AP Physics

Course Description:
The curriculum for this course is developed from the Next Generation Science Standards . and the College Board . In this advanced elective course, students will be immersed in topics and skills related to understanding the physical world around them. Topics covered will include motion, forces, energy, periodic motion, waves, and momentum. Grades are determined by quizzes, tests, projects, and daily work. This course is a weighted (1.0) college equivalent course. Students in this course are encouraged to take the AP Physics 1 exam in the spring. This course is strongly math based, incorporating algebra and trigonometric functions. The information in this course overview outlines what students should understand and be able to do by the end of the semester/year.

Mastery Standards:

Objects and systems have properties such as mass and charge. Systems may have internal structure. (HS- PS1-8)

Fields existing in space can be used to explain interactions. (HS-PS2-4)

The interactions of an object with other objects can be described by forces. (HS-PS2-1)

Interactions between systems can result in changes in those systems. (HS-PS2-5)

Changes that occur as a result of interactions are constrained by conservation laws. (HS-PS2-2)

Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena. (HS-PS-3-4)

Unit	Description of Unit and Learning Targets
Unit Title: Kinematics Essential Questions: ● How can uniform and accelerated linear motion be described and analyzed? ● How can an experimental situation be designed to investigate the motion of an object? ● How can experimental data be analyzed to express the results of a motion experiment?	Students will……. Learning Targets: ● The student will analyze experimental data describing the motion of an object and is able to express the results of the analysis using narrative, mathematical, and graphical representations. ● The student will design an experimental investigation of the motion of an object. ● The student will express the motion of an object using narrative, mathematical, and graphical representations.
Unit Title: Dynamics - Newton's Laws Essential Questions: ● What is force and how does it cause a change in motion? ● How can Newton's laws be utilized to describe an object's motion? ● Why do objects sometimes change their velocity and sometimes not change when interacting with forces?	Students will... Learning Targets: ● The student will design a plan for collecting data to measure gravitational mass and to measure inertial mass and to distinguish between the two experiments. ● The student will design and experiment for collecting data to determine the relationship between the net force exerted on an object, its inertial mass, and its acceleration ● The student will apply F= mg to calculate the gravitational force on an object with mass m in a gravitational field of strength gin

• How are contact forces similar and different from field forces?	the context of the effects of a net force on objects and systems
Unit Title: Circular Motion and Gravitation Essential Questions: • How were internal and gravitational mass verified as the same? • How do forces acting centripetally affect the motion of an object? • How is a field force calculated?	Students will... Learning Targets: • The student will 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. • The student will design an experimental investigation of the motion of an object. • The student will express the motion of an object using narrative, mathematical, and graphical representations. • The student will 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. • The student will use Newton's law of gravitation to calculate the gravitational force between two objects and use that force in contexts involving orbital motion • The student will 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. • The student will apply F= mg to calculate the gravitational force on an object with mass in a gravitational field of strength g in the context of the effects of a net force on objects and systems. • The student will apply g = G M / r2 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.
Simple Harmonic Motion: Simple Pendulum And Mass-Spring Systems Essential Questions • How can the variables of force, displacement, acceleration, velocity, period of motion, frequency, spring constant, string length, and mass, associated with objects in oscillatory motion, be used to obtain data to determine the value of an unknown? • Why does a spring oscillate when displaced? • How is the period of a spring mass system different from a pendulum system?	Students will... Learning Targets • The student will analyze data to identify qualitative or quantitative relationships between given values and variables (ie, 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. • The student will construct a qualitative and/or a quantitative explanation of oscillatory behavior given evidence of a restoring force. • The student will design a plan and collect data in order to ascertain the characteristics of the motion of a system undergoing oscillatory motion caused by restoring force. • The student will predict which properties determine the motion of a simple harmonic oscillator and what the dependence of the motion is on those properties. • The student will 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, the student can 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 Title: Impulse, Linear Momentum	Students will...

