To clarify language around systems, define the cross-cutting concepts, and include additional specificity regarding scalability of models.
(7) ~~(6)~~	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 processes. The student conducts investigations, for at least 40% of instructional time, using safe, environmentally appropriate, and ethical practices. These investigations must involve actively obtaining and analyzing data with physical equipment but may also involve experimentation in a simulated environment as well as field observations that extend beyond the classroom. The student is expected to:**~~	A separate **Scientific and Engineering Practices** Work Group developed recommendations for revisions to the current process skills for K-12. Recommendations from the **Scientific and Engineering Practice**s Work Group for proposed new (1)-(4) are posted on the Science TEKS Review Drafts web page.
~~(A)~~	~~demonstrate safe practices during laboratory and field investigations; and~~	
~~(B)~~	~~demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.~~	
~~(2)~~	~~**Scientific processes. The student uses a systematic approach to answer scientific laboratory and field investigative questions. The student is expected to:**~~	

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~~(A)~~	~~know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;~~	
~~(B)~~	~~know that scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence;~~	
~~(C)~~	~~know that scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established and highly reliable explanations, but may be subject to change;~~	
~~(D)~~	~~design and implement investigative procedures, including making observations, asking well defined questions, formulating testable hypotheses, identifying variables, selecting appropriate equipment and technology, evaluating numerical answers for reasonableness, and identifying causes and effects of uncertainties in measured data;~~	
~~(E)~~	~~demonstrate the use of course apparatus, equipment, techniques, and procedures, including multimeters (current, voltage, resistance), balances, batteries, dynamics demonstration equipment, collision apparatus, lab masses, magnets, plane mirrors, convex lenses, stopwatches, trajectory apparatus, graph paper, magnetic compasses, protractors, metric rulers, spring scales, thermometers, slinky springs, and/or other equipment and materials that will produce the same results;~~	
~~(F)~~	~~use a wide variety of additional course apparatus, equipment, techniques, materials, and procedures as appropriate such as ripple tank with wave generator, wave motion rope, tuning forks, hand-held visual spectroscopes, discharge tubes with power supply (H, He, Ne, Ar), electromagnetic spectrum charts, laser pointers, micrometer, caliper, computer, data acquisition probes, scientific calculators, graphing technology, electrostatic kits, electroscope, inclined plane, optics bench, optics kit, polarized film, prisms, pulley with table clamp, motion detectors, photogates, friction blocks, ballistic carts or equivalent, resonance tube, stroboscope, resistors, copper wire, switches, iron filings, and/or other equipment and materials that will produce the same results;~~	
~~(G)~~	~~make measurements with accuracy and precision and record data using scientific notation and International System (SI) units;~~	
~~(H)~~	~~organize, evaluate, and make inferences from data, including the use of tables, charts, and graphs;~~	
~~(I)~~	~~communicate valid conclusions supported by the data through various methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports; and~~	

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(J)	express relationships among physical variables quantitatively, including the use of graphs, charts, and equations.	
(3)	**Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:**	
(A)	analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student;	
(B)	communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;	
(C)	explain the impacts of the scientific contributions of a variety of historical and contemporary scientists on scientific thought and society;	
(D)	research and describe the connections between physics and future careers; and	
(E)	express, manipulate, and interpret relationships symbolically in accordance with accepted theories to make predictions and solve problems mathematically.	
(4)	**Science concepts. The student knows and applies the laws governing motion in a variety of situations. The student is expected to:**	
(A)	analyze generate and interpret graphs and charts describing in order to different types of motion by generating and interpreting position versus time, velocity versus time, and acceleration versus time graphs investigations using hand graphing and real-time technology such as motion detectors, or photogates, or digital applications;	Standard was revised to make explicit the appropriate graphs to be used in instruction of different types of motion.
(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;	Group wanted to make teaching vectors an explicit lesson for instruction as well as to align with the co-requisite of Algebra I.
(C) (B)	describe and analyze motion in one dimension using equations and graphical vector addition with the concepts of distance, displacement, speed, average velocity, instantaneous velocity, frames of reference, and acceleration;	Group moved graphical vector addition to 4B and deleted average velocity and instantaneous descriptors to make less redundant.
(D) (C)	analyze and describe accelerated motion in two dimensions of horizontally launched projectiles including using equations and graphical vector addition, and projectiles and circular examples; and	Expectation was revised to provide clarity to the types of projectiles. Multiple Viewpoints: “using equations vs conceptual understanding”

