Title	**Roxbury High School AP Physics**
Type	Consensus
Document	Map
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Subject	Science
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Location	Roxbury High School
Curriculum Writing History	
Notes	
Attachments	

Title : Roxbury High School AP Physics
Type : Consensus

Weeks	Unit
September/Week 1 - September/Week 4	**Force and motion**
October/Week 5 - October/Week 8	**Energy and Momentum**
November/Week 9 - December/Week 13	**Planetary, circular, angular motion, and torque**
December/Week 14 - December/Week 16	**Waves**
January/Week 17 - February/Week 23	**Electricity and electical circuits**
February/Week 24 - April/Week 32	**Magnetism**
May/Week 33 - May/Week 34	**Review for Exam**

Title : Roxbury High School AP Physics
Type : Consensus

Duration: September/Week 1 - September/Week 4					
UNIT NAME: Force and motion					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
-determine patterns in data to provide evidence of phenomena -define boundaries of the system -use empirical evidence to differentiate between cause and correlation and make claims about cause and effect -apply kinematic formulas to solve 1-D motion problems -Theories and laws provide explanations in science. -Laws are statements or descriptions of the relationships among observable phenomena.	-what is position, time, velocity, acceleration, and displacement? -what is a position/time and a velocity/time graph? -can the student analyze the position/time and velocity/time graph and analyze its slope? -What is the mathematical expression for velocity, time, acceleration, and displacement? -Can students apply calculus methods to determine a changing rate of velocity or a changing position in time? -How does force, mass, and acceleration relate to one another? -How can the application of a free body diagram be used to determine the net force on an object in static or dynamic motion? -How can Newton's laws be applied to predict the motion of two or more objects connected to one	-cite specific textual evidence to support analysis of technical text -integrate and evaluate multiple sources of information presented -gather relevant information to perform an experiment -Draw evidence from informational texts to support analysis -model with mathematics -use units to guide in multi step problem solving -represent data on a position and velocity time graph -apply algebra, trigonometry, and calculus to problem solving -Newton's second law accurately predicts changes in the motion of macroscopic objects. -Forces cause changes in velocity.	Plan and carry out investigations: -produce data collaboratively -consider limitations -analyze data using technology and models -analyze data applying mathematics -apply scientific theory to solve problems -Represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. -Understand and apply the relationship between the net force exerted on an object, its inertial mass, and its acceleration to a variety of situations. -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.PS1.1.SEP.1-Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.1.CCC.1-Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-1), (HS-PS1-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.3.SEP.1-Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis

	another via a rope and a pulley? -How does the mass of a pulley alter the acceleration of a two body system? -How does the relationship between two surfaces affect the friction between them? -What is the normal force and why does it affect the frictional force? -What is a conservative vs a non conservative force? -What mathematic model is needed to describe the effects of a changing force on an object?	-Force is a vector and can be graphically represented in a free-body diagram. -Acceleration is determined by net external force. -Objects in motion tend to stay in motion. -Forces always exist in pairs. Each acts on a different object. -Friction opposes the applied force and depends on the surfaces in contact. -Kinetic friction is less than static friction. The coefficient of friction is a ratio of the frictional and normal forces acting between two objects.	-Represent and describe the two types of forces that a surface can exert on an object - a normal force, and a friction force parallel to the surface and dependent on the normal force and textures of the two surfaces. -Use Newton's Second Law along with the mathematical relationship among friction force and normal force to predict unknown quantities involving one-dimensional motion with constant velocity and one-dimensional motion with constant acceleration.		for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly . (HS-PS1-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.6.SEP.1- Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.2.SEP.1- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' ow n investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate

					today as they did in the past and will continue to do so in the future. (HS-PS1-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.5.SEP.1-Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.6.SEP.1-Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.SEP.1-Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HSPS2-1) (09-12)

					[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.CNS.1-Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.CNS.2-Laws are statements or descriptions of the relationships among observ able phenomena. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.CCC.1-Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1),(HS-PS2-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.3.SEP.1-Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.4.SEP.1-Use mathematical representations of

					phenomena to describe explanations. (HS-PS2-2), (HS-PS2-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.4.CNS.1-Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.4.CNS.2-Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.CCC.1-Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HSPS3-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.CET.1-Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and

					engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.3.SEP.1-Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly . (HS-PS1-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.3.CCC.1-Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-1), (HS-PS1-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.6.SEP.1-Communicate scientific and technical information

