MIDLAND ISD
ADVANCED PLACEMENT CURRICULUM STANDARDS

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(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;	**Science Practices** **Standard SP.1: Scientific Questions and Predictions** **Asking scientific questions that can be tested empirically and structuring these questions in the form of testable predictions** **SP.1.1 Scientific Questions** Students recognize, formulate, justify and revise scientific questions that can be addressed by science in order to construct explanations. **SP.1.2 Predictions** Students make and justify predictions concerning natural phenomena. Predictions and justifications are based on observations of the world, on knowledge of the discipline and on empirical evidence. **Standard SP.2: Generation of Evidence: Collecting data to address scientific questions and to support predictions** **SP.2.1 Data Collection** Students select and use appropriate measurement methods and techniques for gathering data, and systematically record and organize observations and measurements.	**I. Nature of Science: Scientific Ways of Learning and Thinking** **A. Cognitive skills in science** **1.** Utilize skepticism, logic, and professional ethics in science. **2.** Use creativity and insight to recognize and describe patterns in natural phenomena. **3.** Formulate appropriate questions to test understanding of natural phenomena. **4.** Rely on reproducible observations of empirical evidence when constructing, analyzing, and evaluating explanations of natural events and processes. **B. Scientific inquiry** **1.** Design and conduct scientific investigations In which hypotheses are formulated and tested. **C. Collaborative and safe working practices** **1.** Collaborate on joint projects. **2.** Understand and apply safe procedures in the laboratory and field, including chemical, electrical, and fire safety and safe handling of live or preserved organisms. **3.** Demonstrate skill in the safe use of a wide variety of apparatuses, equipment, techniques, and procedures. **D. Current scientific technology** **1.** Demonstrate literacy in computer use. **2.** Use computer models, applications, and simulations. **3.** Demonstrate appropriate use of a wide

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(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	**SP.2.2 Evaluating Data for Evidence** Students determine which data from a specific investigation can be used as evidence to address a scientific question or to support a prediction or an explanation, and distinguish credible data from noncredible data in terms of quality. **Standard SP.3: Data Analysis** **Searching for regularities and patterns in observations and measurements** **(i.e., data analysis)** **SP.3.1 Analyzing Data for Patterns** Students analyze data to discover patterns. **Standard SP.4:Evidence-Based Explanations and Models :** **Using evidence and science knowledge to construct scientific explanations, models and representations** **SP.4.1 Constructing Explanations** Students construct explanations that are based on observations and measurements of the world, on empirical evidence and on reasoning grounded in the theories, principles and concepts of the discipline. **SP.4.2 Models and Representations** Students construct, use, re-express and revise models and representations of natural and designed objects, systems,	variety of apparatuses, equipment, techniques, and procedures for collecting quantitative and qualitative data. **E. Effective communication of scientific information** **1.** Use several modes of expression to describe or characterize natural patterns and phenomena. These modes of expression include narrative, numerical, graphical, pictorial, symbolic, and kinesthetic. **2.** Use essential vocabulary of the discipline being studied. **II. Foundation Skills: Scientific Applications of Mathematics** **A. Basic mathematics conventions** **1**. Understand the real number system and its properties. **2.** Use exponents and scientific notation. **3.** Understand ratios, proportions, percentages, and decimal fractions, and translate from any form to any other. **4.** Use proportional reasoning to solve problems. **5.** Simplify algebraic expressions. **6.** Estimate results to evaluate whether a calculated result is reasonable. **7**. Use calculators, spreadsheets, computers, etc., in data analysis.

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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	phenomena and scientific ideas in the appropriate context and in formulating their explanation. **SP.4.3 Evaluating Explanations** Students evaluate, compare and contrast explanations that are based on observations of the world, on empirical evidence and on reasoning grounded in the theories, principles and concepts of the discipline. **Standard SP.5:Quantitative Applications Using mathematical reasoning and quantitative applications to interpret and analyze data to solve problems** **SP.5.1 Proportionality Between Variables** Students reason about relationships between variables (e.g., data, representations, uncertainty, samples) through the lens of ratios, rates, percentages, probability or proportional relationships when approaching or solving problems or when interpreting results or situations. **SP.5.2 Patterns of Bivariate Relationships** Students apply, analyze and create algebraic representations, relationships and patterns of linear functions, systems of linear inequalities, and one- or two-dimensional changes to solve problems, interpret situations and address scientific questions.	**B. Mathematics as a symbolic language** **1**. Carry out formal operations using standard algebraic symbols and formulae. **2.** Represent natural events, processes, and relationships with algebraic expressions and algorithms. **C. Understand relationships among geometry, algebra, and trigonometry** **1.** Understand simple vectors, vector notations, and vector diagrams, and carry out simple calculations involving vectors. **2.** Understand that a curve drawn on a defined set of axes is fully equivalent to a set of algebraic equations. **3.** Understand basic trigonometric principles, Including definitions of terms, such as sine, cosine, tangent, cotangent, and their relationship to triangles. **4.** Understand basic geometric principles. **D. Scientific problem solving** **1.** Use dimensional analysis in problem solving. **E. Scientific application of probability and statistics** **1**. Understand descriptive statistics. **F. Scientific measurement** **1.** Select and use appropriate Standard International (SI) units and prefixes to express measurements for real world problems. **2.** Use appropriate significant digits.

