Pine Hill Public Schools Curriculum			
Content Area:	Science		
Course Title/ Grade Level:	AP Physics 1 / Gr. 11 & 12		
Unit 1:	Introduction, Measurement, Estimating	Duration:	1 week
Unit 2:	Describing Motion: Kinematics in One Dimension	Duration:	3 week
Unit 3:	Kinematics in Two Dimensions; Vectors	Duration:	2 weeks
Unit 4:	Dynamics: Newton's Laws of Motion	Duration:	3 weeks
	Benchmark Exam #1	Duration:	1 day (Administered on the 9th instructional Week)
Unit 4:	Dynamics: Newton's Laws of Motion	Duration:	3 weeks
Unit 5:	Circular Motion; Gravitation	Duration:	5 weeks
Unit 6:	Work and Energy	Duration:	1 week
	Benchmark Exam #2	Duration:	1 day (Administered on the 18th instructional Week)
Unit 6:	Work and Energy	Duration:	4 week
Unit 7:	Linear Momentum	Duration:	3 weeks
Unit 8:	Rotational Motion	Duration:	2 weeks
	Benchmark Exam #3	Duration:	1 day (Administered on the 27th instructional Week)
Unit 8:	Rotational Motion	Duration:	2 weeks
Unit 9:	Oscillations and Waves	Duration:	2 weeks
Unit 10:	Sound	Duration:	2 weeks
Unit 11:	Electric Charge and Electric Fields & Electric Potential	Duration:	8 days + 4 days = 12 days
Unit 12	Electric Current	Duration:	1 week
Unit 13	DC Circuits	Duration:	1 week
	Benchmark Exam #4	Duration:	3 day (Administered on the 36th instructional Week)
BOE Approved date:	6/29/16		

Pine Hill Public Schools Science Curriculum	
Unit Title: Introduction, Measurement, Estimating	Unit #1
Course or Grade Level: AP Physics 1	Length of Time: 1 week

NGSS Performance Expectations (PE's)		
	2-1.	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.

Cross Cutting Concepts	Science and Engineering Practices
☒Patterns ☒Cause and Effect ☒Scale, Proportion, and Quantity ☒Systems and Systems Models ☐Energy and Matter in Systems ☐Structure and Function ☐Stability and Change in Systems Nature of Science (NOS) ☒NOS-Science is a Way of Knowing ☒NOS-Scientific Knowledge Assumes an Order and Consistency in Natural Systems ☒NOS-Science is a Human Endeavor ☒NOS-Science Addresses Questions About the Natural and Material World	☒Asking questions and defining problems ☒Developing and using models ☒Planning and carrying out investigations ☒Analyzing and interpreting data ☒Using mathematics and computational thinking ☒Constructing explanations and designing solutions ☐Engaging in argument from evidence ☒Obtaining, evaluating, and communicating information Nature of Science (NOS) ☒Scientific Investigations Use a Variety of Methods ☒Scientific Knowledge is Based on Empirical Evidence ☒Scientific Knowledge is Open to Revision in Light of New Evidence ☒Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

Content	
	- Models, theories, and laws - Significant figures - Units, standards, and the SI system

	- Converting units - Rapid Estimating - Dimensional analysis
Skills	- Learning Objective (3.A.1.1): The student is able to express the motion of an object using narrative, mathematical, and graphical representations. - Learning Objective (3.A.1.2): The student is able to design an experimental investigation of the motion of an object. - Learning Objective (3.A.1.3): The student is able to 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. - Learning Objective (4.A.2.1): The student is able to 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. - Learning Objective (4.A.2.3): The student is able to create mathematical models and analyze graphical relationships for acceleration, velocity, and position of the center of mass of a system and use them to calculate properties of the motion of the center of mass of a system.
Assessments	- Teacher evaluation of special projects - Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports
Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities - Provide options for independent study
Lesson resources/Activities	- Hands on activities - Chapter study guides - Oral presentation of chapter concepts - Laboratory exercises related to subject matter • Bambi/Rudolph Lab • Measurement lab#1 • Conversion Lab

<table>
<tr><td colspan="3">Pine Hill Public Schools Science Curriculum</td></tr>
<tr><td colspan="2">Unit Title: Describing Motion: Kinematics in One Dimension</td><td>Unit #2</td></tr>
<tr><td colspan="2">Course or Grade Level: AP Physics 1</td><td>Length of Time: 3 weeks</td></tr>
<tr><td>NGSS Performance Expectations (PE’s)</td><td colspan="2">2-1. 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-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*

HS-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-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*</td></tr>
<tr><td colspan="2">Cross Cutting Concepts</td><td>Science and Engineering Practices</td></tr>
<tr><td colspan="2">☒Patterns
☒Cause and Effect
☒Scale, Proportion, and Quantity
☒Systems and Systems Models
☐Energy and Matter in Systems
☐Structure and Function
☐Stability and Change in Systems

Nature of Science (NOS)
☒NOS-Science is a Way of Knowing
☒NOS-Scientific Knowledge Assumes an Order and Consistency in Natural Systems
☒NOS-Science is a Human Endeavor
☒NOS-Science Addresses Questions About the Natural and Material World</td><td>☒Asking questions and defining problems
☒Developing and using models
☒Planning and carrying out investigations
☒Analyzing and interpreting data
☒Using mathematics and computational thinking
☒Constructing explanations and designing solutions
☐Engaging in argument from evidence
☒Obtaining, evaluating, and communicating information