					(e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.4.CCC.1-Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.5.SEP.1-Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.6.CCC.1-Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6) (09-12) [Regional:Next Generation Science Standards

					(NGSS)] HS.PS1.7.SEP.1-Use mathematical representations of phenomena to support claims. (HS-PS1-7) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.CNS.1-Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.CCC.1-The total amount of energy and matter in closed systems is conserved. (HS-PS1-7) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1-Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.SEP.1-Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to

					make valid and reliable scientific claims or determine an optimal design solution. (HSPS2-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.CNS.2-Laws are statements or descriptions of the relationships among observ able phenomena. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.DCI.PS2.A.1-Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.2.CCC.1-When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2) (09-12)[Regional:Next Generation Science Standards (NGSS)] 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.* (09-12)

					[Regional:Next Generation Science Standards (NGSS)] HS.PS2.3.SEP.1-Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.CNS.1-Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.DCI.PS3.A.1-A t the macroscopic scale, energy manifests itself in multiple way s, such as in motion, sound, light, and thermal energy . (HSPS3-2) (HS-PS3-3) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS4.3.CNS.1-A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If

					new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HSPS4-3) (09-12)[Regional:Next Generation Science Standards (NGSS)] N.VM.1-(+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v). (09-12)[State:Common Core State Standards (CCSS)] N.VM.2-(+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. (09-12)[State:Common Core State Standards (CCSS)] N.VM.3-(+) Solve problems involving velocity and other quantities that can be represented by vectors. (09-12)[State:Common Core State Standards (CCSS)] N.VM.4-(+) Add and subtract vectors. (09-12)[State:Common Core State Standards (CCSS)] N.VM.4.a-Add vectors end-

					to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. (09-12)[State:Common Core State Standards (CCSS)] N.VM.4.b-Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. (09-12)[State:Common Core State Standards (CCSS)] N.VM.4.c-Understand vector subtraction v – w as v + (–w), where –w is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise. (09-12) [State:Common Core State Standards (CCSS)] N.VM.5.a-Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$. (09-12) [State:Common Core

					State Standards (CCSS)] N.VM.5.b-Compute the magnitude of a scalar multiple cv using ||cv|| = |c| v. Compute the direction of cv knowing that when |c| v ≠ 0, the direction of cv is either along v (for c > 0) or against v (for c < 0). (09-12)[State:Common Core State Standards (CCSS)] A.CED.1-Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* (09-12) [State:Common Core State Standards (CCSS)] A.CED.2-Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (09-12) [State:Common Core State Standards (CCSS)]
Plans:					

Title : Roxbury High School AP Physics
Type : Consensus

Duration: October/Week 5 - October/Week 8					
UNIT NAME: Energy and Momentum					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
-determine patterns in data to provide evidence of phenomena -define boundaries of the system -use empirical evidence to differentiate between cause and correlation and make claims about cause and effect -graph relationships to further understanding of force vs distance. -apply conservation of energy to problem solving -Theories and laws provide explanations in science. -Laws are statements or descriptions of the relationships among observable phenomena.	-What is potential energy and how does it transfer into kinetic energy? -Why is total energy conserved but not mechanical energy? -What does it mean to have a potential energy of zero and why can you "move" that location? -In a closed system, why is momentum conserved? -how does the vector quantity of momentum relate to the scalar quantity of energy? -How is the momentum of an object changed when a force is applied for a given amount of time? -How can one use a graphical model of a force vs distance graph to calculate net energy? -What is the work energy theorem and how does work relate to kinetic energy? -What mathematical	-cite specific textual evidence to support analysis of technical text -integrate and evaluate multiple sources of information presented -gather relevant information to perform an experiment -Draw evidence from informational texts to support analysis -model with mathematics -use units to guide in multi step problem solving -represent data on a position and velocity time graph -apply algebra, trigonometry, and calculus to problem solving -use a dot product for a scalar quantity and a cross product for a vector quantity -apply conservation of energy as an alternate method of solving motion	Plan and carry out investigations: -produce data collaboratively -consider limitations -analyze data using technology and models -analyze data applying mathematics -apply scientific theory to solve problems -Identify and quantify the various types of energies within a system of objects in a well-defined state, such as elastic potential energy, gravitational potential energy, kinetic energy, and thermal energy and represent how these energies may change over time. -Calculate changes in kinetic energy and gravitational potential energy of a system using representations of that system. -Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy		WHST.11–12.1.a-Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. (11, 12)[State:Common Core State Standards (CCSS)] WHST.11–12.1.b-Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases. (11, 12)[State:Common Core State Standards (CCSS)] WHST.11–12.6-Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to

