2021 Introduction	2010 Introduction
(1) Astronomy. In Astronomy, students focus on patterns, processes, and relationships among astronomical objects in our universe. Students acquire basic astronomical knowledge and supporting evidence about sun-Earth-Moon relationships, the solar system, the Milky Way, the size and scale of the universe, and the benefits and limitations of exploration. Students conduct laboratory and field investigations to support their developing conceptual framework of our place in space and time. By the end of Grade 12, students are expected to gain sufficient knowledge of the scientific and engineering practices across the disciplines of science to make informed decisions using critical thinking and scientific problem solving. **(2)** Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable. **(3)** Scientific hypotheses and theories. Students are expected to know that **(A)** hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories; and **(B)** scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established and highly reliable explanations, but they may be subject to change as new areas of science and new technologies are developed. **(4)** Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations include	***(1)*** *Astronomy. In Astronomy, students conduct laboratory and field investigations, use scientific methods, and make informed decisions using critical thinking and scientific problem solving. Students study the following topics: astronomy in civilization, patterns and objects in the sky, our place in space, the moon, reasons for the seasons, planets, the sun, stars, galaxies, cosmology, and space exploration. Students who successfully complete Astronomy will acquire knowledge within a conceptual framework, conduct observations of the sky, work collaboratively, 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 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.* *linking Earth's interior to its surface. The geosphere is composed of materials that move between subsystems at various rates driven by the uneven distribution of thermal energy. These dynamic processes are responsible for the origin and distribution of*

2021 Introduction (continued)	2010 Introduction (continued)
descriptive investigations, which involve collecting data and recording observations without 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.	

2021	2010
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) apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;	*(2)(E) plan and implement investigative procedures, including making observations, asking questions, formulating testable hypotheses, and selecting equipment and technology;*
(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;*
(D) use appropriate tools such as gnomons; sundials; Planisphere; star charts; globe of the Earth; diffraction gratings; spectroscopes; color filters; lenses of multiple focal lengths; concave, plane, and convex mirrors; binoculars; telescopes; celestial sphere; online astronomical databases; and online access to observatories;	*(2)(I) use astronomical technology such as telescopes, binoculars, sextants, computers, and software.*
(E) collect quantitative data using the International System of Units (SI) and qualitative data as evidence;	*(2)(F) collect data and make measurements with accuracy and precision;*
(F) organize quantitative and qualitative data using labeled drawings and diagrams, graphic organizers, charts, tables, and graphs;	*(2)(G) organize, analyze, evaluate, make inferences, and predict trends from data, including making new revised hypotheses when appropriate;*
(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)(D) distinguish between scientific hypotheses and scientific theories;*
	REMOVED *(1)(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.* *(1)(C) use the school's technology and information systems in a wise and ethical manner.* *(2)(A) know the definition of science and understand that it has limitations, as specified in*

2021	2010
	REMOVED Continued… *2)(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 which have been tested over a wide variety of conditions are incorporated into theories;* *(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 as new areas of science and new technologies are developed;*
(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 scientific methods during laboratory and field investigations. 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;	*NEW*
(C) use mathematical calculations to assess quantitative relationships in data; and	*NEW*
(D) evaluate experimental and engineering designs.	*NEW*
(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;	*(2)(H) communicate valid conclusions in writing, oral presentations, and through collaborative projects; and*
(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and	*NEW*
(C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.	NEW

2021	2010
(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) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;*
(B) 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)(D) evaluate the impact of research on scientific thought, society, and the environment; and*
(C) research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a science, technology, engineering, and mathematics (STEM) field in order to investigate STEM careers.	*(3)(E) describe the connection between astronomy and future careers.*
	REMOVED *(3)(B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;* *(3)(C) draw inferences based on data related to promotional materials for products and services;*
Science Concepts	**Science Concepts**
(5) Science concepts. The student understands how astronomy influenced and advanced civilizations. The student is expected to:	***(4) Science concepts. The student recognizes the importance and uses of astronomy in civilization. The student is expected to:***
(A) evaluate and communicate how ancient civilizations developed models of the universe using astronomical structures, instruments, and tools such as the astrolabe, gnomons, and charts and how those models influenced society, time keeping, and navigation;	*(4)(A) research and describe the use of astronomy in ancient civilizations such as the Egyptians, Mayans, Aztecs, Europeans, and the native Americans;*
(B) research and evaluate the contributions of scientists, including Ptolemy, Copernicus, Tycho Brahe, Kepler, Galileo, and Newton, as astronomy progressed from a geocentric model to a heliocentric model; and	*(4)(B) research and describe the contributions of scientists to our changing understanding of astronomy, including Ptolemy, Copernicus, Tycho Brahe, Kepler, Galileo, Newton, Einstein, and Hubble, and the contribution of women astronomers, including Maria Mitchell and Henrietta Swan Leavitt;*