Nature of Science (NOS)
☒Scientific Investigations Use a Variety of Methods
☒Scientific Knowledge is Based on Empirical Evidence
☒Scientific Knowledge is Open to Revision in Light of New Evidence
☒Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena</td></tr>
<tr><td>Content</td><td colspan="2">- Reference frames and displacement
- Average Velocity</td></tr>
</table>

	- Instantaneous Velocity - Acceleration - Motion at Constant acceleration - Solving Problems - Free Falling Objects - Graphical Analysis of Linear Motion
Skills/Learning Objectives	Learning Objective (3.A.1.1): The student is able to express the motion of an object using narrative, mathematical, and graphical representations. Learning Objective (3.A.1.2): The student is able to design an experimental investigation of the motion of an object. Learning Objective (3.A.1.3): The student is able to 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. Learning Objective (4.A.2.1): The student is able to 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. Learning Objective (4.A.2.3): The student is able to create mathematical models and analyze graphical relationships for acceleration, velocity, and position of the center of mass of a system and use them to calculate properties of the motion of the center of mass of a system.
Assessments	- Teacher evaluation of special projects - Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports
Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities - Provide options for independent study
Lesson resources/Activities	- Hands on activities - Laboratory exercises related to subject matter • Speed Lab • Collision point lab • Deriving equations of motion • Acceleration Due to Gravity #1 • Acceleration Due to Gravity #2 • Acceleration Due to Gravity #3 - - Chapter study guides

	- Oral presentation of chapter concepts

Pine Hill Public Schools Science Curriculum		
Unit Title: Kinematics in Two Dimensions		Unit #3
Course or Grade Level: AP Physics 1		Length of Time: 2 weeks
NGSS Performance Expectations (PE's)	2-1.	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-PS2-6.	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 a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
	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.*

Cross Cutting Concepts	Science and Engineering Practices
☒Patterns ☒Cause and Effect ☒Scale, Proportion, and Quantity ☐Systems and Systems Models ☐Energy and Matter in Systems ☐Structure and Function ☐Stability and Change in Systems Nature of Science (NOS) ☒NOS-Science is a Way of Knowing	☒Asking questions and defining problems ☒Developing and using models ☒Planning and carrying out investigations ☒Analyzing and interpreting data ☒Using mathematics and computational thinking ☒Constructing explanations and designing solutions ☒Engaging in argument from evidence ☒Obtaining, evaluating, and communicating information

☒NOS-Scientific Knowledge Assumes an Order and Consistency in Natural Systems ☒NOS-Science is a Human Endeavor ☒NOS-Science Addresses Questions About the Natural and Material World	Nature of Science (NOS) ☒Scientific Investigations Use a Variety of Methods ☒Scientific Knowledge is Based on Empirical Evidence ☒Scientific Knowledge is Open to Revision in Light of New Evidence ☒Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
Content	- Vectors and Scalars - Addition of Vectors, and Multiplication of a Vector by a Scalar - Adding vectors by components - Projectile motion - Solving projectile motion problems - Projectile motion is parabolic - Relative velocity
Skills/Learning Objectives	Learning Objective (3.A.1.1): The student is able to express the motion of an object using narrative, mathematical, and graphical representations. Learning Objective (3.A.1.2): The student is able to design an experimental investigation of the motion of an object. Learning Objective (3.A.1.3): The student is able to 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. Learning Objective (4.A.2.1): The student is able to 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.
Assessments	- Teacher evaluation of special projects - Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports
Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities - Provide options for independent study
Lesson resources/Activities	- Hands on activities - Laboratory exercises related to subject matter

	• Projectile Motion lab1 • Projectile Motion lab2 • Projectile Motion lab3 • Projectile Bingo Lab • Relative Velocity lab - Chapter study guides - Oral presentation of chapter concepts

<table>
<tr><td colspan="3">Pine Hill Public Schools Science Curriculum</td></tr>
<tr><td colspan="2">Unit Title: Dynamics: Newton's Laws of Motion</td><td>Unit #4</td></tr>
<tr><td colspan="2">Course or Grade Level: AP Physics 1</td><td>Length of Time: 6 weeks</td></tr>
<tr><td>NGSS Performance Expectations (PE's)</td><td colspan="2">2-1. 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-PS3-3. 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).</td></tr>
<tr><td colspan="2">Cross Cutting Concepts</td><td>Science and Engineering Practices</td></tr>
<tr><td colspan="2">☒Patterns
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Nature of Science (NOS)</td><td>☒Asking questions and defining problems
☒Developing and using models
☒Planning and carrying out investigations
☒Analyzing and interpreting data
☒Using mathematics and computational thinking
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☒NOS-Science is a Way of Knowing ☒NOS-Scientific Knowledge Assumes an Order and Consistency in Natural Systems ☒NOS-Science is a Human Endeavor ☒NOS-Science Addresses Questions About the Natural and Material World	☒Obtaining, evaluating, and communicating information Nature of Science (NOS) ☒Scientific Investigations Use a Variety of Methods ☒Scientific Knowledge is Based on Empirical Evidence ☒Scientific Knowledge is Open to Revision in Light of New Evidence ☒Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
Content	- Force - Newton's First Law of Motion - Mass - Newton's 2^{nd} Law of Motion - Newton's 3^{rd} Law of Motion - Weight and the force of Gravity and the Normal Force - Solving problems with Newton's Laws: Free-Body Diagrams - Problems involving friction and inclines
Skills/Learning Objectives	Learning Objective (1.A.5.1): The student is able to model verbally or visually the properties of a system based on its substructure and to relate this to changes in the system properties over time as external variables are changed. Learning Objective (1.C.1.1): The student is able to design an experiment for collecting data to determine the relationship between the net force exerted on an object, its inertial mass, and its acceleration. Learning Objective (1.C.3.1): The student is able to design a plan for collecting data to measure gravitational mass and to measure inertial mass, and to distinguish between the two experiments. Learning Objective (2.B.1.1): The student is able to apply $F = mg$ 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. Learning Objective (2.B.2.1): The student is able to 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.