	model is needed to describe a changing force acting over a given distance? -What is a dot product and how does it apply to work? -Why does a non conservative force cause on object to lose mechanical energy? What happens to the lost mechanical energy? -What is conservation of mechanical energy? Total energy? -How can the conservation of energy be used to describe motion as an alternative approach to Newton's laws for 2 body motion? -What effect does adding springs in series or parallel have on their net force and energy? -How does time relate to energy?	problems -Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. -At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. -Momentum describes an object's motion. -Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. -A change in momentum takes force and time. That change over a longer time requires more force. -Stopping times and	associated with the motions of objects and energy associated with the relative positions of objects. -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 and energy flows in and out of the system are known. -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. -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. -Make qualitative predictions about natural phenomena based on conservation of momentum and restoration of kinetic energy in elastic collisions.		ongoing feedback, including new arguments or information. (11, 12) [State:Common Core State Standards (CCSS)] WHST.11–12.8-Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (11, 12) [State:Common Core State Standards (CCSS)] WHST.11–12.9-Draw evidence from informational texts to support analysis, reflection, and research. (11, 12)[State:Common Core State Standards (CCSS)] N.VM.1-(+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |

		distances depend on the impulse-momentum theorem. -Momentum is conserved in collisions and when objects are pushing away from each other. -If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. -Kinetic energy is not constant in inelastic collisions, but is conserved in elastic collisions. -Most collisions are neither elastic nor perfectly inelastic. -Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. -Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between			v|, ||v||, v). (09-12) [State:Common Core State Standards (CCSS)] N.VM.2-(+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. (09-12) [State:Common Core State Standards (CCSS)] N.VM.4.a-Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. (09-12)[State:Common Core State Standards (CCSS)] N.VM.4.b-Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. (09-12)[State:Common Core State Standards (CCSS)] N.VM.4.c-Understand vector subtraction v – w as v + (–w), where –w is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise. (09-12)

		systems. -Mathematical expressions, which quantify how the stored energy in a system depends on its configuration and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. -When two objects interacting through a field change relative position, the energy stored in the field is changed.			[State:Common Core State Standards (CCSS)] N.VM.5.a-Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$. (09-12)[State:Common Core State Standards (CCSS)] N.VM.5.b-Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when |c|v ≠ 0, the direction of cv is either along v (for c > 0) or against v (for c < 0). (09-12)[State:Common Core State Standards (CCSS)] HS.PS1.3.SEP.1-Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly . (HS-PS1-3) (09-12) [Regional:Next Generation Science Standards

					(NGSS)] HS.PS2.6.SEP.1-Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.4.CCC.1-Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.CNS.1-Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.CCC.1-The total amount of energy and matter in closed systems is conserved. (HS-PS1-7) (09-12) [Regional:Next Generation Science Standards (NGSS)]

					HS.PS2.1-Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.SEP.1-Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HSPS2-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.CNS.1-Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.DCI.PS2.A.1-Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.2.CCC.1-When

					investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2) (09-12)[Regional:Next Generation Science Standards (NGSS)] 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.* (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.A.1-Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even

					as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1),(HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.2- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.3- Energy cannot be created or destroy ed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.4- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass

					and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.5-The availability of energy limits what can occur in any system. (HS-PS3-1) (09-12)[Regional:Next Generation Science Standards (NGSS)] 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 position of particles (objects). (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.DCI.PS3.A.1-Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even

					as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1), (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.DCI.PS3.A.2-At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy . (HSPS3-2) (HS-PS3-3) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.DCI.PS3.A.3-These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields

					moves across space. (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.CCC.1-Energy cannot be created or destroy ed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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.* (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.DCI.PS3.A.1-A t the macroscopic scale, energy manifests itself in multiple way s, such as in motion, sound, light, and thermal energy . (HSPS3-2) (HS-PS3-3) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.DCI.PS3.D.2-Although energy cannot be destroy ed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment.