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(E)	apply and explain 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;	The group ultimately decided to break old 4(D) into separate expectations to address each of Newton's three laws. The rationale behind the changes to 4(D) as well as adding additional student expectations to D was to make explicit connections between engineering design principles where applicable as well as to clarify the mathematics to keep it from being an impediment to learning for students taking physics at any grade level, including grade 9. The group formulated suggested new expectations E, F and G.
(F)	*calculate the effect of forces on objects*, including tension, friction, normal, gravity, 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.	The concept in expectation H was moved into KS4 for improved alignment to Newton's laws as well to make understanding of Newton's law of universal gravitation more explicit. Group added scientific notation because of the scale of the values in this concept.
(5)	**Science concepts. The student knows the nature of forces in the physical world. The student is expected to:**	
~~(A)~~	~~describe the concepts of gravitational, electromagnetic, weak nuclear, and strong nuclear forces;~~	Concepts of gravity refined in a new expectation and moved to KS4. Electromagnetic force kept in KS5 as a separate expectation. Group is evaluating if and how to include strong and weak nuclear forces.
~~(B)~~	~~describe and calculate how the magnitude of the gravitational force between two objects depends on their masses and the distance between their centers;~~	Moved and revised to 4H for improved content alignment.

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(A) (C)	describe and calculate using 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 ;	Expectation was revised to provide clarity for appropriate calculations to be included in understanding Coulomb's law. Group added scientific notation because of the scale of the values in this concept.
(B) (D)	identify and describe examples of electric and magnetic forces and fields in everyday life such as generators, motors, and transformers;	
(C) (E)	investigate and describe conservation of charge during the process of induction, conduction, and polarization using different materials such as electroscopes, balloons, rods, fur, silk and Van der Graaf generators; characterize materials as conductors or insulators based on their electric properties; and	SE was re-written to better direct the focus on conservation of charge instead of being a repeat of grade level instructional topics.
(D) (F)	design, construct, and analyze, series and parallel circuits using schematics and materials such as switches, wires, resistors, lightbulbs, batteries, voltmeters, and ammeters; and *calculate current through, potential difference across, resistance of, and power used by electric circuit elements connected in both series and parallel combinations using Ohm's law.*	SE was revised to focus on engineering and design principals included in the K-12 framework.
(E)	*calculate current through, potential difference across, resistance of, and power used by electric circuit elements connected in both series and parallel* circuits combinations using Ohm's law.	F was separated into design and construct with a new expectation to emphasize calculation in one expectation and inquiry in the other as well as engineering principles.
(6)	**Science concepts. The student knows that changes occur within a physical system and applies the laws of conservation of energy and momentum. The student is expected to:**	
(A)	calculate and explain work and power in one dimension and recognize when work is and is not being done by or on a system;	Work group created separate expectation for work and power to make calculations and understanding more explicit.

