High School – Physics

1	**For at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. investigations.**
1A **Tested**	Demonstrate safe practices during field and laboratory investigations. Such as: • Use of safety glasses in projectile motion experiments • Proper operation of lasers in optics experiments • Proper handling of electrical equipment
1B Not Tested	Make wise choices in the use and conservation of resources and the disposal or recycling of materials.
2	**Uses scientific methods during fields & laboratory investigations.**
2A **Tested**	Plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology. --- Design experimental methods to verify theories Including: • Equipment needed • Data to be taken • Data analysis required
2B **Tested**	Make quantitative observations and measurements with precision. --- Appropriate use of measuring tools Such as: • Zeroing/calibrating instruments • Differentiate between accuracy and precision
2C **Tested**	Organize, analyze, evaluate, make inferences, and predict trends from data. --- Organize data in a meaningful form Such as: • Data tables --- Identify appropriate data analysis techniques Such as: • Graphical representations • Mathematical functions to fit data
2D **Tested**	Communicate valid conclusions. --- Summarize data trends --- Evaluate data quality & error sources --- Error analysis Such as: • Percent error • Absolute error --- Use results to validate/invalidate theory
2E	Graph data to observe and identify relationships between variables. --- Appropriate graphical representations of data Including: • Organization of axes • Determine significance of slope • Recognize data relationships Such as: o Linear o Exponential o Polynomial o Inversely proportional

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2F	Read the scale on scientific instruments with precision. Including: • Meterstick • Callipers • Triple beam balance • Spring scale Such as: • Graduated cylinder • Analog ammeter, voltmeter • Choosing appropriate scale on digital multimeter

High School – Physics

3	**Uses critical thinking and scientific problem solving to make informed decisions.**
3A **Tested**	Analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information. --- Accept/reject statements strictly based upon scientific evidence Such as: • Experimental results • Develop valid/testable hypotheses • Making valid extensions of accepted existent theories
3B **Tested**	Express laws symbolically and employ mathematical procedures including vector addition and right-triangle geometry to solve physical problems. Including --- Understand mathematical functions as representations of laws of physics --- Manipulate physics equations to solve for variables Such as: • Algebraic operations • Identifying and isolating variables in equations --- Dimensional Analysis --- Right-triangle geometry Including: • Pythagorean theorem • Trigonometric functions & relationships --- Vector representation of physical quantities --- Vector components --- Vector mathematical operations Including: • Adding and subtracting vectors (graphical & analytical) Such as: ○ 2-D displacements ○ Velocity vectors for objects being the subject of two different motions.
3C Not Tested	Evaluate the impact of research on scientific thought, society, and the environment. --- Relate physics to current topics Such as: • Climate change • Perpetual motion machines • Energy Resources & Conservation
3D Not Tested	Describe connection between physics and future careers. Such as: • Engineering • Medical technology • Sports
3E Not Tested	Research and describe the history of physics and contributions of scientists. Including: • Mechanics (Aristotle, Galileo, Newton) • Heat (Rumford, Kelvin, Clausius, Joule) • Electricity/Magnetism (Franklin, Coulomb, Faraday, Ohm, Ampere, Oerstad) • Atomic model (Thomson, Rutherford, Bohr) • Modern (Planck, Einstein, Schroedinger, Heisenberg)

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High School – Physics

4	**The student knows the laws governing motion.**
4A **Tested**	Generate and interpret graphs describing motion including the use of real-time technology --- Explain the information on graphs • Position-time • Velocity-time • Acceleration-time --- Real-time technology Such as: • Motion detectors • Photogates
4B **Tested**	Analyze examples of uniform and accelerated motion. Including --- Linear • Solve displacement problems • Solve velocity problems • Solve acceleration problems involving uniform acceleration and free fall --- Projectile • Resolving 2-D motion into independent motions • Flat projectiles Including: ○ Range ○ Time of flight • Angled projectiles Including: ○ Relation between range and angle of projection Such as: ○ Determine range, time of flight, and maximum height --- Circular (uniform) --- Characteristics of circular motion Including: • Period • Radius • Frequency • Centripetal acceleration
4C **Tested**	Demonstrate the effects of forces on the motion of objects. Including • Differentiate between mass and weight • Identify mass as a measure of inertia • Solve problems involving force, mass and acceleration • Forces on a single object • Situations involving friction • Objects on inclined planes --- Interpret real life situations using Newton's 3rd Law Including: • Action and reaction forces Such as: • Pairs of forces • Weight and normal force • Weight and tension

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4D Not Tested	Develop and interpret a free-body diagram for force analysis. Including • Represent interactions between objects through free-body diagrams
4E **Tested**	Identify and describe motion relative to different frames of reference. Including • Analyze motion with respect to a specified origin • Analyze motion with respect to objects moving with constant velocity.