	Learning Objective (2.B.2.2): The student is able to 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. Learning Objective (3.A.2.1): The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. Learning Objective (3.A.3.1): The student is able to 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. Learning Objective (3.A.3.2): The student is able to challenge a claim that an object can exert a force on itself. Learning Objective (3.A.3.3): The student is able to describe a force as an interaction between two objects and identify both objects for any force. Learning Objective (3.A.4.1): The student is able to construct explanations of physical situations involving the interaction of bodies using Newton's third law and the representation of action-reaction pairs of forces. Learning Objective (3.A.4.2): The student is able to use Newton's third law to make claims and predictions about the action-reaction pairs of forces when two objects interact. Learning Objective (3.A.4.3): The student is able to analyze situations involving interactions among several objects by using free-body diagrams that include the application of Newton's third law to identify forces. Learning Objective (3.B.1.1): The student is able to predict the motion of an object subject to forces exerted by several objects using an application of Newton's second law in a variety of physical situations with acceleration in one dimension. Learning Objective (3.B.1.2): The student is able to 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. Learning Objective (3.B.1.3): The student is able to re-express a free-body diagram representation into a mathematical

	representation and solve the mathematical representation for the acceleration of the object. Learning Objective (3.B.2.1): The student is able to create and use free-body diagrams to analyze physical situations to solve problems with motion qualitatively and quantitatively. Learning Objective (3.C.1.1): The student is able to 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. Learning Objective (3.C.4.1): The student is able to make claims about various contact forces between objects based on the microscopic cause of those forces. Learning Objective (3.C.4.2): The student is able to explain contact forces (tension, friction, normal, buoyant, spring) as arising from interatomic electric forces and that they therefore have certain directions. Learning Objective (3.G.1.1): The student is able to articulate situations when the gravitational force is the dominant force and when the electromagnetic, weak, and strong forces can be ignored. Learning Objective (4.A.2.2): The student is able to evaluate using given data whether all the forces on a system or whether all the parts of a system have been identified. Learning Objective (4.A.3.1): The student is able to 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. Learning Objective (4.A.3.2): The student is able to 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.
Assessments	- Teacher evaluation of special projects - Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports
Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities - Provide options for independent study

Lesson resources/Activities	- Hands on activities
	- Laboratory exercises related to subject matter
	    • Identifying Forces lab
	    • Drawing FBD’s
	    • Calculating Force lab
	    • Tension Lab
	    • Static Friction lab
	    • Kinetic Friction Lab #1
	    • Kinetic Friction Lab #2
	    • Kinetic Friction Lab #3
	- Chapter study guides
	- Oral presentation of chapter concepts

<table>
<tr><td colspan="4">Pine Hill Public Schools Science Curriculum</td></tr>
<tr><td colspan="3">Unit Title: Dynamics: Circular Motion; Gravitation</td><td>Unit #5</td></tr>
<tr><td colspan="3">Course or Grade Level: AP Physics 1</td><td>Length of Time: 6 weeks</td></tr>
<tr><td rowspan="4">NGSS Performance Expectations (PE’s)</td><td>2-1.</td><td colspan="2">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.</td></tr>
<tr><td>HS-PS2-2.</td><td colspan="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.</td></tr>
<tr><td>HS-PS3-1</td><td colspan="2">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.</td></tr>
<tr><td>HS-PS3-2.</td><td colspan="2">Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).</td></tr>
<tr><td colspan="2">Cross Cutting Concepts</td><td colspan="2">Science and Engineering Practices</td></tr>
<tr><td colspan="2">☒Patterns
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☐Energy and Matter in Systems
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Nature of Science (NOS)
☒NOS-Science is a Way of Knowing
☒NOS-Scientific Knowledge Assumes an Order and Consistency in Natural Systems
☒NOS-Science is a Human Endeavor</td><td colspan="2">☒Asking questions and defining problems
☒Developing and using models
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Nature of Science (NOS)
☒Scientific Investigations Use a Variety of Methods
☒Scientific Knowledge is Based on Empirical Evidence</td></tr>
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☒NOS-Science Addresses Questions About the Natural and Material World		☒Scientific Knowledge is Open to Revision in Light of New Evidence ☒Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
Content	- Kinematic of Uniform Circular Motion - Dynamics of Uniform Circular Motion - Highway Curves: Banked and unbanked - Nonuniform Circular Motion - Newton's Law of Universal Gravitation - Gravity near Earth's Surface - Satellites and "Weightlessness" - Planets, Kepler's Laws, and Newtonian Synthesis - Moon Rises an hour later each day - Types of forces in nature	
Skills/Learning Objectives	Learning Objective (2.B.1.1): The student is able to apply F =mg 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. Learning Objective (3.A.2.1): The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. Learning Objective (3.A.3.1): The student is able to 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. Learning Objective (3.A.3.3): The student is able to describe a force as an interaction between two objects and identify both objects for any force. Learning Objective (3.A.4.1): The student is able to construct explanations of physical situations involving the interaction of bodies using Newton's third law and the representation of action-reaction pairs of forces. Learning Objective (3.A.4.2): The student is able to use Newton's third law to make claims and predictions about the action-reaction pairs of forces when two objects interact. Learning Objective (3.A.4.3): The student is able to analyze situations involving interactions among several objects by using free-body diagrams that include the application of Newton's third law to identify forces.	

