2021 Introduction	2017 Introduction
(1) Physics. In Physics, students conduct laboratory and field investigations, use scientific practices during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study a variety of topics that include: laws of motion, changes within physical systems and conservation of energy and momentum, forces, characteristics and behavior of waves, and electricity and magnetism. Students will apply conceptual knowledge and collaborative skills to experimental design, implementation, and interpretation. By the end of Grade 12, students are expected to gain sufficient knowledge of the scientific and engineering practices across the disciplines of science to make informed decisions using critical thinking and scientific problem solving. **(2)** Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable. **(3)** Scientific hypotheses and theories. Students are expected to know that **(A)** hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories; and **(B)** scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established and highly reliable explanations, but they may be subject to change as new areas of science and new technologies are developed. **(4)** Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked.	***(1)*** *Physics. In Physics, students conduct laboratory and field investigations, use scientific practices during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study a variety of topics that include: laws of motion; changes within physical systems and conservation of energy and momentum; forces; thermodynamics; characteristics and behavior of waves; and atomic, nuclear, and quantum physics. Students who successfully complete Physics will acquire factual knowledge within a conceptual framework, practice experimental design and interpretation, work collaboratively with colleagues, and develop critical-thinking skills.* ***(2)*** *Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable.* ***(3)*** *Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific practices of investigation can be experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.* ***(4)*** *Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods and ethical and social decisions that involve the application of scientific information.* ***(5)*** *Scientific systems. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment..* **(6)** *Statements containing the word "including" reference content that must be mastered, while those*

2021 Introduction (continued)	2017 Introduction (continued)
Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified. **(A)** Scientific practices. Students should be able to ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models. **(B)** Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models. **(5)** Science and social ethics. Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information). **(6)** Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested, while models allow for boundary specification and provide a tool for understanding the ideas presented. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment. **(7)** Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.	*containing the phrase "such as" are intended as possible illustrative examples.*

2021	2017
Scientific and Engineering Practices	***Scientific Processes***
(1) Scientific and engineering practices. The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:	***(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) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;	*NEW*
(B) use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;	*(2)(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*
(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency approved safety standards;	*(1)(A) demonstrate safe practices during laboratory and field investigations; and*
(D) use appropriate tools such as balances, ballistic carts or equivalent, batteries, computers, constant velocity cars, convex lenses, copper wire, discharge tubes with power supply (H, He, Ne, Ar), data acquisition probes and software, dynamics and force demonstration equipment, electrostatic generators, electrostatic kits, friction blocks, graph paper, graphing technology, hand-held visual spectroscopes, inclined planes, iron filings, lab masses, laser pointers, magnets, magnetic compasses, metric rulers, motion detectors, multimeters (current, voltage, resistance), optics bench, optics kit, photogates, plane mirrors, prisms, protractors, pulleys, resistors, rope or string, scientific calculators, stopwatches, springs, spring scales, switches, tuning forks, wave generators, or other equipment and materials that will produce the same results;	*(2)(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* *(2)(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,…*

2021	2017
	and/or other equipment and materials that will produce the same results;
(E) collect quantitative data using the International System of Units (SI) and qualitative data as evidence;	*(2)(G) make measurements with accuracy and precision and record data using scientific notation and International System (SI) units;*
(F) organize quantitative and qualitative data using bar charts, line graphs, scatter plots, data tables, labeled diagrams, and conceptual mathematical relationships;	*(2)(J) express relationships among physical variables quantitatively, including the use of graphs, charts, and equations.*
(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and	*NEW*
(H) distinguish among scientific hypotheses, theories, and laws	*(2)(B) know that scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence* *(2)(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;*
	REMOVED *(1)(C) demonstrate an understanding of the use and conservation of resources and the proper disposal of recycling materials.*
(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:	***(2) Scientific processes. The student uses a systematic approach to answer scientific laboratory and field investigative questions. The student is expected to:***
(A) identify advantages and limitations of models such as their size, scale, properties, and materials;	*NEW*
(B) analyze data by identifying significant statistical features, patterns, sources of error, and limitations;	*(2)(H) organize, analyze, evaluate, make inferences, and predict trends from data; and*
(C) use mathematical calculations to assess quantitative relationships in data; and	*(2)(G) express and manipulate chemical quantities using scientific conventions and mathematical procedures, including dimensional analysis, scientific notation, and significant figures;* *2)(J) express relationships among physical variables quantitatively, including the use of graphs, charts, and equations.*