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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	**Science, Technology and Society** **Standard STS.1:Science, Technology and Society** **A critical interdependence exists among science, technology and society.** **STS.1.1 Interdependence of Science and Technology** Students explain the interdependence of science and technology: how the ongoing development of technology relies on the advancements of science while scientific research relies on technological progress. Students understand how the evolution of various technologies (e.g., biotechnology, seismology, computational software, lasers) radically alters the practice of many science disciplines by affecting the quality and quantity of available data. **STS.1.2 Advantages and Disadvantages to Society** Students understand how science and technology together can be used for the benefit of society as well as their own lives (e.g., weather predictions, development of medications, creation of safety devices in cars), but that some technological capabilities (e.g., cloning, genetic recombination, nuclear energy studies, access to fossil fuels, chemical engineering)	**3**. Understand and use logarithmic notation (base 10). **III. Foundation Skills: Scientific Applications of Communication** **A. Scientific writing** **1.** Use correct applications of writing practices in scientific communication. **B. Scientific reading** **1.** Read technical and scientific articles to gain understanding of interpretations, apparatuses, techniques or procedures, and data. **2.** Set up apparatuses, carry out procedures, and collect specified data from a given set of appropriate instructions. **3.** Recognize scientific and technical vocabulary In the field of study and use this vocabulary to enhance clarity of communication. **4.** List, use, and give examples of specific strategies before, during, and after reading to improve comprehension. **C. Presentation of scientific/technical information** **1.** Prepare and present scientific/technical information in appropriate formats for various audiences. **D. Research skills/information literacy** **1.** Use search engines, databases, and other digital electronic tools effectively to locate information.

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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. **(4) Science concepts. The student knows and applies the laws governing motion in a variety of situations. The student is expected to:** **(A)** generate and interpret graphs and charts describing different types of motion, including the use of real-time technology such as motion detectors or photogates; **(B)** describe and analyze motion in one dimension using equations with the concepts of distance, displacement, speed, average velocity, instantaneous velocity, and acceleration; **(C)** analyze and describe accelerated motion in two dimensions using equations, including projectile and circular examples; **(D)** calculate the effect of forces on objects,	create ethical and economic dilemmas for society. **STS.1.3 Evaluating Online Information** Students recognize that the amount of information, as well as access to information, has exploded since the creation of the Internet. Online information should be judged using the same science practices and critical and skeptical views that reflect the way science is conducted and evaluated. Students also recognize the relationship between digital technology and the **fact** that social networking is a source of information generation and of the determination of "truths" in our current society. Students understand that this information presents a specific perspective that is not backed by research; therefore, the information and the perspective do not represent the empirical reality of science. **Standard P.1** **Interactions, Motion and Forces** **Changes in the natural and designed world are caused by interactions. Interactions of an object with other objects can be described by forces that can cause a change in motion of one or both interacting objects.** **P.1.1 Patterns of Constant and Changing Linear Motion**	**2.** Evaluate quality, accuracy, completeness, reliability, and currency of information from any sources. **IV. Science, Technology, and Society** **A. Interactions between innovations and science** **1.** Recognize how scientific discoveries are connected to technological innovations. **B. Social ethics** **1.** Understand how scientific research and technology have an impact on ethical and legal practices. **2.** Understand how commonly held ethical beliefs impact scientific research. **C. History of science** **1.** Understand the historical development of major theories in science. **2.** Recognize the role of people in important contributions to scientific knowledge. **V. Cross-Disciplinary Themes** **A. Matter/states of matter** **1.** Know modern theories of atomic structure. **2.** Understand the typical states of matter (solid, liquid, gas) and phase changes among these. **B. Energy (thermodynamics, kinetic, potential, energy transfers)** **1.** Understand the Laws of Thermodynamics.

