Physics Side-by-Side

2021 Knowledge and Skill Statement/Student Expectation	2021 Text	2017 Knowledge and Skill Statement/Student Expectation	2017 Text	Notes from TEA Staff
SCIENCE.PHY.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:	P.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:	
		P.2	Scientific processes. ~~The student uses a systematic approach to answer scientific~~ laboratory and field investigative questions. The student is expected to:	
SCIENCE.PHY.1.A	ask questions and define problems based on observations or information from text, phenomena, models, or investigations;	P.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~~;	
SCIENCE.PHY.1.B	apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;			
SCIENCE.PHY.1.C	use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;	P.1.A	~~demonstrate~~ safe practices during laboratory and field investigations; and	
SCIENCE.PHY.1.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;	P.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;	
		P.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, and/~~or other equipment and materials that will produce the same results;	
SCIENCE.PHY.1.E	collect quantitative data using the International System of Units (SI) and qualitative data as evidence;	P.2.G	~~make measurements with accuracy and precision and record~~ data using scientific notation and International System (SI) units;	
SCIENCE.PHY.1.F	organize quantitative and qualitative data ~~using oral or written lab reports, labeled drawings, particle diagrams,~~ charts, tables, graphs, ~~journals, summaries, or technology-based reports~~;	P.2.H	organize, ~~evaluate, and make inferences~~ from data, ~~including the use of~~ tables, charts, and graphs;	
SCIENCE.PHY.1.G	develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and			
		P.2.B	~~know that~~ scientific hypotheses ~~are tentative and testable statements that must be capable of being supported or not supported by observational evidence~~;	

SCIENCE.PHY.1.H	distinguish between scientific hypotheses, theories, and laws.	**P.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~~;	
		~~**P.1.B**~~	~~demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.~~	The use and conservation of resources are covered in elementary and middle school science.
		~~**P.2.A**~~	~~know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;~~	
SCIENCE.PHY.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:			
SCIENCE.PHY.2.A	identify advantages and limitations of models such as their size, scale, properties, and materials;			
SCIENCE.PHY.2.B	analyze data by identifying significant statistical features, patterns, sources of error, and limitations;	~~**P.2.J**~~	~~express relationships among physical variables quantitatively, including the use of graphs, charts, and equations.~~	
SCIENCE.PHY.2.C	use mathematical calculations to assess quantitative relationships in data; and	**P.3.E**	~~express, manipulate, and interpret~~ relationships ~~symbolically in accordance with accepted theories to make predictions and solve problems~~ mathematically.	
SCIENCE.PHY.2.D	evaluate experimental and engineering designs.			
SCIENCE.PHY.3	Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:	~~**P.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:~~	
SCIENCE.PHY.3.A	develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;	~~**P.3.B**~~	~~communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;~~	
SCIENCE.PHY.3.B	communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and	**P.2.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	Students are now being asked to communicate not only as scientists but also as engineers.
SCIENCE.PHY.3.C	engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.			
SCIENCE.PHY.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:			
SCIENCE.PHY.4.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;	**P.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;	

SCIENCE.PHY.4.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	**P.3.C**	~~explain~~ the impacts of the scientific ~~contributions of a variety of historical and contemporary~~ scientists on scientific thought and society;	
SCIENCE.PHY.4.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.	**P.3.D**	research and ~~describe the connections between physics and future~~ careers; and	
SCIENCE.PHY.5	Science concepts. The student knows and applies the laws governing motion in a variety of situations. The student is expected to:	**P.4**	Science concepts. The student knows and applies the laws governing motion in a variety of situations. The student is expected to:	
SCIENCE.PHY.5.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;	**P.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;	
SCIENCE.PHY.5.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;	**P.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;	
SCIENCE.PHY.5.C	describe and analyze motion in one dimension using equations with the concepts of distance, displacement, speed, velocity, frames of reference, and acceleration;			
SCIENCE.PHY.5.D	describe and analyze acceleration in uniform circular and horizontal projectile motion in two dimensions using equations;	**P.4.C**	analyze and describe accelerated motion in two dimensions, ~~including~~ using equations, ~~graphical vector addition, and projectile and circular examples~~; and	
SCIENCE.PHY.5.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;			
SCIENCE.PHY.5.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;	**P.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.	
SCIENCE.PHY.5.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			
SCIENCE.PHY.5.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.	**P.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;	
SCIENCE.PHY.6	Science concepts. The student knows the nature of forces in the physical world. The student is expected to:	**P.5**	Science concepts. The student knows the nature of forces in the physical world. The student is expected to:	
SCIENCE.PHY.6.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;	**P.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;	
SCIENCE.PHY.6.B	identify and describe examples of electric and magnetic forces and fields in everyday life such as generators, motors, and transformers;	**P.5.D**	identify and describe examples of electric and magnetic forces and fields in everyday life such as generators, motors, and transformers;	

