FOLSOM CORDOVA UNIFIED SCHOOL DISTRICT

AP PHYSICS 1

Date: January 2016

Subject Area: Physical Science

Proposed Grade Level(s): 10-12

Course Length: 1 Term (2 Semesters)

Grading: A-F

Number of Credits: 5 per semester

Intent to Pursue 'A-G' College Prep Status: Yes

Prerequisites: Completion of or concurrent enrollment in Integrated Math III

COURSE DESCRIPTION:

AP Physics 1 is designed to be equivalent to the first semester of an introductory college-level algebra-based physics course. This course is useful for potential engineering, pre-med, science, and computer science majors, as well as anyone interested in Physics. The course covers Newtonian mechanics (including rotational dynamics, and angular momentum): work, energy, and power; and mechanical waves and sound. It also introduces electrical circuits. This course will prepare the student to take the Advanced Placement Examination for Physics 1. This course meets UC/CSU (Laboratory Science-d) requirements. AP Physics allows time for thorough, in-depth, student centered inquiry activities allowing students to carry out careful experiments and design laboratory practical work to answer real world questions.

GENERAL GOALS/ESSENTIAL QUESTIONS:

- To provide further challenges and opportunities for gifted and advanced students in their high school curriculum.
- To provide students the opportunity to receive college credit for coursework completed in high school.
- To increase student knowledge and skills in the study of basic physics, including mechanics, wave theory, magnetism, and electricity.
- To use hands-on experience to devise a scientific model and to use that model to predict physical behavior.
- To learn to think using critical thinking processes.

CCSS READING COMPONENT:

Students will read at the 11th and 12th grade level from textbooks, laboratory assignments, and research from the internet and library. The primary textbook used is *College Physics.* Other supplementary materials may also be used to further enhance student understanding of the curriculum such as, Modeling Physics high school curriculum from Arizona State University (http://modeling.asu.edu/Curriculum.html).

CCSS WRITING COMPONENT:

Lab assignments will be given on a regular basis and detailed written reports will be assigned. In addition to lab reports, students will be required to respond to Free Response Questions (FRQ), which will be part of the AP Exam. The FRQ includes writing in experimental design, qualitative/quantitative translation, and additional short answer prompts.

CCSS SPEAKING & LISTENING COMPONENT:

Students will:
- Work collaboratively during laboratory experiments.
- Orally present their homework solutions and lab reports to the class.

CTE INDUSTRY SECTOR / PATHWAY / STANDARDS:

N/A

DETAILED UNITS of INSTRUCTION:

Student expectations for each unit are taken from the AP College Board. These units also cover all of the Physics-related standards in the NGSS.

AP Physics 1 / Big Ideas:
1. Objects and systems have properties such as mass and charge. Systems may have internal structure.
2. Fields existing in space can be used to explain interactions.
3. The interactions of an object with other objects can be described by forces.
4. Interactions between systems can result in changes in those systems.
5. Changes that occur as a result of interactions are constrained by conservation laws.
6. Waves can transfer energy and momentum from one location to another with the permanent transfer of mass and serve as a mathematical model for the description of the other phenomena.

First Semester Units of Instruction:

Unit 1: Kinematics in One and Two Dimensions
- Express the motion of an object using narrative, mathematical, and graphical representations.
- Design an experimental investigation of the motion of an object.
- Analyze experimental data describing the motion of an object and express the results of the analysis using narrative, mathematical, and graphical representations.
- Represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation.

Unit 2: Dynamics: Newton's laws
- Design an experiment for collecting data to determine the relationship between the net force exerted on an object, its inertial mass, and its acceleration.
- Design a plan for collecting data to measure gravitational mass and to measure inertial mass, and to distinguish between the two experiments.
- Describe a force as an interaction between two objects and identify both objects for any force.
- Represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation.
- Challenge a claim that an object can exert a force on itself.
- Apply ρ ρ F m= g to calculate the gravitational force on an object with mass m in a gravitational field of strength g in the context of the effects of a net force on objects and systems.
- Model verbally or visually the properties of a system based on its substructure and relate this to changes in the system properties over time as external variables are changed.
- Analyze a scenario and make claims (develop arguments, justify assertions) about the forces exerted on an object by other objects for different types of forces or components of forces.