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including the law of inertia, the relationship between force and acceleration, and the nature of force pairs between objects; **(E)** develop and interpret free-body force diagrams; and **(F)** identify and describe motion relative to different frames of reference. **(5) Science concepts. The student knows the nature of forces in the physical world. The student is expected to:** **(A)** research and describe the historical development of the concepts of gravitational, electromagnetic, weak nuclear, and strong nuclear forces; **(B)** describe and calculate how the magnitude of the gravitational force between two objects depends on their masses and the distance between their centers; **(C)** describe and calculate how the magnitude of the electrical force between two objects depends on their charges and the distance between them; **(D)** identify examples of electric and magnetic forces in everyday life; **(E)** characterize materials as conductors or insulators based on their electrical properties; **(F)** design, construct, and calculate in terms of current through, potential difference across, resistance of, and power used by electric circuit	Students understand that the constant and changing linear motion of an object is characterized by the vector quantities of displacement, velocity and acceleration. **P.1.2 Forces and Changes of Motion** Students understand that the acceleration of an object is proportional to the vector sum of all the forces (net force) on the object and inversely proportional to the object's mass ($\vec{a} = \vec{F}_{net}/m$). When two interacting objects push or pull on each other,the force on one object is equal in magnitude but opposite in direction to the force on the other object. **P.1.3 Contact Interactions and Forces** Students understand that some types of contact interactions have force laws that are empirical approximations. Some contact interactions have no force laws because the value of the force depends on other forces from different simultaneous interactions. These interactions can cause a change in motion of one or both interacting objects. **P.1.4 Gravitational Interactions and Forces** Students understand that the gravitational force on an object is proportional to the product of the two interacting masses and inversely proportional to the square of the distance between the centers of the masses	**2.** Know the processes of energy transfer. **C. Change over time/equilibrium** **1.** Recognize patterns of change. **D. Classification** **1.** Understand that scientists categorize things according to similarities and differences. **E. Measurements and models** **1.** Use models to make predictions. **2.** Use scale to relate models and structures. **3.** Demonstrate familiarity with length scales from sub-atomic particles through macroscopic objects. **VIII. Physics** **A. Matter** **1.** Demonstrate familiarity with length scales from sub-atomic particles through macroscopic objects. **2.** Understand states of matter and their characteristics. **3**. Understand the concepts of mass and inertia **4**. Understand the concept of density. **5.** Understand the concepts of gravitational force and weight. **B. Vectors** **1.** Understand how vectors are used to represent physical quantities. **2.** Demonstrate knowledge of vector mathematics using a graphical representation. **3.** Demonstrate knowledge of vector

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elements connected in both series and parallel combinations; **(G)** investigate and describe the relationship between electric and magnetic fields in applications such as generators, motors, and transformers; and (**H)** describe evidence for and effects of the strong and weak nuclear forces in nature. **(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:** **(A)** investigate and calculate quantities using the work-energy theorem in various situations; **(B)** investigate examples of kinetic and potential energy and their transformations; **(C)** calculate the mechanical energy of, power generated within, impulse applied to, and momentum of a physical system; **(D)** demonstrate and apply the laws of conservation of energy and conservation of momentum in one dimension; **(E)** describe how the macroscopic properties of a thermodynamic system such as temperature, specific heat, and pressure are related to the molecular level of matter, including kinetic or potential energy of atoms; **(F)** contrast and give examples of different processes of thermal energy transfer, including	(Newton's law of universal gravitation). When an object's distance from Earth's surface is small compared to Earth's radius, then all objects fall with approximately the same acceleration (ignoring the effect of air resistance). **P.1.5 Electrical Interactions and Forces** Students understand that electrical interactions occur between mutually attracting or repelling charged objects, which can cause a change in motion of one or both objects. The attraction between a charged object and a neutral object is caused by the separation of charges in neutral objects. **Standard P.2: Interactions and Conservation Principles** **The interaction of an object with other objects is governed by conservation principles such as the conservation of mass, energy, mass–energy (nuclear interactions), electric charge and linear momentum.** **P.2.1 Conservation of Charge, Mass and Energy** Students understand that charge is always conserved. Mass and energy are conserved separately for all types of interactions (except for interactions at the subatomic scale) and for all defined systems (open and closed). There is no measurable change in	mathematics using a numerical representation. **C. Forces and motion** **1.** Understand the fundamental concepts of kinematics. **2.** Understand forces and Newton's Laws. 3. Understand the concept of momentum. **D. Mechanical energy** **1.** Understand potential and kinetic energy. **2.** Understand conservation of energy. **3.** Understand the relationship of work and mechanical energy. **E. Rotating systems** **1.** Understand rotational kinematics. **2.** Understand the concept of torque. **3.** Apply the concept of static equilibrium. **4.** Understand angular momentum. **F. Fluids** **1.** Understand pressure in a fluid and its applications. **2.** Understand Pascal's Principle. **3.** Understand buoyancy. **4.** Understand Bernoulli's principle. **G. Oscillations and waves** **1.** Understand basic oscillatory motion and simple harmonic motion. **2.** Understand the difference between transverse and longitudinal waves. **3.** Understand wave terminology: wavelength, period, frequency, and amplitude. **4.** Understand the properties and behavior of