					(HS-PS3-3),(HS-PS3-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.CCC.1-Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HSPS3-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.CET.1-Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.4.DCI.PS3.B.1-Energy cannot be created or destroy ed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.4.DCI.PS3.B.2-

					Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.5.DCI.PS3.C.1-When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.2.DCI.PS2.A.1-Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-2) (09-12) [Regional:Next Generation Science Standards (NGSS)]

					HS.PS2.2.DCI.PS2.A.2-If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3) (09-12) [Regional:Next Generation Science Standards (NGSS)]
Plans:					

Title : Roxbury High School AP Physics
Type : Consensus

Duration: November/Week 9 - December/Week 13					
UNIT NAME: Planetary, circular, angular motion, and torque					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
determine patterns in data to provide evidence of phenomena -define boundaries of the system -use empirical evidence to differentiate between cause and correlation and make claims about cause and effect -relate angular motion to linear motion -Theories and laws provide explanations in science. -Laws are statements or descriptions of the relationships among observable phenomena.	-How does angular motion relate to kinematic equations? -How does the radius and period relate to objects in circular motion? -What is the direction of the centripetal and tangential acceleration of an object at any given point whether in constant motion or angularly accelerating? -How does the motion of a horizontal vs vertical circle differ? -What is the cross product and how is it applied to determine an objects angular motion? -How is conservation of angular momentum applied to objects in circular or elliptical orbits? -What is the effect of mass and distance in determining the net gravitational force and field experienced by an object?	-cite specific textual evidence to support analysis of technical text -integrate and evaluate multiple sources of information presented -gather relevant information to perform an experiment -Draw evidence from informational texts to support analysis -model with mathematics -use units to guide in multi step problem solving -represent data on a position and velocity time graph -apply algebra, trigonometry, and calculus to problem solving -apply angular motion equations and relate to linear motion -derive the "k" value for Kepler's law based on energy	Plan and carry out investigations: -produce data collaboratively -consider limitations -analyze data using technology and models -analyze data applying mathematics -apply scientific theory to solve problem -apply cross products and dot products		HS.PS1.4.CCC.1-Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.SEP.1-Use mathematical representations of phenomena to support claims. (HS-PS1-7) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.CNS.1-Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.CCC.1-The total amount of energy and matter in closed systems is conserved. (HS-PS1-7) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.1-Analyze data to support the claim that Newton's second law of

	-How can conservation of energy be used to determine escape velocity? -How does the net torque of an object effect its angular momentum and angular motion? -What is Kepler's laws of planetary motion and how does it relate to Newton's laws of gravitation? -How is the cross product used to predict the net torque on an object? -What is translational vs rotational motion? -What is a cross product and why can it be used instead of the right hand rule to predict the angular motion of an object given a force acting at a horizontal distance? -What is the cross product and how does it differ from a dot product? -What is the moment of inertia and how does it affect the angular motion of an object?	-relate Kepler's 2nd law of planetary motion with conservation of angular momentum			motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.SEP.1-Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HSPS2-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.CNS.1-Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.DCI.PS2.A.1-Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.2.SEP.1-Use mathematical representations of phenomena to describe explanations. (HS-PS2-2), (HS-PS2-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.2.CCC.1-When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.3.CCC.1-Systems can be designed to cause a desired effect. (HS-PS2-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation

					Science Standards (NGSS)] HS.PS2.4.DCI.PS2.B.1-Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.4.DCI.PS2.B.2-Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.5.SEP.1-Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on

					the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly . (HS-PS2-5) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.5.DCI.PS2.B.1-Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.CNS.1-Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.A.1-Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total

					energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1), (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.2- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.3- Energy cannot be created or destroy ed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.4- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic

					energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.DCI.PS3.A.1-Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1), (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.DCI.PS3.A.2-At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy . (HSPS3-2) (HS-PS3-3) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.DCI.PS3.A.3-