- Design a plan to collect and analyze data for motion (static, constant, or accelerating) from force measurements and carry out an analysis to determine the relationship between the net force and the vector sum of the individual forces.
- Create and use free-body diagrams to analyze physical situations to solve problems with motion qualitatively and quantitatively.
- Re-express a free-body diagram representation into a mathematical representation and solve the mathematical representation for the acceleration of the object.
- Apply Newton’s second law to systems to calculate the change in the center-of-mass velocity when an external force is exerted on the system.
- Use visual or mathematical representations of the forces between objects in a system to predict whether or not there will be a change in the center-of-mass velocity of that system.
- Make predictions about the motion of a system based on the fact that acceleration is equal to the change in velocity per unit time, and velocity is equal to the change in position per unit time.
- Construct explanations of physical situations involving the interaction of bodies using Newton’s third law and the representation of action-reaction pairs of forces.
- Use Newton’s third law to make claims and predictions about the action-reaction pairs of forces when two objects interact.

<u>Unit 3: Circular Motion and Gravitation</u>

- Model verbally or visually the properties of a system based on its substructure and relate this to changes in the system properties over time as external variables are changed.
- Describe a force as an interaction between two objects and identify both objects for any force.
- Analyze a scenario and make claims (develop arguments, justify assertions) about the forces exerted on an object by other objects for different types of forces or components of forces.
- Represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation.
- Design a plan to collect and analyze data for motion (static, constant, or accelerating) from force measurements and carry out an analysis to determine the relationship between the net force and the vector sum of the individual forces.
- Re-express a free-body diagram representation into a mathematical representation and solve the mathematical representation for the acceleration of the object.
- Create and use free-body diagrams to analyze physical situations to solve problems with motion qualitatively and quantitatively.
- Articulate situations when the gravitational force is the dominant force and when the electromagnetic, weak, and strong forces can be ignored.
- Apply g G M r = 2 to calculate the gravitational field due to an object with mass M, where the field is a vector directed toward the center of the object of mass M.
- Approximate a numerical value of the gravitational field (g) near the surface of an object from its radius and mass relative to those of the Earth or other reference objects.
- Apply ρ ρ F m= g to calculate the gravitational force on an object with mass m in a gravitational field of strength g in the context of the effects of a net force on objects and systems.
- Use Newton’s law of gravitation to calculate the gravitational force the two objects exert on each other and use that force in contexts other than orbital motion.

<u>Unit 4: Energy and Conservation of Energy</u>

- Describe and make qualitative and/or quantitative predictions about everyday examples of systems with internal potential energy.
- Describe and make predictions about the internal energy of everyday systems.