	Learning Objective (3.B.1.1): The student is able to predict the motion of an object subject to forces exerted by several objects using an application of Newton's second law in a variety of physical situations with acceleration in one dimension. Learning Objective (3.B.1.3): The student is able to re-express a free-body diagram representation into a mathematical representation and solve the mathematical representation for the acceleration of the object. Learning Objective (3.B.2.1): The student is able to create and use free-body diagrams to analyze physical situations to solve problems with motion qualitatively and quantitatively. Learning Objective (3.C.1.2): The student is able to use Newton's law of gravitation to calculate the gravitational force between two objects and use that force in contexts involving orbital motion (for circular orbital motion only in Physics 1).
Assessments	- Teacher evaluation of special projects - Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports
Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities - Provide options for independent study

Lesson resources/Activities	- Hands on activities
	- Laboratory exercises related to subject matter
	  • Flying Pig Lab
	  • Circular motion lab
	  • Cavendish experiment
	  • Motion Detector lab
	  • Virtual Lab on Planetary Data
	- Chapter study guides
	- Oral presentation of chapter concepts

<table>
<tr><td colspan="3">Pine Hill Public Schools Science Curriculum</td></tr>
<tr><td colspan="2">Unit Title: Work and Energy</td><td>Unit #6</td></tr>
<tr><td colspan="2">Course or Grade Level: AP Physics 1</td><td>Length of Time: 5 weeks</td></tr>
<tr><td>NGSS Performance Expectations (PE’s)</td><td colspan="2">
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-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 a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
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-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
</td></tr>
<tr><td colspan="2">Cross Cutting Concepts</td><td>Science and Engineering Practices</td></tr>
<tr><td colspan="2">
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Nature of Science (NOS)
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Nature of Science (NOS)
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</table>

☒NOS-Science Addresses Questions About the Natural and Material World	☒Scientific Knowledge is Open to Revision in Light of New Evidence ☒Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
Content	- Work done by constant force - Work done by varying force - Kinetic energy, and the Work-Energy Principle - Potential energy - Conservative and neoconservative forces - Mechanical Energy and its conservation - Problem solving using conservation of mechanical energy - Other forms of energy and energy transformations: The Law of Conservation of Energy - Energy conservation with dissipative forces: solving problems - Power
Skills/Learning Objectives	Learning Objective (2.B.1.1): The student is able to apply F =mg 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. Learning Objective (3.A.2.1): The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. Learning Objective (3.A.3.3): The student is able to describe a force as an interaction between two objects and identify both objects for any force. Learning Objective (3.E.1.1): The student is able to 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. Learning Objective (3.E.1.2): The student is able to use net force and velocity vectors to determine qualitatively whether kinetic energy of an object would increase, decrease, or remain unchanged. Learning Objective (3.E.1.3): The student is able to 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.

	Learning Objective (3.E.1.4): The student is able to 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. Learning Objective (4.C.1.1): The student is able to 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. Learning Objective (4.C.1.2): The student is able to predict changes in the total energy of a system due to changes in position and speed of objects or frictional interactions within the system. Learning Objective (4.C.2.1): The student is able to 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. Learning Objective (4.C.2.2): The student is able to 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. Learning Objective (5.A.2.1): The student is able to define open and closed systems for everyday situations and apply conservation concepts for energy, charge, and linear momentum to those situations. Learning Objective (5.B.1.1): The student is able to 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. Learning Objective (5.B.1.2): The student is able to 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. Learning Objective (5.B.3.1): The student is able to describe and make qualitative and/or quantitative predictions about everyday examples of systems with internal potential energy.

	Learning Objective (5.B.3.2): The student is able to make quantitative calculations of the internal potential energy of a system from a description or diagram of that system. Learning Objective (5.B.3.3): The student is able to 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. Learning Objective (5.B.4.1): The student is able to describe and make predictions about the internal energy of systems. Learning Objective (5.B.4.2): The student is able to calculate changes in kinetic energy and potential energy of a system, using information from representations of that system. Learning Objective (5.B.5.1): The student is able to 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. Learning Objective (5.B.5.2): The student is able to 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. Learning Objective (5.B.5.3): The student is able to 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. Learning Objective (5.B.5.4): The student is able to 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). Learning Objective (5.B.5.5): The student is able to 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.
Assessments	- Teacher evaluation of special projects - Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports
Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities

	- Provide options for independent study
Lesson resources/Activities	- Hands on activities - Laboratory exercises related to subject matter • Friction Lab revisited with work and energy • Work and Energy lab • Potential energy and Kinetic energy lab • Revisit the velocity of a marble lab using the work and energy theorems - Chapter study guides - Oral presentation of chapter concepts

Pine Hill Public Schools Science Curriculum		
Unit Title: Linear Momentum		Unit #7
Course or Grade Level: AP Physics 1		Length of Time: 3 weeks
NGSS Performance Expectations (PE's)	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-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 a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
	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.*

