Physics Scope and Sequence

Grading Period	Unit Title	Learning Targets
Throughout the School Year		(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) 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: (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. Hypotheses of durable explanatory power which 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) design and implement investigative procedures, including making observations, asking well-defined questions, formulating testable hypotheses, identifying variables, selecting appropriate equipment and technology, and evaluating numerical answers for reasonableness; (F) demonstrate the use of course apparatus, equipment, techniques, and procedures, including multimeters (current, voltage, resistance), triple beam balances, batteries, clamps, dynamics demonstration equipment, collision apparatus, data acquisition probes, discharge tubes with power supply (H, He, Ne, Ar), hand-held visual spectroscopes, hot plates, slotted and hooked lab masses, bar magnets, horseshoe magnets, plane mirrors, convex lenses, pendulum support, power supply, ring clamps, ring stands, stopwatches, trajectory apparatus, tuning forks, carbon paper, graph

	paper, magnetic compasses, polarized film, prisms, protractors, resistors, friction blocks, mini lamps (bulbs) and sockets, electrostatics kits, 90-degree rod clamps, metric rulers, spring scales, knife blade switches, Celsius thermometers, meter sticks, scientific calculators, graphing technology, computers, cathode ray tubes with horseshoe magnets, ballistic carts or equivalent, resonance tubes, spools of nylon thread or string, containers of iron filings, rolls of white craft paper, copper wire, Periodic Table, electromagnetic spectrum charts, slinky springs, wave motion ropes, and laser pointers; (G) 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, micrometer, caliper, radiation monitor, computer, ballistic pendulum, electroscope, inclined plane, optics bench, optics kit, pulley with table clamp, resonance tube, ring stand screen, four inch ring, stroboscope, graduated cylinders, and ticker timer; (H) make measurements with accuracy and precision and record data using scientific notation and International System (SI) units; (I) identify and quantify causes and effects of uncertainties in measured data; (J) organize and evaluate data and make inferences from data, including the use of tables, charts, and graphs; (K) 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 (L) express and manipulate 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) 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) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials; (C) draw inferences based on data related to promotional materials for products and services; (D) explain the impacts of the scientific contributions of a variety of historical and contemporary scientists on scientific thought and society; (E) research and describe the connections between physics and future careers; and (F) express and interpret relationships symbolically in accordance with accepted theories to make predictions and solve problems mathematically, including problems requiring proportional reasoning and graphical vector addition.

First Grading Period	1D Motion	• Convert numbers to and from scientific notation. • Convert units within and outside of the metric system. • Identify a scalar quantity. • Identify a vector quantity. • Define, describe, and calculate distance, position and displacement. • Calculate the speed and/or average speed of an object. • Calculate the velocity of an object. • Determine the relative speed of an object. • Calculate the acceleration of an object. • Use the kinematic equations to solve problems involving one-dimensional horizontal motion with constant acceleration. • Use the quadratic equation to solve kinematic equations. • Create and interpret graphs (position v time, velocity v time, and acceleration v time) to describe the motion of moving object. • Calculate the acceleration of an object. • Use the kinematic equations to solve problems involving one-dimensional vertical motion with constant acceleration. • Use the quadratic equation to solve kinematic equations. • Create and interpret graphs (position v time, velocity v time, and acceleration v time) to describe the motion of moving object.
	2D Motion	• Describe a quantity in terms of its magnitude and direction. • Resolve a vector into its x- and y-components. • Add vector components to find a resultant vector. • Use the kinematic equations to solve problems involving two-dimensional motion with constant acceleration. • Solve projectile motion problems with only an initial horizontal velocity. • Solve projectile motion problems with a two-dimensional initial velocity. • Create and interpret graphs (position v time, velocity v time, and acceleration v time) to describe the motion of moving object

Second Grading Period	Forces	• Identify Newton's three laws of motion. • Solve force problems using kinematics • Create and interpret graphs (force v acceleration, force v mass, mass v acceleration) to describe the force or acceleration experienced by an object. • Draw a free body force diagram for an object. • Write and solve net force equations to find unknown forces, accelerations, and masses for single objects. • Write and solve net force equations to find unknown forces, accelerations, and masses for systems. • Solve systems of equations. • Perform calculations involving friction for objects moving across a rough surface. • Determine if a stationary object will move when pushed/pulled across a rough surface. • Draw an unresolved and resolved free body force diagram. • Perform calculations for objects experiencing a force in two dimensions. • Describe and calculate the effect of an incline on the forces acting on an object. • Use Newton's Law of Universal Gravitation to calculate the force that one mass exerts on another. • Calculate the period and frequency of an object undergoing circular motion. • Perform calculations for an object undergoing circular motion.
	Energy, Work, and Power	• Identify the types of energy in a system. • Apply the law of conservation of energy to an isolated system. • Calculate the kinetic and potential energy of a system. • Calculate the heat lost from a system due to friction. • Write and solve equations to calculate the work, force, or displacement of an object. • Determine the amount of work required to change the energy of a system. • Create and interpret graphs (force v distance) to determine the work done on an object. • Calculate power of a physical system using a variety of work and energy equations.
	Momentum	• Calculate the total linear momentum of a system of objects. • Calculate impulse delivered to an object. • Create and interpret graphs (force v time) to determine the impulse applied to an object. • Apply the principle of conservation of linear momentum to analyze one-dimensional elastic and inelastic collisions. • Apply the principle of conservation of linear momentum to analyze one-dimensional explosions.