- Model verbally or visually the properties of a system based on its substructure and relate this to changes in the system properties over time as external variables are changed.
- Make quantitative calculations of the internal potential energy of a system from a description or diagram of that system.
- Apply mathematical reasoning to create a description of the internal potential energy of a system from a description or diagram of the objects and interactions in that system. Calculate the total energy of a system and justify the mathematical routines used in the calculation of component types of energy within the system whose sum is the total energy.
- Predict changes in the total energy of a system due to changes in position and speed of objects or frictional interactions within the system.
- Set up a representation or model showing that a single object can only have kinetic energy and use information about that object to calculate its kinetic energy.
- Translate between a representation of a single object, which can only have kinetic energy, and a system that includes the object, which may have both kinetic and potential energies.
- Calculate changes in kinetic energy and potential energy of a system, using information from representations of that system.
- Make predictions about the changes in kinetic energy of an object based on considerations of the direction of the net force on the object as the object moves.
- Use net force and velocity vectors to determine qualitatively whether kinetic energy of an object would increase, decrease, or remain unchanged.
- Use force and velocity vectors to determine qualitatively or quantitatively the net force exerted on an object and qualitatively whether kinetic energy of that object would increase, decrease, or remain unchanged.
- Apply mathematical routines to determine the change in kinetic energy of an object given the forces on the object and the displacement of the object.
- Design an experiment and analyze data to examine how a force exerted on an object or system does work on the object or system as it moves through a distance.
- Design an experiment and analyze graphical data in which interpretations of the area under a force-distance curve are needed to determine the work done on or by the object or system.
- Predict and calculate from graphical data the energy transfer to or work done on an object or system from information about a force exerted on the object or system through a distance.
- Model verbally or visually the properties of a system based on its substructure and relate this to changes in the system properties over time as external variables are changed.
- Define open and closed systems for everyday situations and apply conservation concepts for energy, charge, and linear momentum to those situations.
- Make claims about the interaction between a system and its environment in which the environment exerts a force on the system, thus doing work on the system and changing the energy of the system (kinetic energy plus potential energy).
- Predict and calculate the energy transfer to (i.e., the work done on) an object or system from information about a force exerted on the object or system through a distance.
- Make predictions about the changes in the mechanical energy of a system when a component of an external force acts parallel or antiparallel to the direction of the displacement of the center of mass.
- Apply the concepts of conservation of energy and the work-energy theorem to determine qualitatively and/or quantitatively that work done on a two-object system in linear motion will change the kinetic energy of the center of mass of the system, the potential energy of the systems, and/or the internal energy of the system.

- Calculate the expected behavior of a system using the object model (i.e., by ignoring changes in internal structure) to analyze a situation. Then, when the model fails, justify the use of conservation of energy principles to calculate the change in internal energy due to changes in internal structure because the object is actually a system.

Unit 5: Impulse, Momentum, and Conservation of Momentum

- Predict the change in momentum of an object from the average force exerted on the object and the interval of time during which the force is exerted.
- Analyze data to characterize the change in momentum of an object from the average force exerted on the object and the interval of time during which the force is exerted.
- Design a plan for collecting data to investigate the relationship between changes in momentum and the average force exerted on an object over time.
- Calculate the change in linear momentum of a two-object system with constant mass in linear motion from a representation of the system (data, graphs, etc.).
- Perform analysis on data presented as a force-time graph and predict the change in momentum of a system.
- Justify the selection of data needed to determine the relationship between the direction of the force acting on an object and the change in momentum caused by that force.
- Justify the selection of routines for the calculation of the relationships between changes in momentum of an object, average force, impulse, and time of interaction.
- Apply mathematical routines to calculate the change in momentum of a system by analyzing the average force exerted over a certain time on the system.
- Analyze data to find the change in linear momentum for a constant-mass system using the product of the mass and the change in velocity of the center of mass.
- Define open and closed systems for everyday situations and apply conservation concepts for energy, charge, and linear momentum to those situations.
- Make qualitative predictions about natural phenomena based on conservation of linear momentum and restoration of kinetic energy in elastic collisions.
- Apply the principles of conservation of momentum and restoration of kinetic energy to reconcile a situation that appears to be isolated and elastic, but in which data indicate that linear momentum and kinetic energy are not the same after the interaction, by refining a scientific question to identify interactions that have not been considered. Solve qualitatively and/or quantitatively for one-dimensional situations and only qualitatively in two dimensional situations.
- Apply mathematical routines appropriately to problems involving elastic collisions in one dimension and justify the selection of those mathematical routines based on conservation of momentum and restoration of kinetic energy.
- Predict the velocity of the center of mass of a system when there is no interaction outside of the system but there is an interaction within the system (i.e., the student simply recognizes that interactions within a system do not affect the center of mass motion of the system and is able to determine that there is no external force.
- Design an experimental test of an application of the principle of the conservation of linear momentum, predict an outcome of the experiment using the principle, analyze data generated by that experiment whose uncertainties are expressed numerically, and evaluate the match between the prediction and the outcome.
- Classify a given collision situation as elastic or inelastic, justify the selection of conservation of linear momentum and restoration of kinetic energy as the appropriate principles for analyzing an elastic collision, solve for missing variables, and calculate their values.