2021	2010
(C) describe and explain the historical origins of the perceived patterns of constellations and the role of constellations in ancient and modern navigation	*(4)(C) describe and explain the historical origins of the perceived patterns of constellations and the role of constellations in ancient and modern navigation; and*
	REMOVED *(4)(D) explain the contributions of modern astronomy to today's society, including the identification of potential asteroid/comet impact hazards and the Sun's effects on communication, navigation, and high-tech devices.*
(6) Science concepts. The student conducts and explains astronomical observations made from the point of reference of Earth. The student is expected to:	***(5) Science concepts. The student develops a familiarity with the sky. The student is expected to:***
(A) observe, record, and analyze the apparent movement of the Sun, Moon, and stars and predict sunrise and sunset;	*(5)(A) observe and record the apparent movement of the Sun and Moon during the day;*
(D) observe the movement of planets throughout the year and measure how their positions change relative to the constellations;	*(5)(B) observe and record the apparent movement of the Moon, planets, and stars in the nighttime sky; and*
(C) identify constellations such as Ursa Major, Ursa Minor, Orion, Cassiopeia, and constellations along the ecliptic and describe their importance; and	*(5)(A) recognize and identify constellations such as Ursa Major, Ursa Minor, Orion, Cassiopeia, and constellations of the zodiac.*
(D) understand the difference between astronomy and astrology, the reasons for their historical conflation, and their eventual separation.	*NEW*
(7) Science concepts. The student knows our relative place in the solar system. The student is expected to:	***(6) Science concepts. The student knows our place in space. The student is expected to:***
(A) demonstrate the use of units of measurement in astronomy, including astronomical units and light years, minutes, and seconds;	*(6)(E) demonstrate the use of units of measurement in astronomy, including Astronomical Units and light years.*
(B) model the scale, size, and distances of the Sun, Earth, and Moon system and identify the limitations of physical models; and	*(6)(A) compare and contrast the scale, size, and distance of the Sun, Earth, and Moon system through the use of data and modeling;*
(C) model the scale, sizes, and distances of the Sun and the planets in our solar system and identify the limitations of physical models.	*(6)(B) compare and contrast the scale, size, and distance of objects in the solar system such as the Sun and planets through the use of data and modeling;*

2021	2010
	REMOVED *(6)(C) examine the scale, size, and distance of the stars, Milky Way, and other galaxies through the use of data and modeling;* *(6)(D) relate apparent versus absolute magnitude to the distances of celestial objects; and*
(8) Science concepts. The student observes and models the interactions within the Sun, Earth, and Moon system. The student is expected to:	***(7) Science concepts. The student knows the role of the Moon in the Sun, Earth, and Moon system. The student is expected to:***
(A) model how the orbit and relative position of the Moon cause lunar phases and predict the timing of moonrise and moonset during each phase;	*(7)(B) illustrate the cause of lunar phases by showing positions of the Moon relative to Earth and the Sun for each phase, including new moon, waxing crescent, first quarter, waxing gibbous, full moon, waning gibbous, third quarter, and waning crescent;*
(B) model how the orbit and relative position of the Moon cause lunar and solar eclipses; and	*(7)(C) identify and differentiate the causes of lunar and solar eclipses, including differentiating between lunar phases and eclipses; and*
(C) examine and investigate the dynamics of tides using the Sun, Earth, and Moon model.	*(7)(D) identify the effects of the Moon on tides.*
	REMOVED *(7)(A) observe and record data about lunar phases and use that information to model the Sun, Earth, and Moon system;*
(9) Science concepts. The student models the cause of planetary seasons. The student is expected to:	***(8) Science concepts. The student knows the reasons for the seasons. The student is expected to:***
(A) examine the relationship of a planet's axial tilt to its potential seasons;	*(8)(A) recognize that seasons are caused by the tilt of Earth's axis;*
(B) predict how changing latitudinal position affects the length of day and night throughout a planet's orbital year;	*(8)(B) explain how latitudinal position affects the length of day and night throughout the year;*
(C) investigate the relationship between a planet's axial tilt, angle of incidence of sunlight, and concentration of solar energy; and	*(8)(C) recognize that the angle of incidence of sunlight determines the concentration of solar energy received on Earth at a particular location; and*
(D) explain the significance of Earth's solstices and equinoxes.	*(8)(D) examine the relationship of the seasons to equinoxes, solstices, the tropics, and the equator.*