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conduction, convection, and radiation; and **(G)** analyze and explain everyday examples that illustrate the laws of thermodynamics, including the law of conservation of energy and the law of entropy. **(7) Science concepts. The student knows the characteristics and behavior of waves. The student is expected to:** **(A)** examine and describe oscillatory motion and wave propagation in various types of media; **(B)** investigate and analyze characteristics of waves, including velocity, frequency, amplitude, and wavelength, and calculate using the relationship between wavespeed, frequency, and wavelength; **(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; **(D)** investigate behaviors of waves, including reflection, refraction, diffraction, interference, resonance, and the Doppler effect; **(E)** describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens; and **(F)** describe the role of wave characteristics and behaviors in medical and industrial	the mass of a system when energy is transferred across the boundary of the system. **P.2.2 Conservation of Linear Momentum** Students understand that the linear momentum of an object/system is the product of its mass multiplied by its velocity, and that interactions across the boundary of the system can transfer momentum into or out of the system. Linear momentum is always conserved for all defined systems (open and closed) and types of interactions. **P.2.3 Nuclear Interactions and the Conservation of Mass–Energy** Students understand that much larger amounts of energy can be transferred out of a system during nuclear interactions than during chemical interactions. Nuclear interactions can result in a change in the number of protons, thus changing the identity of the element. **Standard P.3: Interactions and Energy Interactions of an object with other objects can be described and explained by using the concept of the transfer of energy from one object to another, both within a defined system and across the boundary of the system. Energy transfers across the**	sound waves. **H. Thermodynamics** **1.** Understand the gain and loss of heat energy in matter. **2.** Understand the basic laws of thermodynamics. **I. Electromagnetism** **1.** Discuss electric charge and electric force. **2.** Gain qualitative and quantitative understandings of voltage, current, and resistance. **3.** Understand Ohm's Law. **4.** Apply the concept of power to electricity. **5.** Discuss basic DC circuits that include voltage sources and combinations of resistors. **6.** Discuss basic DC circuits that include voltage sources and combinations of capacitors. **7.** Understand magnetic fields and their relationship to electricity. **8.** Relate electricity and magnetism to everyday life. **J. Optics** **1.** Know the electromagnetic spectrum. **2.** Understand the wave/particle duality of light. **3.** Understand concepts of geometric optics

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applications. **(8) Science concepts. The student knows simple examples of atomic, nuclear, and quantum phenomena. The student is expected to:** **(A)** describe the photoelectric effect and the dual nature of light; **(B)** compare and explain the emission spectra produced by various atoms; **(C)** describe the significance of mass-energy equivalence and apply it in explanations of phenomena such as nuclear stability, fission, and fusion; and **(D)** give examples of applications of atomic and nuclear phenomena such as radiation therapy, diagnostic imaging, and nuclear power and examples of applications of quantum phenomena such as digital cameras.	**boundary of a system can change the energy within the system.** **P.3.1 Contact Interactions and Energy** Students understand that a mechanical energy transfer (work) across the boundary of a system can change the kinetic energy, the stored elastic energy and other types of energy within the system. **P.3.2 Electric Current Interactions and Energy** Students understand that during electric circuit interactions, electrical energy is transferred from the source of electric current to the electric device, or devices, in the circuit. In most electric circuit interactions, energy is also transferred to the surroundings. **P.3.3 Mechanical Wave Interactions and Energy** Students understand that during mechanical wave interactions, mechanical energy is transferred through a material without a transfer of matter; different objects or materials can cause the path of the wave to change; and waves pass through each other, causing interference patterns. **P.3.4 Radiant Energy Interactions** Students understand that during radiant energy interactions, energy can be transferred over a distance without a	

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	material (medium) and that there are two models that illustrate how this happens. There is a continuous range of radiant energies that includes visible light. Some objects produce their own visible light, while others reflect light from their surroundings. **P.3.5 Heating and Cooling Interactions and Energy** Students understand that during heating and cooling interactions, there is a thermal energy transfer (heat) across the boundary of a system, affecting the temperature or the state of matter of the system. These interactions depend on the properties of the materials and on how far the system is from equilibrium. **Standard P.4:Interactions and Fields Attractive and repulsive interactions at a distance (e.g., gravitational, magnetic, electrical and electromagnetic) can be described by using the concept of fields.** **P.4.1 Forces and Fields** Students understand that a field model is used to visualize at-a-distance interactions, and that these fields are the agents of the interaction. **P.4.2 Energy and Fields** Students understand that the energy stored in a system of two mutually attracting or	

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	repelling objects can be modeled as energy stored in the field of the two objects. **P.4.3 Electromagnetic Interactions and Fields** Students understand that an electromagnetic interaction occurs when a flow of charged particles creates a magnetic field.	