- Qualitatively predict, in terms of linear momentum and kinetic energy, how the outcome of a collision between two objects changes depending on whether the collision is elastic or inelastic.
- Plan data collection strategies to test the law of conservation of momentum in a two-object collision that is elastic or inelastic and analyze the resulting data graphically.
- Apply the conservation of linear momentum to a closed system of objects involved in an inelastic collision to predict the change in kinetic energy.
- Analyze data that verify conservation of momentum in collisions with and without an external friction force.
- Classify a given collision situation as elastic or inelastic, justify the selection of conservation of linear momentum as the appropriate solution method for an inelastic collision, recognize that there is a common final velocity for the colliding objects in the totally inelastic case, solve for missing variables, and calculate their values.

Second Semester Units of Instruction:

Unit 6: Simple Harmonic Motion

- Describe a force as an interaction between two objects and identify both objects for any force.
- Represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation.
- Predict which properties determine the motion of a simple harmonic oscillator and what the dependence of the motion is on those properties.
- Design a plan and collect data in order to ascertain the characteristics of the motion of a system undergoing oscillatory motion caused by a restoring force.
- Analyze data to identify qualitative or quantitative relationships between given values and variables (i.e., force, displacement, acceleration, velocity, period of motion, frequency, spring constant, string length, mass) associated with objects in oscillatory motion to use that data to determine the value of an unknown.
- Construct a qualitative and/or a quantitative explanation of oscillatory behavior given evidence of a restoring force.

Unit 7: Rotational Motion and Conservation of Angular Momentum

- Use representations of the relationship between force and torque. Compare the torques on an object caused by various forces.
- Estimate the torque on an object caused by various forces in comparison to other situations.
- Design an experiment and analyze data testing a question about torques in a balanced rigid system.
- Calculate torques on a two-dimensional system in static equilibrium, by examining a representation or model (such as a diagram or physical construction).
- Model verbally or visually the properties of a system based on its substructure and relate this to changes in the system properties over time as external variables are changed.
- Use representations of the center of mass of an isolated two-object system to analyze the motion of the system qualitatively and semi quantitatively.
- Make predictions about the change in the angular velocity about an axis for an object when forces exerted on the object cause a torque about that axis.
- Describe a representation and use it to analyze a situation in which several forces exerted on a rotating system of rigidly connected objects change the angular velocity and angular momentum of the system.

- Plan data collection and analysis strategies designed to test the relationship between a torque exerted on an object and the change in angular velocity of that object about an axis.
- Predict the behavior of rotational collision situations by the same processes that are used to analyze linear collision situations using an analogy between impulse and change of linear momentum and angular impulse and change of angular momentum.
- In an unfamiliar context or using representations beyond equations, justify the selection of a mathematical routine to solve for the change in angular momentum of an object caused by torques exerted on the object.
- Plan data collection and analysis strategies designed to test the relationship between torques exerted on an object and the change in momentum of that object. Plan data collection strategies designed to establish that torque, angular velocity, angular acceleration, and angular momentum can be predicted accurately when the variables are treated as being clockwise or counterclockwise with respect to a well-defined axis of rotation, and refine the research question based on the examination of data.
- Describe a model of a rotational system and use that model to analyze a situation in which angular momentum changes due to interaction with other objects or systems
- Plan a data collection and analysis strategy to determine the change in angular momentum of a system and relate it to interactions with other objects and systems.
- Use appropriate mathematical routines to calculate values for initial or final angular momentum, or change in angular momentum of a system, or average torque or time during which the torque is exerted in analyzing a situation involving torque and angular momentum.
- Plan a data collection strategy designed to test the relationship between the change in angular momentum of a system and the product of the average torque applied to the system and the time interval during which the torque is exerted.
- Do qualitative reasoning with compound objects. Do calculations with a fixed set of extended objects and point masses.
- Make qualitative predictions about the angular momentum of a system for a situation in which there is no net external torque.
- Make calculations of quantities related to the angular momentum of a system when the net external torque on the system is zero.
- Make qualitative predictions about the angular momentum of a system for a situation in which there is no net external torque.
- Describe or calculate the angular momentum and rotational inertia of a system in terms of the locations and velocities of objects that make up the system. Do qualitative reasoning with compound objects. Do calculations with a fixed set of extended objects and point masses.