					These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.CCC.1-Energy cannot be created or destroy ed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.DCI.PS3.A.1-A t the macroscopic scale, energy manifests itself in multiple way s, such as in motion, sound, light, and

					thermal energy . (HSPS3-2) (HS-PS3-3) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.4.DCI.PS3.B.1- Energy cannot be created or destroy ed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.5.DCI.PS3.C.1- When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS4.2.CET.2- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HSPS4-2) (09-12) [Regional:Next Generation Science Standards (NGSS)]
Plans:					

Title : Roxbury High School AP Physics
Type : Consensus

Duration: December/Week 14 - December/Week 16					
UNIT NAME: Waves					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
determine patterns in data to provide evidence of phenomena -define boundaries of the system -use empirical evidence to differentiate between cause and correlation and make claims about cause and effect -relate a mass on spring to a pendulum mass system -Theories and laws provide explanations in science. -Laws are statements or descriptions of the relationships among observable phenomena.	-What is the difference between longitudinal and transverse waves? -How does the amplitude affect the energy of a wave? -How does the frequency, wavelength, and speed of a wave relate to one another? -What happens when two or more waves combine, or superimpose themselves on one another? -What is resonance? -How can a student apply calculus to determine the position, velocity, and acceleration of an object is simple harmonic motion? -What is damped harmonic motion vs. simple harmonic motion? -How can one use integration to determine the energy of a wave? -How can one predict the motion of a simple and	-cite specific textual evidence to support analysis of technical text -integrate and evaluate multiple sources of information presented -gather relevant information to perform an experiment -Draw evidence from informational texts to support analysis -model with mathematics -use units to guide in multi step problem solving -represent data on a position and velocity time graph -apply algebra, trigonometry, and calculus to problem solving -graph of motion of an object in time in simple harmonic motion -determine velocity, acceleration, and position from energy methods as well as calculus	Plan and carry out investigations: -produce data collaboratively -consider limitations -analyze data using technology and models -analyze data applying mathematics -apply scientific theory to solve problems -identify the conditions of simple harmonic motion. -Explain how force, velocity, and acceleration change as an object vibrates. -Calculate the spring force using Hooke's Law. -Interpret transverse and longitudinal waveforms. -Evaluate problems to solve for wave speed, frequency, and wavelength. -Relate energy and amplitude. -Differentiate between constructive and		HS.PS1.4.CCC.1-Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.SEP.1-Use mathematical representations of phenomena to support claims. (HS-PS1-7) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.CNS.1-Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.CCC.1-The total amount of energy and matter in closed systems is conserved. (HS-PS1-7) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.SEP.1-Analyze data using tools, technologies, and/or

	complex pendulum? -What is the appropriate mathematical expression of the wave in time? (y = Asinwt) -At what locations of the wave's motion does maximum velocity and acceleration take place on a mass in Simple Harmonic Motion?		destructive interference. -Identify nodes and antinodes of standing waves.		models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HSPS2-1) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.CNS.1-Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.CNS.2-Laws are statements or descriptions of the relationships among observ able phenomena. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.DCI.PS2.A.1-Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) (09-12)[Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.SEP.1-Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.A.1-Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1), (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.2-Conservation of energy means that the total change of energy in any system is always equal to

					the total energy transferred into or out of the system. (HS-PS3-1) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.3-Energy cannot be created or destroy ed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.4-Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.CCC.1-Energy cannot be created or destroy ed—only moves between one place and another place, between objects and/or fields, or

					between systems. (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.DCI.PS3.A.1-A t the macroscopic scale, energy manifests itself in multiple way s, such as in motion, sound, light, and thermal energy . (HSPS3-2) (HS-PS3-3) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.DCI.PS3.D.2-Although energy cannot be destroy ed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.CET.1-Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3) (09-12) [Regional:Next Generation Science Standards (NGSS)]

					HS.PS4.1-Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS4.1.DCI.PS4.A.1-The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS4.2-Evaluate questions about the advantages of using a digital transmission and storage of information. (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS4.2.DCI.PS4.A.1-Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2),(HSPS4-5) (09-12)