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(B) ~~(A)~~	investigate and calculate mechanical, kinetic, and potential energy of a system; ~~investigate and calculate quantities using the work-energy theorem in various situations;~~	SE was revised to separate and make more explicit from the work-energy theorem and to allow for more hands-on learning with different types of energy.
(C) ~~(B)~~	apply the concept of conservation of energy using the work-energy theorem, energy diagrams, and energy transformation equations; ~~investigate examples of kinetic and potential energy and their transformations;~~	SE was revised to allow for connection between energy transformations and the work energy theorem.
(D) ~~(C)~~	calculate and describe the ~~mechanical energy of, power generated within,~~ impulse ~~applied to,~~ and momentum of ~~a~~ physical systems using examples such as automobile safety features, athletics, and rockets; and	New expectation created to emphasize conceptual learning and provide clarity and specificity to content to be taught. Mechanical energy and power were moved to other SE's.
(E) ~~(D)~~	analyze the conservation of momentum in inelastic and elastic collisions in one dimension qualitatively using models, diagrams, and simulations. ~~demonstrate and apply the laws of conservation of energy and conservation of momentum in one dimension; and~~	New expectation created to emphasize conceptual nature of conservation of linear momentum and to reduce the burden of complex calculations.
~~(E)~~	~~explain everyday examples that illustrate the four laws of thermodynamics and the processes of thermal energy transfer.~~	Expectation does not align with anything else which is a separate topic. Heat is covered in Chemistry. Topic was removed to allow for additional time to teach other expectations. Chemistry does not include laws of thermodynamics, but workgroup will consider moving/including in their treatment of thermodynamic related expectations.
(7)	**Science concepts. The student knows the characteristics and behavior of waves. The student is expected to:**	
(A)	examine and describe simple harmonic ~~oscillatory~~ motion, standing waves, and wave energy propagation in various types of media using examples such as springs, pendulums, surface waves on a body of water, and ropes;	Expectation language changed to make explicit the concepts of simple harmonic motion and standing waves to be included in instruction.

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(B)	investigate and analyze characteristics of waves, including velocity, frequency, amplitude, and wavelength, and calculate using the relationships ~~relationship~~ between wave speed, frequency, energy, and wavelength;	Expectation changed to include energy and the relationships between different wave characteristics to make more explicit and topic was removed from chemistry to be included in physics.
(C)	compare the different applications of the electromagnetic spectrum;	Group may ask 8th Grade Science TEKS revision workgroup to consider adding understanding of color to SE's related to light behavior. New SE created to highlight real world applications of the electromagnetic spectrum.
(D)	~~compare and explain~~ investigate *the emission spectra produced by various atoms,* and explain the relationship to the electromagnetic spectrum;	Moved from KS8 to better organize within the concepts in 8.
(E) ~~(C)~~	compare the characteristics of transverse and longitudinal waves including electromagnetic and sound waves; ~~compare characteristics and behaviors of transverse waves, including electromagnetic waves and the electromagnetic spectrum, and characteristics and behaviors of longitudinal waves, including sound waves;~~	SE was revised to simplify language and reduce redundancy.
(F) ~~(D)~~	investigate behaviors of waves, including reflection, refraction, diffraction, interference, resonance, and the Doppler effect; and	Work group would like to consider future recommendations to these SE's to include additional scientific and engineering practices.
(G) ~~(E)~~	describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens;	Work group would like to consider future recommendations to these SE's to include additional scientific and engineering practices.
~~(8)~~	~~**Science concepts. The student knows simple examples of atomic, nuclear, and quantum phenomena. The student is expected to:**~~	KS deleted to better align with waves.
(H) ~~(A)~~	describe the photoelectric effect and the dual nature of light.	SE moved to KS7 F.
~~*(B)*~~	~~*compare and explain the emission spectra produced by various atoms;*~~	EM spectra and quantum covered in chem. Partially combined with new SE in KS7.

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~~(C)~~	~~calculate and describe the applications of mass-energy equivalence; and~~	SE removed to allow for more time to teach the curriculum.
~~(D)~~	~~give examples of applications of atomic and nuclear phenomena using the standard model such as nuclear stability, fission and fusion, radiation therapy, diagnostic imaging, semiconductors, superconductors, solar cells, and nuclear power and examples of applications of quantum phenomena.~~	Moved to Chemistry per work group discussion.

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