2021	2010
(10) Science concepts. The student knows how astronomical tools collect and record information about celestial objects. The student is expected to:	***NEW***
(A) investigate the use of black body radiation curves and emission, absorption, and continuous spectra in the identification and classification of celestial objects;	*NEW*
(B) calculate the relative light-gathering power of different-sized telescopes to compare telescopes for different applications;	*NEW*
(C) analyze the importance and limitations of optical, infrared, and radio telescopes, gravitational wave detectors, and other ground-based technology; and	*(14)(C) analyze the importance of ground-based technology in astronomical studies;*
(D) analyze the importance and limitations of space telescopes in the collection of astronomical data across the electromagnetic spectrum.	*(14)(D) recognize the importance of space telescopes to the collection of astronomical data across the electromagnetic spectrum; and*
(11) Science concepts. The student uses models to explain the formation, development, organization, and significance of solar system bodies. The student is expected to:	***(9) Science concepts. The student knows that planets of different size, composition, and surface features orbit around the Sun. The student is expected to:***
(A) relate Newton's law of universal gravitation and Kepler's laws of planetary motion to the formation and motion of the planets and their satellites;	*(9)(C) relate the role of Newton's law of universal gravitation to the motion of the planets around the Sun and to the motion of natural and artificial satellites around the planets; and*
(B) explore and communicate the origins and significance of planets, planetary rings, satellites, asteroids, comets, Oort cloud, and Kuiper belt objects;	*(9)(D) explore the origins and significance of small solar system bodies, including asteroids, comets, and Kuiper belt objects.*
(C) compare the planets in terms of orbit, size, composition, rotation, atmosphere, natural satellites, magnetic fields, and geological activity; and	*(9)(B) compare the planets in terms of orbit, size, composition, rotation, atmosphere, natural satellites, and geological activity;*
(D) compare the factors essential to life on Earth such as temperature, water, gases, and gravitational and magnetic fields to conditions on other planets and their satellites.	*(9)(A) compare and contrast the factors essential to life on Earth such as temperature, water, mass, and gases to conditions on other planets;*
(12) Science concepts. The student knows that our Sun serves as a model for stellar activity. The student is expected to:	***(10) Science concepts. The student knows the role of the Sun as the star in our solar system. The student is expected to:***
(A) identify the approximate mass, size, motion, temperature, structure, and composition of the Sun;	*(10)(A) identify the approximate mass, size, motion, temperature, structure, and composition of the Sun;*