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(D) evaluate experimental and engineering designs.	*NEW*
	REMOVED *(2)(A) know the definition of science and understand that is has limitations, as specified in subsection (b)(2) of this section;*
(3) Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:	***(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) develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;	*NEW*
(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and	*(2)(I) 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.*
(C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.	*NEW*
(4) Scientific and engineering practices. The student knows the contributions of scientists and recognizes the importance of scientific research and innovation on society. The student is expected to:	***NEW***
(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;	*(3)(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) relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists as related to the content; and	*(3)(C) explain the impacts of the scientific contributions of a variety of historical and contemporary scientists on scientific thought and society*
(C) research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a science, technology, engineering, and mathematics (STEM) field in order to investigate STEM careers.	*(3)(D) research and describe the connections between physics and future careers; and*
	REMOVED *(3)(E) express, manipulate, and interpret relationships symbolically in accordance with accepted theories to make predictions and solve problems mathematically*

2021 Science Concepts	2017 Science Concepts
(5) Science concepts. The student knows and applies the laws governing motion in a variety of situations. The student is expected to:	***(4) Science concepts. The student knows and applies the laws governing motion in a variety of situations. The student is expected to:***
(A) analyze different types of motion by generating and interpreting position versus time, velocity versus time, and acceleration versus time using hand graphing and real-time technology such as motion detectors, photogates, or digital applications;	*(4)(A) generate and interpret graphs and charts describing different types of motion, including investigations using real-time technology such as motion detectors or photogates;*
(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;	*(4)(C) analyze and describe accelerated motion in two dimensions, including using equations, graphical vector addition, and projectile and circular examples; and*
(C) describe and analyze motion in one dimension using equations with the concepts of distance, displacement, speed, velocity, frames of reference, and acceleration;	*(4)(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;*
(D) describe and analyze acceleration in uniform circular and horizontal projectile motion in two dimensions using equations;	*(4)(C) analyze and describe accelerated motion in two dimensions, including using equations, graphical vector addition, and projectile and circular examples; and*
(E) explain and apply the concepts of equilibrium and inertia as represented by Newton's first law of motion using relevant real-world examples such as rockets, satellites, and automobile safety devices;	*NEW*
(F) calculate the effect of forces on objects, including tension, friction, normal, gravity, centripetal, and applied forces, using free body diagrams and the relationship between force and acceleration as represented by Newton's second law of motion;	*(4)(D) calculate the effect of forces on objects, including the law of inertia, the relationship between force and acceleration, and the nature of force pairs between objects using methods, including free-body force diagrams.*
(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	*NEW*
(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.	*(5)(B) describe and calculate how the magnitude of the gravitational force between two objects depends on their masses and the distance between their centers;*

