Physics K-12 Vertical Alignment

Topic	Kinder §112.2	1st §112.3	2nd §112.4	3rd §112.5	4th §112.6	5th §112.7	6th §112.26	7th §112.27	8th §112.28	Biology §112.42	IPC §112.44	Chemistry §112.43	Physics §112.45	Earth Systems §112.49	Environmental Science §112.50	Aquatic Science §112.47	Astronomy §112.48
Force Interactions	K.7.A The student is expected to describe and predict how a magnet interacts with various materials and how magnets can be used to push or pull.			3.7.A demonstrate and describe forces acting on an object in contact or at a distance, including magnetism, gravity, and pushes and pulls;	4.7.A The student is expected to plan and conduct descriptive investigations to explore the patterns of forces such as gravity, friction, or magnetism in contact or at a distance on an object.	5.7.B design a simple experimental investigation that tests the effect of force on an object in a system such as a car on a ramp or a balloon rocket on a string.	6.7.A identify and explain how forces act on objects, including gravity, friction, magnetism, applied forces, and normal forces, using real-world applications;				IPC.5.D describe the nature of the four fundamental forces: gravitation; electromagnetic; the strong and weak nuclear forces, including fission and fusion; and mass-energy equivalency;		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; Phy.6.B identify and describe examples of electric and magnetic forces and fields in everyday life such as generators, motors, and transformers; 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;				
Balanced and Unbalanced Forces		1.7A explain how pushes and pulls can start, stop, or change the speed or direction of an object's motion; 1.7.B plan and conduct a descriptive investigation that predicts how pushes and pulls can start, stop, or change the speed or direction of an object's motion.	2.7.B plan and conduct a descriptive investigation to demonstrate how the strength of a push and pull changes an object's motion.	3.7.B plan and conduct a descriptive investigation to demonstrate and explain how position and motion can be changed by pushing and pulling objects such as swings, balls, and wagons.		5.7.A investigate and explain how equal and unequal forces acting on an object cause patterns of motion and transfer of energy; and	6.7.B calculate the net force on an object in a horizontal or vertical direction using diagrams and determine if the forces are balanced or unbalanced; 6.7.C identify simultaneous force pairs that are equal in magnitude and opposite in direction that result from the interactions between objects using Newton's Third Law of Motion.	7.7.D analyze the effect of balanced and unbalanced forces on the state of motion of an object using Newton's First Law of Motion.	8.7.A calculate and analyze how the acceleration of an object is dependent upon the net force acting on the object and the mass of the object using Newton's Second Law of Motion; 8.7.B investigate and describe how Newton's three laws of motion act simultaneously within systems such as in vehicle restraints, sports activities, amusement park rides, Earth's tectonic activities, and rocket launches.				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; 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;				
				3.8.B plan and conduct investigations that demonstrate how the speed of an object is related to its mechanical energy.				7.7.B distinguish between speed and velocity in linear motion in terms of distance, displacement, and direction; 7.7.A calculate average speed using distance and time measurements from investigations;			IPC.5.A investigate, analyze, and model motion in terms of position, velocity, acceleration, and time using tables, graphs, and mathematical relationships; IPC.5.B analyze data to explain the relationship between mass and acceleration in terms of the net force on an object in one dimension using force diagrams, tables, and graphs;		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; 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;				

Linear Motion								7.7.C measure, record, and interpret an object's motion using distance-time graphs;					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; Phy.5.D describe and analyze acceleration in uniform circular and horizontal projectile motion in two dimensions using equations;				
Collisions			2.7.A explain how objects push on each other and may change shape when they touch or collide;								IPC.5.C 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;		Phy.7.D calculate and describe the impulse and momentum of objects in physical systems such as automobile safety features, athletics, and rockets; and Phy.7.E analyze the conservation of momentum qualitatively in inelastic and elastic collisions in one dimension using models, diagrams, and simulations.				
Work & Power													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;				
Newton's Law of Universal Gravitation								7.9.B describe how gravity governs motion within Earth's solar system;			IPC.5.E 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.		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.				Astro.11.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;
Light	K.8.A communicate the idea that objects can only be seen when a light source is present and compare the effects of different amounts of light on the appearance of objects; K.8.B demonstrate and explain that light travels through some objects and is blocked by other objects, creating shadows.			3.8.A identify everyday examples of energy, including light, sound, thermal, and mechanical; and		5.8.C demonstrate and explain how light travels in a straight line and can be reflected, refracted, or absorbed.					IPC.7.D explain how electrons can transition from a high energy level to a low energy state, emitting photons at different frequencies for different energy transitions;		Phy.8.G describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens. Phy.9.C compare and explain how superposition of quantum states is related to the wave-particle duality nature of light; Phy.8.E compare the different applications of the electromagnetic spectrum, including radio telescopes, microwaves, and x-rays;				