2021	*2010*
(B) distinguish between nuclear fusion and nuclear fission and identify the source of energy within the Sun as nuclear fusion of hydrogen to helium;	*(10)(B) distinguish between nuclear fusion and nuclear fission, and identify the source of energy within the Sun as nuclear fusion of hydrogen to helium;*
(C) describe the eleven-year solar cycle and the significance of sunspots; and	*(10)(C) describe the eleven-year solar cycle and the significance of sunspots; and*
(D) analyze the origins and effects of space weather, including the solar wind, coronal mass ejections, prominences, flares, and sunspots.	(10)(D) analyze solar magnetic storm activity, including coronal mass ejections, prominences, flares, and sunspots.
(13) Science concepts. The student understands the characteristics and life cycle of stars. The student is expected to:	***(11)Science concepts. The student knows the characteristics and life cycle of stars. The student is expected to:***
(A) identify the characteristics of main sequence stars, including surface temperature, age, relative size, and composition;	*(11)(A) identify the characteristics of main sequence stars, including surface temperature, age, relative size, and composition;*
(B) describe and communicate star formation from nebulae to protostars to the development of main sequence stars;	*(11)(B) characterize star formation in stellar nurseries from giant molecular clouds, to protostars, to the development of main sequence stars;*
(C) evaluate the relationship between mass and fusion on stellar evolution;	*(11)(C) evaluate the relationship between mass and fusion on the dying process and properties of stars;*
(D) compare how the mass of a main sequence star will determine its end state as a white dwarf, neutron star, or black hole;	*(11)(E) compare how the mass and gravity of a main sequence star will determine its end state as a white dwarf, neutron star, or black hole;*
(E) describe the use of spectroscopy in obtaining physical data on celestial objects such as temperature, chemical composition, and relative motion;	*(11)(F) relate the use of spectroscopy in obtaining physical data on celestial objects such as temperature, chemical composition, and relative motion; and*
(F) use the Hertzsprung-Russell diagram to classify stars and plot and examine the life cycle of stars from birth to death;	*(11)(G) use the Hertzsprung-Russell diagram to plot and examine the life cycle of stars from birth to death.*
(G) illustrate how astronomers use geometric parallax to determine stellar distances and intrinsic luminosities; and	*NEW*
(H) describe how stellar distances are determined by comparing apparent brightness and intrinsic luminosity when using spectroscopic parallax and the Leavitt relation for variable stars.	*NEW*
	REMOVED *(11)(D) differentiate among the end states of stars, including white dwarfs, neutron stars, and black holes;*

2021	2010
(14) Science concepts. The student knows the structure of the universe and our relative place in it. The student is expected to:	***(12) Science concepts. The student knows the variety and properties of galaxies. The student is expected to:***
(A) illustrate the structure and components of our Milky Way galaxy and model the size, location, and movement of our solar system within it;	*(12)(B) recognize the type, structure, and components of our Milky Way galaxy and location of our solar system within it; and*
(B) compare spiral, elliptical, irregular, dwarf, and active galaxies;	*(12)(C) compare and contrast the different types of galaxies, including spiral, elliptical, irregular, and dwarf.*
(C) develop and use models to explain how galactic evolution occurs through mergers and collisions;	*NEW*
(D) describe the Local Group and its relation to larger-scale structures in the universe; and	*NEW*
(E) evaluate the indirect evidence for the existence of dark matter	*NEW*
	REMOVED *(12)(A) describe characteristics of galaxies;*
(15) Science concepts. The student knows the scientific theories of cosmology. The student is expected to:	***(13) Science concepts. The student knows the scientific theories of cosmology. The student is expected to:***
(A) describe and evaluate the historical development of evidence supporting the Big Bang Theory;	*(13)(A) research and describe the historical development of the Big Bang Theory, including red shift, cosmic microwave background radiation, and other supporting evidence;*
(B) evaluate the limits of observational astronomy methods used to formulate the distance ladder;	*NEW*
(C) evaluate the indirect evidence for the existence of dark energy;	*NEW*
(D) describe the current scientific understanding of the evolution of the universe, including estimates for the age of the universe; and	*(13)(B) research and describe current theories of the evolution of the universe, including estimates for the age of the universe; and*
(E) describe current scientific hypotheses about the fate of the universe, including open and closed universes.	*(13)(C) research and describe scientific hypotheses of the fate of the universe, including open and closed universes and the role of dark matter and dark energy.*
(16) Science concepts. The student knows the structure of the universe and our relative place in it. The student is expected to:	***(14) Science concepts. The student recognizes the benefits and challenges of space exploration to the study of the universe. The student is expected to:***
(A) describe and communicate the historical development of human space flight and its challenges;	*(14)(A) identify and explain the contributions of human space flight and future plans and challenges;*

2021	2010
(B) describe and communicate the uses and challenges of robotic space flight;	*(14)(B) recognize the advancement of knowledge in astronomy through robotic space flight;*
(C) evaluate the evidence of the existence of habitable zones and potentially habitable planetary bodies in extrasolar planetary systems;	*NEW*
(D) evaluate the impact on astronomy from light pollution, radio interference, and space debris;	*NEW*
(E) examine and describe current developments and discoveries in astronomy; and	*(14)(E) demonstrate an awareness of new developments and discoveries in astronomy.*
(F) explore and explain careers that involve astronomy, space exploration, and the technologies developed through them.	*NEW*