Cross Cutting Concepts	Science and Engineering Practices
☒Patterns ☒Cause and Effect ☒Scale, Proportion, and Quantity ☒Systems and Systems Models ☒Energy and Matter in Systems ☒Structure and Function ☒Stability and Change in Systems Nature of Science (NOS) ☒NOS-Science is a Way of Knowing	☒Asking questions and defining problems ☒Developing and using models ☒Planning and carrying out investigations ☒Analyzing and interpreting data ☒Using mathematics and computational thinking ☒Constructing explanations and designing solutions ☐Engaging in argument from evidence ☒Obtaining, evaluating, and communicating information

☒NOS-Scientific Knowledge Assumes an Order and Consistency in Natural Systems ☒NOS-Science is a Human Endeavor ☒NOS-Science Addresses Questions About the Natural and Material World	Nature of Science (NOS) ☒Scientific Investigations Use a Variety of Methods ☒Scientific Knowledge is Based on Empirical Evidence ☒Scientific Knowledge is Open to Revision in Light of New Evidence ☒Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
Content	- Momentum and its relation to force - Conservation of Momentum - Collisions and impulse - Conservation of energy and momentum in collisions - Elastic collisions in one dimension - Inelastic collisions - Collision in two dimensions - Center of Mass - Center of mass for the human body - Center of mass and translational motion
Skills/Learning Objectives	Learning Objective (3.A.2.1): The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. Learning Objective (3.D.1.1): The student is able to 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. Learning Objective (3.D.2.1): The student is able to 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. Learning Objective (3.D.2.2): The student is able to 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. Learning Objective (3.D.2.3): The student is able to 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.

	Learning Objective (3.D.2.4): The student is able to design a plan for collecting data to investigate the relationship between changes in momentum and the average force exerted on an object over time. Learning Objective (4.B.1.1): The student is able to 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.). Learning Objective (4.B.1.2): The student is able to 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. Learning Objective (4.B.2.1): The student is able to 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. Learning Objective (4.B.2.2): The student is able to perform analysis on data presented as a force-time graph and predict the change in momentum of a system. Learning Objective (5.A.2.1): The student is able to define open and closed systems for everyday situations and apply conservation concepts for energy, charge, and linear momentum to those situations. Learning Objective (5.D.1.1): The student is able to make qualitative predictions about natural phenomena based on conservation of linear momentum and restoration of kinetic energy in elastic collisions. Learning Objective (5.D.1.2): The student is able to 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. Learning Objective (5.D.1.3): The student is able to 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.

	Learning Objective (5.D.1.4): The student is able to 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. Learning Objective (5.D.1.5): The student is able to 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. Learning Objective (5.D.2.1): The student is able to 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. Learning Objective (5.D.2.2): The student is able to 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. Learning Objective (5.D.2.3): The student is able to apply the conservation of linear momentum to a closed system of objects involved in an inelastic collision to predict the change in kinetic energy. Learning Objective (5.D.2.4): The student is able to analyze data that verify conservation of momentum in collisions with and without an external friction force. Learning Objective (5.D.2.5): The student is able to 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. Learning Objective (5.D.3.1): The student is able to 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).
Assessments	- Teacher evaluation of special projects

	- Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports
Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities - Provide options for independent study

Lesson resources/Activities	- Hands on activities
	- Laboratory exercises related to subject matter
	  • Friction Lab revisited with momentum
	  • Pendulum Lab
	  • Ramp lab
	  • Revisit the velocity of a marble lab using momentum
	- Chapter study guides
	- Oral presentation of chapter concepts

Pine Hill Public Schools Science Curriculum		
Unit Title: Rotational Motion		Unit #8
Course or Grade Level: AP Physics 1		Length of Time: 4 weeks
NGSS Performance Expectations (PE's)	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-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 a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
	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.*

Cross Cutting Concepts	Science and Engineering Practices
☒Patterns ☒Cause and Effect ☒Scale, Proportion, and Quantity	☒Asking questions and defining problems ☒Developing and using models ☒Planning and carrying out investigations

☒Systems and Systems Models ☒Energy and Matter in Systems ☒Structure and Function ☒Stability and Change in Systems Nature of Science (NOS) ☒NOS-Science is a Way of Knowing ☒NOS-Scientific Knowledge Assumes an Order and Consistency in Natural Systems ☒NOS-Science is a Human Endeavor ☒NOS-Science Addresses Questions About the Natural and Material World	☒Analyzing and interpreting data ☒Using mathematics and computational thinking ☒Constructing explanations and designing solutions ☐Engaging in argument from evidence ☒Obtaining, evaluating, and communicating information Nature of Science (NOS) ☒Scientific Investigations Use a Variety of Methods ☒Scientific Knowledge is Based on Empirical Evidence ☒Scientific Knowledge is Open to Revision in Light of New Evidence ☒Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
Content	- Momentum and its relation to force - Conservation of Momentum - Collisions and impulse - Conservation of energy and momentum in collisions - Elastic collisions in one dimension - Inelastic collisions - Collision in two dimensions - Center of Mass - Center of mass for the human body - Center of mass and translational motion
Skills/Learning Objectives	Learning Objective (3.A.2.1): The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. Learning Objective (3.F.1.1): The student is able to use representations of the relationship between force and torque. Learning Objective (3.F.1.2): The student is able to compare the torques on an object caused by various forces. Learning Objective (3.F.1.3): The student is able to estimate the torque on an object caused by various forces in comparison to other situations.