and Conservation of Linear Momentum <u>Essential Questions:</u> ● How can collisions be classified as either elastic or inelastic? ● Why do some collisions conserve both linear momentum and kinetic energy and some only conserve momentum? ● How does impulse change momentum?	<u>Learning Targets:</u> ● The student will 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. ● The student will 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. ● The student will apply mathematical routines appropriately to problems involving elastic collisions in one dimension and justify the selection of those mathematical routine based on conversation of momentum and restoration of kinetic energy. ● The student will 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 ● The student will calculate the change in linear momentum of a two-object system with constant mass in linear motion from a representation of that system. ● The student will 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. ● The student will define open and closed/isolated systems for everyday situations and apply conservation concepts for energy, charge, and linear momentum to those situations. ● The student will describe sound in terms of transfer of energy and momentum in a medium and relate the concepts to everyday examples.
Unit Title: Rotational Motion <u>Essential Questions:</u> ● How do changes in rotational inertia affect rotational motion? ● How are experiments designed to analyze the change in angular momentum in a system?	Students will... <u>Learning Targets:</u> ● The student will calculate torques on a two-dimensional system in static equilibrium by examining a representation of the model (such as a diagram or physical construction). ● The student will compare the torques on an object caused by various forces.The student will design an experiment and analyze data testing a question about torques in a balanced rigid system. ● The student will estimate the torque on an object caused by various forces in comparison to other situations. ● The student will 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 ● The student will make calculations of quantities related to the angular momentum of the system when the net external torque on the system is zero. ● The student will 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. ● The student will make qualitative predictions about the angular momentum of a system for a situation in which there is no net external torque. ● The student will plan a 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.

	- The student will plan data collection and analysis strategies designed to test the relationship between torque exerted on an object and the change in angular velocity of that object about an axis. - The student will plan data collection and analysis strategies designed to test the relationship between torques exerted on an object and the - change in angular momentum of that object. - The student will 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. - The student will use representations of the relationship between force and torque
Unit Title: Electrostatics <u>Essential Questions:</u> - How are gravitational forces similar and different from electrical forces? - How are open systems different from closed systems?	Students will... <u>Learning Targets:</u> - The student will challenge the claim that an electric charge smaller than the charge has been isolated. - The student will connect the strength of electromagnetic forces with the spatial scale of the situation, the magnitude of the electric charges, and the motion of the electrically charged objects involved. - The student will construct an explanation of the two-charge model of electric charge based on evidence produced through scientific practices. - The student will make claims about natural phenomena based on conservation of electric charge. - The student will 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. - The student will explain contact forces (tension, friction, normal, buoyant, spring) as arising from interatomic electric forces and that they therefore have certain directions. - The student will connect the concepts of gravitational force and electric force to compare similarities and differences between the forces
Unit Title: DC Circuits Resistors Only <u>Essential Questions:</u> - How is conservation of charge demonstrated in a simple DC electric circuit? - How is conservation of energy measured in a simple DC circuit?	Students will... <u>Learning Targets</u> - The student will make claims about natural phenomena based on conservation of electric charge. - The student will 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. - The student will 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.

	- The student will 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. - The student will 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. - The student will 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). - The student will use a description or schematic diagram of an electrical circuit to calculate unknown values of current in various segments or branches of the circuit
Unit Title: Waves <u>Essential Questions:</u> - How are standing waves formed? - Why is resonance such a critical concept for energy transfer?	Students will... Learning Targets: - The student will 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. - The student will 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 should include musical instruments. - The student will 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. - The student will describe representations and models of situations in which standing waves result from the addition of incident and reflected waves confined to a region. - The student will describe representations of transverse and longitudinal waves. - The student will 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. - The student will design a suitable experiment and analyze data illustrating the superposition of mechanical waves (only for wave pulses or standing waves). - The student will 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. - The student will 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. - The student will 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.
Unit Title: Work and Energy	Students will...

Essential Questions:	Learning Targets:
<u>Essential Questions:</u> ● How is energy exchanged and transformed within various systems? ● Why does the conservation of energy not necessarily mean all energy is useful?	Learning Targets: ● The student will 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. ● The student will 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. ● The student will 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. Students will be expected to solve qualitatively and/or quantitatively for one-dimensional situations and only qualitatively in two-dimensional situations. ● The student will calculate changes in kinetic energy and potential energy of a system using information from representations of the system. ● The student will 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. ● The student will 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). ● The student will 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.