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(6) Science concepts. The student knows the nature of forces in the physical world. The student is expected to:	***(7) Science concepts. The student knows the nature of forces in the physical world. The student is expected to:***
(A) use scientific notation and predict how the magnitude of the electric force between two objects depends on their charges and the distance between their centers using Coulomb's law;	*(5)(C) describe and calculate how the magnitude of the electric force between two objects depends on their charges and the distance between their centers;*
(B) identify and describe examples of electric and magnetic forces and fields in everyday life such as generators, motors, and transformers;	*(5)(D) identify and describe examples of electric and magnetic forces and fields in everyday life such as generators, motors, and transformers;*
(C) investigate and describe conservation of charge during the processes of induction, conduction, and polarization using different materials such as electroscopes, balloons, rods, fur, silk, and Van de Graaf generators;	*(5)(E) characterize materials as conductors or insulators based on their electric properties; and*
(D) analyze, design, and construct series and parallel circuits using schematics and materials such as switches, wires, resistors, lightbulbs, batteries, voltmeters, and ammeters; and	*(5)(F) investigate and calculate current through, potential difference across, resistance of, and power used by electric circuit elements connected in both series and parallel combinations.*
(E) calculate current through, potential difference across, resistance of, and power used by electric circuit elements connected in both series and parallel circuits using Ohm's law.	
	REMOVED *(5)(A) describe the concepts of gravitational, electromagnetic, weak nuclear, and strong nuclear forces;*
(7) Science concepts. The student knows that changes occur within a physical system and applies the laws of conservation of energy and momentum. The student is expected to:	***(7) Science concepts. The student knows that changes occur within a physical system and applies the laws of conservation of energy and momentum. The student is expected to:***
(A) calculate and explain work and power in one dimension and identify when work is and is not being done by or on a system;	*(6)(A) investigate and calculate quantities using the work-energy theorem in various situations;*
(B) investigate and calculate mechanical, kinetic, and potential energy of a system;	*(6)(B) investigate examples of kinetic and potential energy and their transformations;*
(C) apply the concept of conservation of energy using the work-energy theorem, energy diagrams, and energy transformation equations, including transformations between kinetic, potential, and thermal energy;	*(6)(D) demonstrate and apply the laws of conservation of energy and conservation of momentum in one dimension; and*
(D) calculate and describe the impulse and momentum of objects in physical systems such as automobile safety features, athletics, and rockets; and	*(6)(C) calculate the mechanical energy of, power generated within, impulse applied to, and momentum of a physical system;*

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(E) analyze the conservation of momentum qualitatively in inelastic and elastic collisions in one dimension using models, diagrams, and simulations.	*(6)(D) demonstrate and apply the laws of conservation of energy and conservation of momentum in one dimension; and*
	REMOVED *(6)(E) explain everyday examples that illustrate the four laws of thermodynamics and the processes of thermal energy transfer.*
(8) Science concepts. The student knows the characteristics and behavior of waves. The student is expected to:	***(7) Science concepts. The student knows the characteristics and behavior of waves. The student is expected to:***
(A) examine and describe simple harmonic motion such as masses on springs and pendulums and wave energy propagation in various types of media such as surface waves on a body of water and pulses in ropes;	*(7)(A) examine and describe oscillatory motion and wave propagation in various types of media;*
(B) compare the characteristics of transverse and longitudinal waves, including electromagnetic and sound waves;	*(7)(C) compare characteristics and behaviors of transverse waves, including electromagnetic waves and the electromagnetic spectrum, and characteristics and behaviors of longitudinal waves, including sound waves;*
(C) investigate and analyze characteristics of waves, including velocity, frequency, amplitude, and wavelength, and calculate using the relationships between wave speed, frequency, and wavelength;	*(7)(B) investigate and analyze characteristics of waves, including velocity, frequency, amplitude, and wavelength, and calculate using the relationship between wave speed, frequency, and wavelength;*
(D) investigate behaviors of waves, including reflection, refraction, diffraction, interference, standing wave, the Doppler effect and polarization and superposition; and	*(7)(D) investigate behaviors of waves, including reflection, refraction, diffraction, interference, resonance, and the Doppler effect; and*
(E) compare the different applications of the electromagnetic spectrum, including radio telescopes, microwaves, and x-rays;	*NEW*
(F) investigate the emission spectra produced by various atoms and explain the relationship to the electromagnetic spectrum; and	NEW
(G) describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens.	*(7)(E) describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens.*
(9) Science concepts. The student knows examples of quantum phenomena and their applications. The student is expected to:	***(8) Science concepts. The student knows simple examples of atomic, nuclear, and quantum phenomena. The student is expected to:***

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(A) describe the photoelectric effect and emission spectra produced by various atoms and how both are explained by the photon model for light;	*(8)(A) describe the photoelectric effect and the dual nature of light;* *(8)(B) compare and explain the emission spectra produced by various atoms;*
(B) investigate Malus's Law and describe examples of applications of wave polarization, including 3-D movie glasses and LCD computer screens;	*NEW*
(C) compare and explain how superposition of quantum states is related to the wave-particle duality nature of light; and	*NEW*
(D) give examples of applications of quantum phenomena, including the Heisenberg uncertainty principle, quantum computing, and cybersecurity.	*NEW*
	REMOVED *(8)(C) calculate and describe the applications of mass-energy equivalence; and* *(8)(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.*