	Learning Objective (3.F.1.4): The student is able to design an experiment and analyze data testing a question about torques in a balanced rigid system. Learning Objective (3.F.1.5): The student is able to calculate torques on a two-dimensional system in static equilibrium, by examining a representation or model (such as a diagram or physical construction). Learning Objective (3.F.2.1): The student is able to 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. Learning Objective (3.F.2.2): The student is able to 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. Learning Objective (3.F.3.1): The student is able to 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. Learning Objective (3.F.3.2): In an unfamiliar context or using representations beyond equations, the student is able to 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. Learning Objective (3.F.3.3): The student is able to 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. Learning Objective (4.A.1.1): The student is able to use representations of the center of mass of an isolated two-object system to analyze the motion of the system qualitatively and semi-quantitatively. Learning Objective (4.D.1.1): The student is able to 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. Learning Objective (4.D.1.2): The student is able to 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. Learning Objective (4.D.2.1): The student is able to 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. Learning Objective (4.D.2.2): The student is able to 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. Learning Objective (4.D.3.1): The student is able to 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. Learning Objective (4.D.3.2): The student is able to 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. Learning Objective (5.E.1.1): The student is able to make qualitative predictions about the angular momentum of a system for a situation in which there is no net external torque. Learning Objective (5.E.1.2): The student is able to make calculations of quantities related to the angular momentum of a system when the net external torque on the system is zero. Learning Objective (5.E.2.1): The student is able to 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. Students are expected to do qualitative reasoning with compound objects. Students are expected to do calculations with a fixed set of extended objects and point masses.
Assessments	- Teacher evaluation of special projects - Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports

Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities - Provide options for independent study

Lesson resources/Activities	- Hands on activities
	- Laboratory exercises related to subject matter
	  • Elastic collision lab
	  • Inelastic collision lab
	  • Find the Center of mass of an irregular shape
	  • Bat Speed lab
	- Chapter study guides
	- Oral presentation of chapter concepts

Pine Hill Public Schools Science Curriculum		
Unit Title: Oscillations and Waves (Ch 11)		Unit #9
Course or Grade Level: AP Physics 1		Length of Time: 2 weeks
NGSS Performance Expectations (PE's)	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-PS1-2.	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
	HS-PS1-7.	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
	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-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 a combination of energy associated with the motions of

		particles (objects) and energy associated with the relative positions of particles (objects).
	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.*

Cross Cutting Concepts	Science and Engineering Practices
☒Patterns ☒Cause and Effect ☒Scale, Proportion, and Quantity ☒Systems and Systems Models ☒Energy and Matter in Systems ☒Structure and Function ☒Stability and Change in Systems Nature of Science (NOS) ☒NOS-Science is a Way of Knowing	☒Asking questions and defining problems ☒Developing and using models ☒Planning and carrying out investigations ☒Analyzing and interpreting data ☒Using mathematics and computational thinking ☐Constructing explanations and designing solutions ☐Engaging in argument from evidence ☐Obtaining, evaluating, and communicating information

☒NOS-Scientific Knowledge Assumes an Order and Consistency in Natural Systems ☒NOS-Science is a Human Endeavor ☒NOS-Science Addresses Questions About the Natural and Material World	Nature of Science (NOS) ☒Scientific Investigations Use a Variety of Methods ☒Scientific Knowledge is Based on Empirical Evidence ☒Scientific Knowledge is Open to Revision in Light of New Evidence ☒Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
Content	- Simple Harmonic motion - Energy in simple harmonic motion - The period and sinusoidal nature of SHM - The simple pendulum - Damped harmonic motion - Forced oscillations; Resonance - Wave Motion - Types of waves and their speeds - Energy Transported by waves - Reflection and transmission of waves - Interference; Principle of Superposition - Standing waves; Resonance - Refraction - Diffraction - Mathematical representation of traveling wave
Skills/Learning Objectives	Learning Objective (2.B.1.1): The student is able to apply F =mg 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. Learning Objective (3.A.2.1): The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. Learning Objective (3.B.3.1): The student is able to predict which properties determine the motion of a simple harmonic oscillator and what the dependence of the motion is on those properties. Learning Objective (3.B.3.2): The student is able to 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. Learning Objective (3.B.3.3): The student can 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. Learning Objective (3.B.3.4): The student is able to construct a qualitative and/or a quantitative explanation of oscillatory behavior given evidence of a restoring force. Learning Objective (3.C.4.1): The student is able to make claims about various contact forces between objects based on the microscopic cause of those forces. Learning Objective (3.C.4.2): The student is able to explain contact forces (tension, friction, normal, buoyant, spring) as arising from interatomic electric forces and that they therefore have certain directions. Learning Objective (5.B.2.1): The student is able to 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.
Assessments	- Teacher evaluation of special projects - Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports
Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities - Provide options for independent study
Lesson resources/Activities	- Hands on activities - Laboratory exercises related to subject matter • Pendulum Lab #2 • Pendulum Lab #3 • Damped Harmonic Motion Vs. Undamped • Resonance lab • Lenses lab • Mirror/reflection lab - Chapter study guides - Oral presentation of chapter concepts

Pine Hill Public Schools Science Curriculum		
Unit Title: Sound (Ch 12)		Unit #10
Course or Grade Level: AP Physics 1		Length of Time: 2 weeks
NGSS Performance Expectations (PE's)	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-PS1-2.	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
	HS-PS1-7.	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
	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-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 a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
	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.