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5	**The student knows that changes occur within a physical system and recognizes that energy and momentum are conserved.**
5A Not Tested	Interpret evidence for the work-energy theorem. Including • Relate work to energy changes • Applying work-energy theorem in problems involving conservative and non-conservative forces.
5B Not Tested	Observe and describe examples of kinetic and potential energy and their transformations. Including • Classify energy forms according to their dependence o Gravitational potential energy – height o Kinetic energy – velocity o Thermal energy – temperature o Elastic potential energy – stretch o Electric potential energy – distance --- Describe conversion of forms of mechanical energy in different systems Such as • falling bodies • roller coasters • pendulums
5C **Tested**	Calculate the mechanical energy and momentum in a physical system. Such as • Billiards • Cars • Trains --- Solve problems involving conservation and calculation of mechanical energy. --- Calculate velocities in elastic and inelastic collisions.
5D **Tested**	Demonstrate the conservation of energy and momentum. Including • Equate impulse to the change in momentum • Appreciate the importance of impulse and momentum in daily situations o Protection in car accidents ▪ Seat belts ▪ Air bags ▪ Crumple zones ▪ Collapsible barriers o Sports ▪ Collisions in football ▪ Collisions in auto racing ▪ Baseball ▪ Tennis • Solve problems involving impulse and change of momentum. • Explain the law of conservation of momentum. • Solve problems involving the law of conservation of momentum. • Explain the law of conservation of energy • Solve problems involving conservation of energy • Observe the law of conservation of momentum in elastic and inelastic collisions Such as: o Explosions o Collisions between carts

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6	The student knows forces in nature.
6A Not Tested	Identify the influence of mass and distance on gravitational forces. Including • Describe the law of universal gravitation. • Calculate the amount of gravitational force between two objects. • Determine the strength of a gravitational field.
6B Not Tested	Research and describe the historical development of the concepts of gravitational, electrical, and magnetic force. Including • Trace the historical progression of thought regarding gravity. o Newton o Cavendish o Einstein • Trace the history of our understanding of electricity and magnetism. o Coulomb o Faraday o Maxwell
6C **Tested**	Identify and analyze the influences of charge and distance on electric forces. Including • Solve problems involving Coulomb's law. • Solve electric field intensity problems. • Describe charging by induction. • Quantify charge as integer multiple of elementary charges. • Explain electric potential difference. • Describe the properties of electric fields. • Describe the effects of electric fields on charges. • Describe electric fields in conductors.
6D Not Tested	Demonstrate the relationship between electricity and magnetism. Including • Describe magnetic field lines. • Describe the flow of magnetic field through a surface as flux • Explain Faraday's law of induction. • Determine the direction of induced current using Lenz's law. • Explain why a rotating loop in a magnetic field produces alternating current.
6E **Tested**	Design and analyze electric circuits. Including • Build and diagram series and parallel circuits • Define electric current and resistance • Use Ohm's law to solve and simplify (reduce) circuits
6F Not Tested	Identify examples of electrical and magnetic forces in everyday life. Including • Solve problems involving electric power consumption. • Compare & contrast the current and voltage in the wires in a long distance transmission line and the wires that carry electricity to a home. • Describe everyday applications Such as o Electric motors o MRI o Cat Scan o Aurora Borealis/Australis

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7	**The student knows the laws of Thermodynamics.**
7A **Tested**	Analyze and explain everyday examples that illustrate the laws of thermodynamics. Including • Heat engines & efficiency • Describe the role of heat in phase changes • Explain thermal expansion in examples such as bridges, metallic structures of buildings, railroad tracks. • Compare and contrast alternative heating methods Such as o Heat pumps o Air conditioning o Radiant heating o Solar o Geothermal
7B **Tested**	Evaluate different methods of heat energy transfer that result in an increasing amount of disorder. Including • Describe entropy as a measure of the degree of order/disorder • Explain the relationship between internal energy, heat, and work. • Convection, conduction, radiation • Define heat in terms of molecular motion. • Describe the concept of thermal equilibrium. • Explain the importance of specific heat. • Describe the relationship between heat energy and entropy as it relates to a system and its surroundings.

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8	**The student knows the characteristics and behavior of waves.**
8A **Tested**	Examine and describe a variety of waves propagated in various types of media and describe wave characteristics Such as • Describe the properties of oscillation / simple harmonic motion • Describe factors that affect the period of a simple pendulum and spring-mass system • Describe pulses and periodic waves • Describe characteristics of waves o Velocity o Frequency o Wavelength o Amplitude o Crest/compression o Trough/rarefaction • Describe the two types of waves o Transverse o Longitudinal • Describe wave behaviors Such as o Reflection (fixed & loose end) o Refraction o Interference (including constructive & destructive) o Diffraction o Polarization • Describe standing waves and how they are formed
8B **Tested**	Identify the characteristics and behaviors of sound and electromagnetic waves. Including • Explain how sound waves are produced • Describe properties of sound waves Including o Intensity & relative intensity o Frequency & pitch (including beats) o Harmonics – quality & timbre (including standing waves w/ stringed and pipe instruments) o Resonance o The Doppler effect • Extend general properties & behaviors of waves to electromagnetic waves Including: o reflection ▪ mirrors o refraction ▪ Snell's Law ▪ total internal reflection & critical angle ▪ lenses
8C **Tested**	Interpret the role of wave characteristics and behaviors found in medicinal (medical) and industrial applications. Including • Ultrasound (sonograms) • Doppler weather • Police radar • Sonar/Echolocation • Radio/TV communications

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9	**The student knows simple examples of quantum physics.**
9A Not Tested	Describe the photoelectric effect. Including • Relations between: o Intensity / number of photons & photoelectric current o Frequency & kinetic energy of electrons o Threshold frequency & work function
9B Not Tested	Explain the line spectra from different gas-discharge tubes. Including • Identify gases by their spectra • Relate line spectrum to atomic models (including Bohr's model)