					[Regional:Next Generation Science Standards (NGSS)] HS.PS4.2.CET.1-Modern civilization depends on major technological sy stems. (HS-PS4-2), (HSPS4-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS4.2.CET.2-Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HSPS4-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS4.3.CNS.1-A scientific theory is a substantiated explanation of some aspect of the natural world, based on a

					body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HSPS4-3) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS4.3.DCI.PS4.A.1- [From the 3–5 grade band endpoints] Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary : The discussion at this grade level is qualitative only ; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS4.3.DCI.PS4.B.3- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a

					wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS4.3.CCC.1-Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions — including energy , matter, and information flows—within and between systems at different scales. (HS-PS4-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS4.4.DCI.PS4.B.1-When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-ray s, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4) (09-12)[Regional:Next Generation Science

					Standards (NGSS)] HS.PS4.5.DCI.PS4.A.2- Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2), HSPS4-5) (09-12) [Regional:Next Generation Science Standards (NGSS)]
Plans:					

Title : Roxbury High School AP Physics
Type : Consensus

Duration: January/Week 17 - February/Week 23					
UNIT NAME: Electricity and electical circuits					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
-determine patterns in data to provide evidence of phenomena -define boundaries of the system -use empirical evidence to differentiate between cause and correlation and make claims about cause and effect -Theories and laws provide explanations in science. -Laws are statements or descriptions of the relationships among observable phenomena.	-What causes a charge to be attracted or repelled to another charge? -What is the mathematical expression of Coulomb's law that can be applied to determine the net electric force between two or more objects in 1 dimension or 2 dimensions? -What is a polarized or induced charge? -How does the mass of a charged object affect the influence of Coulomb's law? -What is an electric field? -What is the force on a charged placed in an electric field and what is the direction of that force? -How do electric field lines emulate from a point charge? -How does the density of the electric field affect a charged object? -What is electric potential and why does it increase	-cite specific textual evidence to support analysis of technical text -integrate and evaluate multiple sources of information presented -gather relevant information to perform an experiment -Draw evidence from informational texts to support analysis -model with mathematics -use units to guide in multi step problem solving -represent data on a position and velocity time graph -apply algebra, trigonometry, and calculus to problem solving -relate springs in series and parallel to capacitors in series and parallel -derive Gauss' law	Plan and carry out investigations: -produce data collaboratively -consider limitations -analyze data using technology and models -analyze data applying mathematics -apply scientific theory to solve problems -Develop and use a model of two objects interacting through electric fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. -Use mathematical representations of Coulomb's Law to describe and predict the electrostatic forces between objects. -Make predictions about the sign and relative quantity of net charge of objects or systems after various charging processes. -Construct an explanation		HS.PS1.1.DCI.PS2.B.3-Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS1-1),(HS-PS1-3),(HSPS2-6) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.1.CCC.1-Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-1),(HS-PS1-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)]

	or decrease? -How much work is done on a charge to bring it from one location to another in an electric potential? -How can calculus be applied to determine the electric potential on a continuous line charge? -What is the appropriate Gaussian surface needed to calculate the electric field of a given continuous charge? -What is the relationship between flux, electric field, and the area in which it passes through? -What is a dielectric and how it is used in electrical components? -What is the net capacitance of a circuit in series or parallel? -What is charging an object by induction? -What is the relationship between capacitance, voltage, and charge? -How will the dimensions of a capacitor change its capacitance?		of a model of electric charge, and make a qualitative prediction about the distribution of positive and negative electric charges within neutral systems as they undergo various processes.		HS.PS1.3.SEP.1-Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly . (HS-PS1-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.3.DCI.PS1.A.1-The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3), (secondary to HS-PS2-6) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.3.DCI.PS2.B.2-Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS1-1),(HS-PS1-3), (HSPS2-6) (09-12) [Regional:Next Generation

	-What is a resistor and how would you calculate the net resistance of a circuit in series or parallel? -How does the length and cross section affect the resistance of a wire? -How can the loop rule and junction rule of Kirchoff's laws be applied circuits in series and parallel for multiple power sources? -What is the time constant of a resistor/capacitor circuit and how many time constants does it take to be considered fully charged?				Science Standards (NGSS)] HS.PS2.6.SEP.1- Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.6.DCI.PS1.A.1- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3), (secondary to HS-PS2-6) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.6.DCI.PS2.B.2- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS1-1),(HS-PS1-3), (HSPS2-6) (09-12) [Regional:Next Generation Science Standards (NGSS)]