<table>
<tr><td></td><td>HS-PS4-3.</td><td colspan="2">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.</td></tr>
<tr><td colspan="2">Cross Cutting Concepts</td><td colspan="2">Science and Engineering Practices</td></tr>
<tr><td colspan="2">☒Patterns
☒Cause and Effect
☒Scale, Proportion, and Quantity
☒Systems and Systems Models
☒Energy and Matter in Systems
☒Structure and Function
☒Stability and Change in Systems

Nature of Science (NOS)
☒NOS-Science is a Way of Knowing
☒NOS-Scientific Knowledge Assumes an Order and Consistency in Natural Systems
☒NOS-Science is a Human Endeavor
☒NOS-Science Addresses Questions About the Natural and Material World</td><td colspan="2">☒Asking questions and defining problems
☒Developing and using models
☒Planning and carrying out investigations
☒Analyzing and interpreting data
☒Using mathematics and computational thinking
☐Constructing explanations and designing solutions
☐Engaging in argument from evidence
☐Obtaining, evaluating, and communicating information

Nature of Science (NOS)
☒Scientific Investigations Use a Variety of Methods
☒Scientific Knowledge is Based on Empirical Evidence
☒Scientific Knowledge is Open to Revision in Light of New Evidence
☒Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena</td></tr>
<tr><td>Content</td><td colspan="3">- Characteristics of sound
- Intensity of sound: Decibels
- Sources of sound: Vibrating strings and air columns
- Interference of sound waves; Beats
- Doppler effect</td></tr>
<tr><td>Skills/Learning Objectives</td><td colspan="3">Learning Objective (6.A.1.2): The student is able to describe representations of transverse and longitudinal waves.

Learning Objective (6.A.2.1): The student is able to describe sound in terms of transfer of energy and momentum in a medium and relate the concepts to everyday examples.

Learning Objective (6.A.3.1): The student is able to use graphical representation of a periodic mechanical wave to determine the amplitude of the wave.

Learning Objective (6.A.4.1): The student is able to explain and/or predict qualitatively how the energy carried by a sound</td></tr>
</table>

	wave relates to the amplitude of the wave, and/or apply this concept to a real-world example. Learning Objective (6.B.1.1): The student is able to 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. Learning Objective (6.B.2.1): The student is able to use a visual representation of a periodic mechanical wave to determine wavelength of the wave. Learning Objective (6.B.4.1): The student is able to design an experiment to determine the relationship between periodic wave speed, wavelength, and frequency and relate these concepts to everyday examples. Learning Objective (6.B.5.1): The student is able to 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. Learning Objective (6.D.1.1): The student is able to use representations of individual pulses and construct representations to model the interaction of two wave pulses to analyze the superposition of two pulses. Learning Objective (6.D.1.2): The student is able to design a suitable experiment and analyze data illustrating the superposition of mechanical waves (only for wave pulses or standing waves). Learning Objective (6.D.1.3): The student is able to 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. Learning Objective (6.D.2.1): The student is able to 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. Learning Objective (6.D.3.1): The student is able to 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. Learning Objective (6.D.3.2): The student is able to 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. Learning Objective (6.D.3.3): The student is able to 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. Learning Objective (6.D.3.4): The student is able to describe representations and models of situations in which standing waves result from the addition of incident and reflected waves confined to a region. Learning Objective (6.D.4.1): The student is able to 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. Learning Objective (6.D.4.2): The student is able to 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. Learning Objective (6.D.5.1): The student is able to use a visual representation to explain how waves of slightly different frequency give rise to the phenomenon of beats
Assessments	- Teacher evaluation of special projects - Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports
Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities - Provide options for independent study

Lesson resources/Activities	- Hands on activities
	- Laboratory exercises related to subject matter
	    • Building a speaker lab
	    • Speed of sound lab
	- Chapter study guides
	- Oral presentation of chapter concepts

Pine Hill Public Schools Science Curriculum		
Unit Title: Electric Charge and Electric Field, Electric Potential (Ch 16 and 17)		Unit #11
Course or Grade Level: AP Physics 1		Length of Time: 8 + 4 = 12 days (only 4 days on electric potential)
NGSS Performance Expectations (PE's)	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-PS1-2.	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
	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-PS1-7.	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
	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-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.*

Cross Cutting Concepts	Science and Engineering Practices
☒Patterns ☒Cause and Effect ☒Scale, Proportion, and Quantity ☒Systems and Systems Models ☒Energy and Matter in Systems ☐Structure and Function ☐Stability and Change in Systems Nature of Science (NOS) ☒NOS-Science is a Way of Knowing ☒NOS-Scientific Knowledge Assumes an Order and Consistency in Natural Systems ☒NOS-Science is a Human Endeavor ☒NOS-Science Addresses Questions About the Natural and Material World	☒Asking questions and defining problems ☒Developing and using models ☒Planning and carrying out investigations ☒Analyzing and interpreting data ☒Using mathematics and computational thinking ☐Constructing explanations and designing solutions ☐Engaging in argument from evidence ☒Obtaining, evaluating, and communicating information Nature of Science (NOS) ☒Scientific Investigations Use a Variety of Methods ☒Scientific Knowledge is Based on Empirical Evidence ☒Scientific Knowledge is Open to Revision in Light of New Evidence ☒Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