Third Grading Period	Fluids	• Use the combined gas law to qualitatively and quantitatively describe the properties of a gas under different conditions. • Define fluid. • Apply the relationship between pressure, force, and area for a fluid. • Apply the relationship between density, mass, and volume for a fluid. • Qualitatively explain Bernoulli's Principle and its' ramifications.
	Heat	• Define and apply the following terms: heat, temperature, internal energy, thermal equilibrium, thermal expansion/contraction, conduction, convection, radiation • Draw a heating curve for an object that has lost or gained heat. • Use a heating curve to determine the equation for calculating the heat lost/gained by an object. • Describe warming/cooling processes as it relates to phase changes • Draw heating curves showing the transfer of heat between objects. • Define specific heat and calculate heat lost/gained. • Calculate changes in heat due to mechanical work. • Calculate the heat transfer between objects.
	Thermodynamics	• Define and apply the following terms: Thermodynamics, System, Zeroth law of thermodynamics, Work • Calculate the work done on/by a system • Use a Pressure v Volume graph to determine the work done on/by a system. • Define and apply the following terms: First Law of Thermodynamics, Internal Energy, Thermodynamic Process, Isothermal, Isobaric, Isovolumetric, Adiabatic • Calculate changes in internal energy of a system. • Describe the effect of each of a thermodynamic process on the internal energy of a system. • Identify the type of thermodynamic process using a Pressure v Volume graph. • Define and apply the following terms: Second Law of Thermodynamics, Heat Engine, Heat pump, Entropy • Identify and describe different types of heat engines and heat pumps. • Define and apply the following terms: Efficiency, Absolute Zero • Calculate the efficiency of a heat engine. • Describe how changes to an engine will impact the engine's efficiency.

	Electrostatics	• Define and apply the following terms in relation to static charges: Nucleus, Proton, Neutron, Electron, Conductor, Insulator, Friction, Conduction, Induction, Conservation of Charge • Define Electric Force • Describe attraction and repulsion between different charges. • Apply Coulomb's Law to calculate the magnitude and direction of the electric force other charges. • Define electric field. • Draw an electric field around a point charge or point charges. • Calculate the strength of the electric field. • Calculate the force placed on an electric charge with in an electric field. • Determine the direction of the force a specified charge would experience in an electric field.
Fourth Grading Period	Circuits	• Identify components within a circuit. • Perform calculations using Ohm's Law. • Identify or describe the difference between a series and a parallel circuit. • Identify devices to measure voltage and current and the orientation of those devices with in a circuit. • Calculate the voltage and current for any resistor in a series circuit. • Calculate total resistance of a series circuit. • Understand how equivalent circuits are used in circuit analysis. • Calculate the voltage and current for any resistor in a parallel circuit. • Calculate total resistance of a parallel circuit. • Identify a combination circuit. • Calculate the voltage and current for any resistor in a combination circuit. • Calculate total resistance of a combination circuit. • Understand how equivalent circuits are used in circuit analysis. • Calculate the power output of a resistor. • Rank resistors in terms of brightness.
	Magnetism	• Define and apply the following terms: Magnetism, Ferromagnetic, Domain Theory of Magnetism, Magnetic Poles • Define a magnetic field • Calculate the strength of a magnetic field • Draw the magnetic field around Earth, bar magnets, or point charges • Using the right hand rules, determine the direction of a magnetic field surrounding a wire. • Calculate the magnitude of the magnetic force acting on a charged particle moving through a magnetic field. • Calculate the magnitude of the force on a current carrying wire in a magnetic field.

		• Using the right hand rule, determine the direction of the magnetic force, field, or velocity of a charged particle • Define and apply the following terms in relation to electromagnetism: Lenz's Law, Solenoid, Motor, Generator, Transformer • Calculate the output voltage or current for a given power transformer.
	Waves, Sound and Light	• Define and apply the following terms in relation to waves: resonance, beat frequency, interference, forced vibration, Doppler effect, sonic boom • Identify the limits of Human Hearing • Know the speed of sound and what variables affect it • Describe the effect of frequency and amplitude of a sound wave as it relates to pitch and loudness • Identify parts of a standing wave • Define the following terms in relation to electromagnetic waves: energy, frequency, wavelength, electromagnetic spectrum. • Organize the electromagnetic spectrum by frequency, wavelength or energy. • Use the wave equation to calculate the frequency and wavelength of a light wave. • Calculate the speed of light in a transparent medium. • Use the Snell's Law to determine the angle of refraction for light as it moves between media. • Sketch the direction of reflected and refracted rays. • Define and calculate the critical angle. • Dray ray diagrams for converging and diverging devices • Use a ray diagram to predict characteristics of the image formed. • Use the thin lens equation to predict characteristics of the image formed. • Calculate the magnification of the image for both lenses and mirrors.
	Nuclear and Modern	• Define and apply the following terms: Alpha decay, + Beta decay, – Beta decay, Gamma decay, Nuclear Fission, Nuclear Fusion, Critical Mass, Chain Reaction • Use conservation of mass and charge to complete nuclear decay reactions. • Identify the following scientists and identify their experiment, JJ Thomson • Ernst Rutherford, Neils Bohr, Bohr Model, Plum Pudding Model, Gold Foil Experiment, Cathode Ray Tube Experiment, Absorption Spectrum, Emission Spectrum, Photoelectric Effect • Compare and explain the emission spectra produced by various atoms • Describe the photoelectric effect and the dual nature of light • Describe qualitatively how the number of photoelectrons and their maximum kinetic energy depend on the wavelength and intensity of the light striking the photosensitive surface.