												Phy.8.F investigate the emission spectra produced by various atoms and explain the relationship to the electromagnetic spectrum;				
												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;				
Sound			2.8.A demonstrate and explain that sound is made by vibrating matter and that vibrations can be caused by a variety of means, including sound; 2.8.B explain how different levels of sound are used in everyday life such as a whisper in a classroom or a fire alarm; and 2.8.C design and build a device using tools and materials that uses sound to solve the problem of communicating over a distance.	3.8.A identify everyday examples of energy, including light, sound, thermal, and mechanical; and												
Kinetic Energy				3.8.A identify everyday examples of energy, including light, sound, thermal, and mechanical; and				7.8.C explain the relationship between temperature and the kinetic energy of the particles within a substance.					Phy.7.B investigate and calculate mechanical, kinetic, and potential energy of a system;				
Transfer of Energy					4.8.A investigate and identify the transfer of energy by objects in motion, waves in water, and sound;	5.8.A investigate and describe the transformation of energy in systems such as energy in a flashlight battery that changes from chemical energy to electrical energy to light energy;	6.8.B describe how energy is conserved through transfers and transformations in systems such as electrical circuits, food webs, amusement park rides, or photosynthesis; and 6.8.C explain how energy is transferred through transverse and longitudinal waves.	7.8.A investigate methods of thermal energy transfer into and out of systems, including conduction, convection, and radiation;	8.8.B explain the use of electromagnetic waves in applications such as radiation therapy, wireless technologies, fiber optics.		IPC.6.D investigate and demonstrate the movement of thermal energy through solids, liquids, and gases by convection, conduction, and radiation such as weather, living, and mechanical systems; IPC.6.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; IPC.6.C plan and conduct an investigation to provide evidence that energy is conserved within a closed system;	Chem.13.B investigate the process of heat transfer using calorimetry; Chem.13.D perform calculations involving heat, mass, temperature change, and specific heat	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; 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;	Earth.8.A evaluate heat transfer through Earth's systems by convection and conduction and include its role in plate tectonics and volcanism;	Env.7.D identify and describe how energy is used, transformed, and conserved as it flows through ecosystems. Env.5.B explain the cycling of water, phosphorus, carbon, silicon, and nitrogen through ecosystems, including sinks, and the human interactions that alter these cycles using tools such as models; Env.7.B relate biogeochemical cycles to the flow of energy in ecosystems, including energy sinks such as oil, natural gas, and coal deposits Env.7.C explain the flow of heat energy in an ecosystem, including conduction, convection, and radiation; and		

Electricity					**4.8.C demonstrate and describe how electrical energy travels in a closed path that can produce light and thermal energy.** **4.8.B identify conductors and insulators of thermal and electrical energy; and**	**5.8B demonstrate that electrical energy in complete circuits can be transformed into motion, light, sound, or thermal energy and identify the requirements for a functioning electrical circuit;**					**IPC.6.A 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;** **IPC.6.B design, evaluate, and refine a device that generates electrical energy through the interaction of electric charges and magnetic fields;**		**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;** **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.**				
Potential Energy							**6.8.A compare and contrast gravitational, elastic, and chemical potential energies with kinetic energy;**						**Phy.7.B investigate and calculate mechanical, kinetic, and potential energy of a system;**				
Characteristics of Waves									**8.8.A compare the characteristics of amplitude, frequency, and wavelength in transverse waves, including the electromagnetic spectrum;** **8.8.B explain the use of electromagnetic waves in applications such as radiation therapy, wireless technologies, fiber optics.**		**IPC.6.F construct and communicate an evidence-based explanation for how wave interference, reflection, and refraction are used in technology such as medicine, communication, and scientific research;** **IPC.7.E explain how atomic energy levels and emission spectra present evidence for the wave particle duality;**	**Chem.6.C investigate the mathematical relationship between energy, frequency, and wavelength of light using the electromagnetic spectrum and relate it to the quantization of energy in the emission spectrum;**	**Phy.8.B compare the characteristics of transverse and longitudinal waves, including electromagnetic and sound waves;** **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;** **Phy.8.D investigate behaviors of waves, including reflection, refraction, diffraction, interference, standing wave, the Doppler effect and polarization and superposition; and** **Phy.9.B investigate Malus's Law and describe examples of applications of wave polarization, including 3-D movie glasses and LCD computer screens;**				
Thermodynamics				**3.8.A identify everyday examples of energy, including light, sound, thermal, and mechanical; and**				**7.8.B investigate how thermal energy moves in a predictable pattern from warmer to cooler until all substances within the system reach thermal equilibrium;**				**Chem.13.A explain everyday examples that illustrate the four laws of thermodynamics;** **Chem.10.A describe the postulates of the kinetic molecular theory;**					

Quantum Physics												**Phy.9.D give examples of applications of quantum phenomena, including the Heisenberg uncertainty principle, quantum computing, and cybersecurity.**				
Conservation of Charge												**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;**				
Key	**SE containing blue text aligns with more than one topic. The black text is relevant to the topic in that row.**															