Unit 8: Mechanical Waves and Sound

- Use a visual representation to construct an explanation of the distinction between transverse and longitudinal waves by focusing on the vibration that generates the wave.
- Describe representations of transverse and longitudinal waves.
- Use graphical representation of a periodic mechanical wave to determine the amplitude of the wave.
- Describe sound in terms of transfer of energy and momentum in a medium and relate the concepts to everyday examples.
- Explain and/or predict qualitatively how the energy carried by a sound wave relates to the amplitude of the wave, and/or apply this concept to a real-world example.
- Design an experiment to determine the relationship between periodic wave speed, wavelength, and frequency and relate these concepts to everyday examples.

- Use a graphical representation of a periodic mechanical wave (position versus time) to determine the period and frequency of the wave and describe how a change in the frequency would modify features of the representation.
- Use a visual representation of a periodic mechanical wave to determine wavelength of the wave.
- Create or use a wave front diagram to demonstrate or interpret qualitatively the observed frequency of a wave, dependent upon relative motions of source and observer.
- Use representations of individual pulses and construct representations to model the interaction of two wave pulses to analyze the superposition of two pulses.
- Design a suitable experiment and analyze data illustrating the superposition of mechanical waves (only for wave pulses or standing waves).
- Design a plan for collecting data to quantify the amplitude variations when two or more traveling waves or wave pulses interact in a given medium.
- Analyze data or observations or evaluate evidence of the interaction of two or more traveling waves in one or two dimensions (i.e., circular wave fronts) to evaluate the variations in resultant amplitudes.
- Use representations of individual pulses and construct representations to model the interaction of two wave pulses to analyze the superposition of two pulses.
- Refine a scientific question related to standing waves and design a detailed plan for the experiment that can be conducted to examine the phenomenon qualitatively or quantitatively.
- Plan data collection strategies, predict the outcome based on the relationship under test, perform data analysis, evaluate evidence compared to the prediction, explain any discrepancy, and, if necessary, revise the relationship among variables responsible for establishing standing waves on a string or in a column of air.
- Calculate wavelengths and frequencies (if given wave speed) of standing waves based on boundary conditions and length of region within which the wave is confined, and calculate numerical values of wavelengths and frequencies. Examples include musical instruments.
- Use a visual representation to explain how waves of slightly different frequency give rise to the phenomenon of beats.
- Predict properties of standing waves that result from the addition of incident and reflected waves that are confined to a region and have nodes and antinodes.
- Describe representations and models of situations in which standing waves result from the addition of incident and reflected waves confined to a region.
- Challenge with evidence the claim that the wavelengths of standing waves are determined by the frequency of the source regardless of the size of the region.

Unit 9: Electrostatics

- Make claims about natural phenomena based on conservation of electric charge.
- Make predictions, using the conservation of electric charge, about the sign and relative quantity of net charge of objects or systems after various charging processes, including conservation of charge in simple circuits
- Construct an explanation of the two-charge model of electric charge based on evidence produced through scientific practices.
- Challenge the claim that an electric charge smaller than the elementary charge has been isolated.
- Use Coulomb's law qualitatively and quantitatively to make predictions about the interaction between two electric point charges.
- Connect the concepts of gravitational force and electric force to compare similarities and differences between the forces.