					HS.PS1.4.CCC.1-Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.SEP.1-Use mathematical representations of phenomena to support claims. (HS-PS1-7) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.CNS.1-Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.CCC.1-The total amount of energy and matter in closed systems is conserved. (HS-PS1-7) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.1-Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

					(09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.CNS.1-Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.CNS.2-Laws are statements or descriptions of the relationships among observ able phenomena. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.DCI.PS2.A.1-Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.2.DCI.PS2.A.2-If a system interacts with objects outside itself, the

					total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.2.CCC.1-When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.3.DCI.PS2.A.1-If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.4.DCI.PS2.B.1- Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.4.DCI.PS2.B.2- Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.5.DCI.PS2.B.1- Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic

					fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.5.DCI.PS3.A.2-… and “electrical energy ” may mean energy stored in a battery or energy transmitted by electric currents. (secondary to HS-PS2-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.A.1-Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system’s total energy is conserved, even as, within the system,

					energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1), (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.2- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.3- Energy cannot be created or destroy ed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.4- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the

					concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.DCI.PS3.A.1-Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1), (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.DCI.PS3.A.2-At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy . (HSPS3-2) (HS-PS3-3) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.DCI.PS3.A.3-These relationships are better understood at the

					microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.CCC.1-Energy cannot be created or destroy ed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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.* (09-12)[Regional:Next

					Generation Science Standards (NGSS)] HS.PS3.3.SEP.1-Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HSPS3-3) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.DCI.PS3.A.1-At the macroscopic scale, energy manifests itself in multiple way s, such as in motion, sound, light, and thermal energy . (HSPS3-2) (HS-PS3-3) (09-12)[Regional:Next Generation Science Standards (NGSS)] 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.* (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.CET.1-Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and

					engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.5.DCI.PS3.C.1-When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5) (09-12) [Regional:Next Generation Science Standards (NGSS)]
Plans:					

Title : Roxbury High School AP Physics
Type : Consensus

Duration: February/Week 24 - April/Week 32					
UNIT NAME: Magnetism					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
-determine patterns in data to provide evidence of phenomena -define boundaries of the system -use empirical evidence to differentiate between cause and correlation and make claims about cause and effect -Theories and laws provide explanations in science. -Laws are statements or descriptions of the relationships among observable phenomena.	-What happens to a charged particle that enters a magnetic field? -How can the cross product be used to predict the magnetic field created by a moving point charge and a flowing current in a wire? -How can the cross product be used instead of the right hand rule to determine the direction of the magnetic force of a point charge or current moving in a magnetic field? -How can the mass of a charged object be determined in a mass spectrometer? -What is the magnitude and rotation direction of the torque produced on a current carrying rectangle in a magnetic field? -How can calculus be applied to determine the magnetic field near a continuous charge distribution?	-cite specific textual evidence to support analysis of technical text -integrate and evaluate multiple sources of information presented -gather relevant information to perform an experiment -Draw evidence from informational texts to support analysis -model with mathematics -use units to guide in multi step problem solving -represent data on a position and velocity time graph -apply algebra, trigonometry, and calculus to problem solving -Forces at a distance are explained by fields (electric and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or	Plan and carry out investigations: -produce data collaboratively -consider limitations -analyze data using technology and models -analyze data applying mathematics -apply scientific theory to solve problems -Develop and use a model of two objects interacting through magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. -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. -Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.		HS.PS1.1.DCI.PS2.B.3-Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS1-1),(HS-PS1-3),(HSPS2-6) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.3.SEP.1-Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly . (HS-PS1-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.3.DCI.PS1.A.1-The structure and interactions of matter at the bulk scale are

	-What is the force between two current carrying wires and will the force be attractive or repulsive? -What is self inductance? -How can you apply Kirchoff's laws to a simple LR series circuit? -What causes the current in the circuit to "take time" to reach maximum flow? -What is the energy stored in an inductor? -What is the graph of the current in time in a inductor/capacitor circuit? -What are Maxwell's equations?	changing magnetic fields cause electric fields. -Like magnetic poles repel each other, and opposite poles attract each other. -Solenoids produce a strong magnetic field by combining several loops or wire. -A charge moving through a magnetic field experiences a force. -Use the right-hand rule to find the direction of the magnetic force on a positive charge. -Generators produce electrical energy from mechanical energy by turning wire in a magnetic field. -Electric motors transform electrical energy into mechanical energy. -Transformers are used to change the voltage moving through wire.	-Predict whether magnets will attract or repel in certain situations. -Describe and diagram the magnetic field around a permanent bar magnet. -Describe the magnetic field produced by a current carrying straight wire and in a solenoid. -Describe how electric motors and generators work. -Explain how step up and step down transformers work and what they are used for.		determined by electrical forces within and between atoms. (HS-PS1-3), (secondary to HS-PS2-6) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.3.DCI.PS2.B.2- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS1-1),(HS-PS1-3), (HSPS2-6) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.6.SEP.1- Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.6.DCI.PS1.A.1- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between