Content	Ch 16 - Static Electricity: Electric charge and its conservation - Insulators and Conductors - Coulomb's law - Solving problems involving Coulomb's Law and vectors - The electric field - Electric field lines and Conductors Ch 17 - Electric Potential Energy and Potential Difference

	- Capacitance
Skills/Learning Objectives	Learning Objective (1.B.1.1): The student is able to make claims about natural phenomena based on conservation of electric charge. Learning Objective (1.B.2.1): The student is able to construct an explanation of the two-charge model of electric charge based on evidence produced through scientific practices. Learning Objective (1.B.3.1): The student is able to challenge the claim that an electric charge smaller than the elementary charge has been isolated. Learning Objective (3.A.2.1): The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. Learning Objective (3.C.2.1): The student is able to use Coulomb's law qualitatively and quantitatively to make predictions about the interaction between two electric point charges (interactions between collections of electric point charges are not covered in Physics 1 and instead are restricted to Physics 2). Learning Objective (3.C.2.2): The student is able to connect the concepts of gravitational force and electric force to compare similarities and differences between the forces. Learning Objective (5.A.2.1): The student is able to define open and closed systems for everyday situations and apply conservation concepts for energy, charge, and linear momentum to those situations.
Assessments	- Teacher evaluation of special projects - Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports
Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities - Provide options for independent study
Lesson resources/Activities	- Hands on activities - Laboratory exercises related to subject matter • Electroscope/Charge lab • Virtual Lab on Electric field lines - - Chapter study guides

	- Oral presentation of chapter concepts

Pine Hill Public Schools Science Curriculum		
Unit Title: Electric Current (Ch 18)		Unit #12
Course or Grade Level: AP Physics 1		Length of Time: 1 week
NGSS Performance Expectations (PE's)	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 a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
	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

<table>
<tr><td></td><td colspan="2">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.*</td></tr>
<tr><td colspan="2">Cross Cutting Concepts</td><td>Science and Engineering Practices</td></tr>
<tr><td colspan="2">☒Patterns
☒Cause and Effect
☒Scale, Proportion, and Quantity
☒Systems and Systems Models
☒Energy and Matter in Systems
☐Structure and Function
☐Stability and Change in Systems

Nature of Science (NOS)
☒NOS-Science is a Way of Knowing
☒NOS-Scientific Knowledge Assumes an Order and Consistency in Natural Systems
☒NOS-Science is a Human Endeavor
☒NOS-Science Addresses Questions About the Natural and Material World</td><td>☒Asking questions and defining problems
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<tr><td>Content</td><td colspan="2">- The electric battery
- Electric Current
- Ohm’s Law: Resistance and Resistors
- Resistivity
- Electric power</td></tr>
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Assessments	- Teacher evaluation of special projects - Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports
Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities - Provide options for independent study
Lesson resources/Activities	- Hands on activities - Laboratory exercises related to subject matter • Set up a Bread Board lab • Analyze resistance lab • Analyze current lab • Analyze voltage lab • RC circuits lab - Chapter study guides - Oral presentation of chapter concepts

Pine Hill Public Schools Science Curriculum		
Unit Title: DC Circuits (ch 19)		Unit #13
Course or Grade Level: AP Physics 1		Length of Time: 1 week
NGSS Performance Expectations (PE's)	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 a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
	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.*

Cross Cutting Concepts	Science and Engineering Practices
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Content	- Emf and Terminal Voltage - Resistors in series and in parallel - Kirchoff's Rules - EMF's in series and in parallel: charging a battery
Skills/Learning Objectives	Learning Objective (1.B.1.2): The student is able to 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. Learning Objective (1.E.2.1): The student is able to choose and justify the selection of data needed to determine resistivity for a given material. Learning Objective (5.B.9.1): The student is able to 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). Learning Objective (5.B.9.2): The student is able to apply conservation of energy concepts to the design of an experiment that will demonstrate the validity of Kirchhoff's loop rule in a circuit with only a battery and resistors either in series or in, at most, one pair of parallel branches. Learning Objective (5.B.9.3): The student is able to 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. Learning Objective (5.C.3.1): The student is able to 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. Learning Objective (5.C.3.2): The student is able to 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. Learning Objective (5.C.3.3): The student is able to use a description or schematic diagram of an electrical circuit to calculate unknown values of current in various segments or branches of the circuit.
Assessments	- Teacher evaluation of special projects - Quizzes and chapter tests - Homework/class work assignments - Experiments/lab reports
Interventions/ differentiated instruction	- Provide advanced notice for tests - Present materials suitable to student's level of functioning - Include hands on activities

	- Provide options for independent study

Lesson resources/Activities	- Hands on activities
	- Laboratory exercises related to subject matter
	    • Node rule lab
	    • Loop rule lab
	    • Building a boat Project
	- RC circuits lab
	- Chapter study guides
	- Oral presentation of chapter concepts

Resources

Textbook

Giancoli, Douglas C. *Physics: Principles With Applications.* Boston, MA: Pearson, 2014.

Equipment

- Computers
- Motion Detectors
- Internet
- Microsoft Office (Excel, Word, and PowerPoint)
- Multi-meters
- Breadboards
- Power Supplies
- Resistors, LED's, and Capacitors
- Logger Pro Software
- Capital or Budget for projects
- Calculators
- Stop watches
- Photo-gates and accompanying software