Unit 10: DC Circuits

- Make claims about natural phenomena based on conservation of electric charge.
- Make predictions, using the conservation of electric charge, about the sign and relative quantity of net charge of objects or systems after various charging processes, including conservation of charge in simple circuits.
- Apply conservation of energy concepts to the design of an experiment that will demonstrate the validity of Kirchhoff's loop rule ($\sum \Delta V = 0$) in a circuit with only a battery and resistors either in series or in, at most, one pair of parallel branches.
- Design an investigation of an electrical circuit with one or more resistors in which evidence of conservation of electric charge can be collected and analyzed.
- Choose and justify the selection of data needed to determine resistivity for a given material.
- Construct or interpret a graph of the energy changes within an electrical circuit with only a single battery and resistors in series and/or in, at most, one parallel branch as an application of the conservation of energy (Kirchhoff's loop rule).
- Apply conservation of energy (Kirchhoff's loop rule) in calculations involving the total electric potential difference for complete circuit loops with only a single battery and resistors in series and/or in, at most, one parallel branch.
- Apply conservation of electric charge (Kirchhoff's junction rule) to the comparison of electric current in various segments of an electrical circuit with a single battery and resistors in series and in, at most, one parallel branch and predict how those values would change if configurations of the circuit are changed.
- Use a description or schematic diagram of an electrical circuit to calculate unknown values of current in various segments or branches of the circuit.

TEXTBOOKS and RESOURCE MATERIALS:

The textbook has yet to be determined, but the College Board suggests the following:

- Cutnell, J. D. and Johnson, K. *Physics*. Hoboken, NJ: John Wiley & Sons.
- Etkina, E., Gentile, M. and Van Heuvelen, A. *College Physics*, Boston, MA: Pearson.
- Giambatista, A., Richardson, B., and Richardson, R.C. *College Physics*. Boston, MA: McGraw-Hill Higher Education.
- Freedman, Roger A., and Todd G. Ruskell. *College Physics*. New York: W. H. Freeman and Company, 2014.
- Giancoli, D.C. *Physics: Principles with Applications*. Englewood Cliffs, NJ: Pearson Education.
- Knight, R, Jones, B. and Field, S. *College Physics: A Strategic Approach*. Boston, MA: Pearson Education.
- Walker, J.S. *Physics*. Upper Saddle River, NJ: Prentice Hall.
- Wilson, J. Buffa, A. and Lou, B. *College Physics*. San Francisco, CA: Addison-Wesley.

SUBJECT AREA CONTENT STANDARDS TO BE ADDRESSED:

HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles

HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision
HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current
HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials
HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known
HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields
HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy
HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
HS-PS3–5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction
HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media
HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information
HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter
HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy
HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem

<u>DISTRICT ESLR'S to be ADDRESSED</u>:

Student will be:

- **<u>Self-Directed Learners</u>:** Who will be expected to take responsibility for their learning by participating in class activities, labs, and discussions. Students will be expected to keep up with homework and lab prep assignments.
- **<u>Collaborative Workers:</u>** Who will participate in cooperative groups for laboratory assignments and in class activities. They will be expected to collaborate with each other in developing class concepts.
- **<u>Effective Communicators:</u>** Who will actively participate in class discussions on a regular basis.
- **<u>Quality Producers/ Performers</u>:** Students will be guided to be quality performers and producers through ongoing assessment of their class work.
- **<u>Constructive Thinkers:</u>** Who will participate in many hands-on activities and labs that require them to analyze their results critically and apply what they have learned to new situations. Students will also develop models to explain physical behaviors and phenomenon.
- **<u>Responsible Citizen</u>:** By using their knowledge of physics and scientific inquiry to make informed decisions about issues related to physics, the world around them, and their daily lives.