					atoms. (HS-PS1-3), (secondary to HS-PS2-6) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.6.DCI.PS2.B.2-Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS1-1),(HS-PS1-3), (HSPS2-6) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.6.CCC.1-Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.2.SEP.1-Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' ow n investigations, models,

					theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-PS1-2) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.4.CCC.1-Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.6.DCI.ETS1.C.2-Criteria may need to be broken down into simpler ones that can be approached systematically , and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS1-6) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.SEP.1-Use mathematical representations of phenomena to support claims. (HS-PS1-7) (09-12) [Regional:Next Generation

					Science Standards (NGSS)] Scientific Knowledge Assumes an Order and Consistency in Natural Systems (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.7.CCC.1-The total amount of energy and matter in closed systems is conserved. (HS-PS1-7) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.1-Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.SEP.1-Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HSPS2-1) (09-12) [Regional:Next Generation Science Standards (NGSS)]

					HS.PS2.1.CNS.1-Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.CNS.2-Laws are statements or descriptions of the relationships among observ able phenomena. (HS-PS2-1),(HS-PS2-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.1.DCI.PS2.A.1-Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.2.DCI.PS2.A.2-If a system interacts with objects outside itself, the total momentum of the system can change; however, any such

					change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.2.CCC.1-When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.3.SEP.1-Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.3.DCI.PS2.A.1-If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.4.DCI.PS2.B.2-Forces at a distance are

					explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.5.SEP.1-Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly . (HS-PS2-5) (09-12)

					[Regional:Next Generation Science Standards (NGSS)] HS.PS2.5.DCI.PS2.B.1-Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.5.DCI.PS3.A.2-… and “electrical energy ” may mean energy stored in a battery or energy transmitted by electric currents. (secondary to HS-PS2-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)]

					HS.PS3.1.DCI.PS3.A.1- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1), (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.2- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.1.DCI.PS3.B.3- Energy cannot be created or destroy ed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) (09-12) [Regional:Next Generation Science Standards

					(NGSS)] HS.PS3.1.DCI.PS3.B.4- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.DCI.PS3.A.1- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1), (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.DCI.PS3.A.3-

					These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.2.CCC.1-Energy cannot be created or destroy ed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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.* (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.DCI.PS3.A.1-A t the macroscopic scale, energy manifests itself in multiple way s, such as in motion, sound, light, and thermal energy . (HSPS3-2) (HS-PS3-3) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.DCI.PS3.D.2-Although energy cannot be destroy ed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.3.CCC.1-Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HSPS3-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.4.DCI.PS3.B.1-Energy cannot be created or destroy ed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-

					PS3-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.4.DCI.PS3.B.2-Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.4.DCI.PS3.D.3-Although energy cannot be destroy ed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4) (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS3.4.CCC.1-When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS3.5.DCI.PS3.C.1- When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS4.1-Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS4.2.DCI.PS4.A.1- Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2),(HSPS4-5) (09-12)

					[Regional:Next Generation Science Standards (NGSS)] HS.PS4.2.CET.1-Modern civilization depends on major technological sy stems. (HS-PS4-2), (HSPS4-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS4.3.DCI.PS4.A.1-[From the 3–5 grade band endpoints] Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary : The discussion at this grade level is qualitative only ; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-

					PS4-3) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS4.3.DCI.PS4.B.3-Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3) (09-12) [Regional:Next Generation Science Standards (NGSS)]
Plans:					

Title : Roxbury High School AP Physics
Type : Consensus

Duration: May/Week 33 - May/Week 34					
UNIT NAME: Review for Exam					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
Plans:					