SCIENCE.PHY.6.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;			
SCIENCE.PHY.6.D	analyze, design, and construct series and parallel circuits using schematics and materials such as switches, wires, resistors, lightbulbs, batteries, voltmeters, and ammeters; and			
SCIENCE.PHY.6.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.	P.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~~.	
		~~P.5.A~~	~~describe the concepts of gravitational, electromagnetic, weak nuclear, and strong nuclear forces;~~	The fundamental forces are described in Integrated Physics and Chemistry.
		~~P.5.E~~	~~characterize materials as conductors or insulators based on their electric properties; and~~	Conductors and insulators are covered in Grade 5. Properties of substances are covered in Chemistry.
SCIENCE.PHY.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:	P.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:	
SCIENCE.PHY.7.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;	P.6.A	~~investigate~~ and calculate ~~quantities using the~~ work~~-energy theorem in various situations~~;	
SCIENCE.PHY.7.B	investigate and calculate mechanical, kinetic, and potential energy of a system;	P.6.B	investigate ~~examples of~~ kinetic and potential energy ~~and their transformations~~;	
SCIENCE.PHY.7.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;	~~P.6.E~~	~~explain everyday examples that illustrate the four laws of thermodynamics and the processes of thermal energy transfer.~~	Thermodynamics was moved to Chemistry.
		P.6.A	~~investigate and calculate quantities~~ using the work-energy theorem ~~in various situations~~;	
SCIENCE.PHY.7.D	calculate and describe the impulse and momentum of objects in physical systems such as automobile safety features, athletics, and rockets; and	P.6.C	calculate the ~~mechanical energy of, power generated within~~, impulse ~~applied to~~, and momentum of a physical system;	
SCIENCE.PHY.7.E	analyze the conservation of momentum qualitatively in inelastic and elastic collisions in one dimension using models, diagrams, and simulations.	P.6.D	~~demonstrate and apply the laws of conservation of energy and~~ conservation of momentum in one dimension; and	
SCIENCE.PHY.8	Science concepts. The student knows the characteristics and behavior of waves. The student is expected to:	P.7	Science concepts. The student knows the characteristics and behavior of waves. The student is expected to:	
SCIENCE.PHY.8.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;	P.7.A	examine and describe ~~oscillatory~~ motion and wave propagation in various types of media;	
SCIENCE.PHY.8.B	compare the characteristics of transverse and longitudinal waves, including electromagnetic and sound waves;	P.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;	
SCIENCE.PHY.8.C	investigate and analyze characteristics of waves, including velocity, frequency, amplitude, and wavelength, and calculate using the relationships between wave speed, frequency, and wavelength;	P.7.B	investigate and analyze characteristics of waves, including velocity, frequency, amplitude, and wavelength, and calculate using the relationship between wavespeed, frequency, and wavelength;	
SCIENCE.PHY.8.D	investigate behaviors of waves, including reflection, refraction, diffraction, interference, standing wave, the Doppler effect and polarization and superposition; and	P.7.D	investigate behaviors of waves, including reflection, refraction, diffraction, interference, ~~resonance~~, and the Doppler effect; and	

SCIENCE.PHY.8.E	compare the different applications of the electromagnetic spectrum, including radio telescopes, microwaves, and x-rays;			
SCIENCE.PHY.8.F	investigate the emission spectra produced by various atoms and explain the relationship to the electromagnetic spectrum; and	P.8.B	~~compare and explain~~ the emission spectra produced by various atoms;	
SCIENCE.PHY.8.G	describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens.	P.7.E	describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens.	
SCIENCE.PHY.9	Science concepts. The student knows examples of quantum phenomena and their applications. The student is expected to:	P.8	Science concepts. The student knows ~~simple~~ examples of ~~atomic, nuclear~~, and quantum phenomena. The student is expected to:	
SCIENCE.PHY.9.A	describe the photoelectric effect and emission spectra produced by various atoms and how both are explained by the photon model for light;	P.8.A	describe the photoelectric effect and the ~~dual nature of~~ light;	
SCIENCE.PHY.9.B	investigate Malus's Law and describe examples of applications of wave polarization, including 3-D movie glasses and LCD computer screens;			
SCIENCE.PHY.9.C	compare and explain how superposition of quantum states is related to the wave-particle duality nature of light; and			
SCIENCE.PHY.9.D	give examples of applications of quantum phenomena, including the Heisenberg uncertainty principle, quantum computing, and cybersecurity.	P.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.	Nuclear phenomena were moved entirely to Chemistry.
		~~P.8C~~	~~calculate and describe the applications of mass-energy equivalence; and~~	Mass-energy equivalence was deleted from Physics.
KEY	Blue double underline: indicates content new to the grade level		~~Orange strike through: indicates content was deleted~~	