Title	**Roxbury High School Introduction to Chemistry & Physics**
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Notes	
Attachments	

Title : Roxbury High School Introduction to Chemistry & Physics
Type : Consensus

	September				October				November				December				January				February				March				April				May				June			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

September/Week 1 - October/Week 6

1C Phases of Matter

September/Week 1 - October/Week 6

1P Forces and Motion

October/Week 7 - December/Week 13

2C - Atomic Structure and Bonding

October/Week 7 - December/Week 13

2P Types of Interactions

December/Week 14 - January/Week 20

3C - Chemical Reactions

December/Week 14 - January/Week 20

3P Energy

February/Week 21 - March/Week 26

4C - Atomic Structure and Electrons

February/Week 21 - March/Week 26

4P Waves and Applications

March/Week 27 - April/Week 32

5C - Solutions

March/Week 27 - April/Week 32

5P Electricity and Magnetism

May/Week 33 - June/Week 38

6 C/P Nuclear Chemistry

Title : Roxbury High School Introduction to Chemistry & Physics
Type : Consensus

Duration: September/Week 1 - October/Week 6					
UNIT NAME: 1C Phases of Matter					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
Patterns 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. **Change** Much of science deals with constructing explanations of how things change and how they remain stable.	• What is Chemistry? • How did chemistry begin? • How do I use the scientific method? • What safety precautions should be allowed in the lab? • What are the tools in the lab that I am expected to use and how do I use them? • What are the types of matter and how can they be represented visually? • What is the difference between a chemical and a physical change? • How do I know what tools to use to separate a given mixture? • What are the different phases of matter and how can they be visualized?	• Chemistry is the study of matter and its changes. • Matter is anything that takes up space and has a mass. Physical non-matter interacts with matter and causes changes. • The scientific method is based on observation hypothesis data analysis and conclusions. • Laboratory safety should include goggles, gloves and aprons, no eating in lab, no horseplay in lab, hair tied back to prevent hazards. All waste should be disposed of properly with instruction of teacher. • Use aspects of particulate models (i.e., particle spacing, motion, and forces of attraction) to reason about observed differences between solid, liquid and gas phases of certain materials.	**Private Investigation** Students will research and develop concepts addressed in the course. **Develop Hypothesis** Students will be able to develop their own hypothesis, **Developing and Using Models** Students use, synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. • Use a model to predict the relationships between systems or between components of a system.) **Investigate** • 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,		PS1.A-Structure and Properties of Matter (09-12)[Regional:Next Generation Science Standards (NGSS)] PS2.B-Types of Interactions (09-12) [Regional:Next Generation Science Standards (NGSS)] PS1.C-Nuclear Processes (09-12)[Regional:Next Generation Science Standards (NGSS)] 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.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)]

		• Plan and conduct an investigation to gather evidence to compare the structure of substance at bulk scale to infer the strength of electrical forces between particulates. • Separation techniques such as filtration, evaporation, extraction, and chromatography.	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. **Planning and Carrying Out Investigations** Students plan investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. **Analyzing and Interpreting Data** • Analyze data using a model (Periodic table) in order to make a valid scientific claim. **Constructing Explanations and Designing Solutions** Students Construct explanations and design solutions that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.		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.PS1.1-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. (09-12)[Regional:Next Generation Science Standards (NGSS)] Patterns (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)

			• Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own 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. •		[Regional:Next Generation Science Standards (NGSS)]

Plans:

Title : Roxbury High School Introduction to Chemistry & Physics
Type : Consensus

Duration: September/Week 1 - October/Week 6					
UNIT NAME: 1P Forces and Motion					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
Speed verse Velocity Given a graph of position or velocity as a function of time, recognize in what time intervals the position, velocity and acceleration of an object are positive, negative, or zero and sketch a graph of each quantity as a function of time. ***Vectors*** Represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. ***Acceleration*** Understand and apply the relationship between the net force exerted on an object, its inertial mass, and its acceleration to a variety of situations. ***Kinetic Theory*** Analyze data to support	What is the relationship between speed and velocity with respect distance verse time? How does the graph of velocity differ from a graph of speed What is a vector? What are the component units of a vectors? What is the definition of acceleration? What are the similarities and difference between acceleration and deceleration? How can acceleration be related to vectors? What is the relationship linking Motion (Kinetic Energy) mass and acceleration?	Similarities and differences in definitions of Speed, Velocity and Acceleration Graphical analysis, correlation and trends of speed, velocity and acceleration Vector and Vector component Identification Acceleration determined as a : a. mathematical calculation b. vector Kinetic theory and a motion of a body a. Force verse mass (fixed acceleration) b. Force verse acceleration (fixed mass)	**Planning and Carrying out Investigations** Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • 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 **Analyzing and Interpreting Data** Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use		PS2.A-Forces and Motion (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.PS2.2-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)] PS2.A-Forces and Motion (09-12)[Regional:Next Generation Science Standards (NGSS)]

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. ***Conservation of Momentum*** 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. ***Collisions*** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	Why /how is momentum conserved is system? What is a collision? Explain/identify the forces affecting a body during a collision	Conservation of Momentum Collisions and the relationship to Kinetic Theory	of models to generate and analyze data. • 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. **PS2.A: Forces and Motion** • Newton's second law accurately predicts changes in the motion of macroscopic objects. • Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. • 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. **ETS1.A: Defining and Delimiting an Engineering Problem** • Criteria and constraints also include satisfying any requirements set by		

• Systems can be designed to cause a desired effect. **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. **Connections to Nature of Science** Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena • Theories and laws provide explanations in science. • Laws are statements or descriptions of the relationships			society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9– 12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.		

			• Use mathematical representations of phenomena to describe explanations. **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects.		
Plans:					

Title : Roxbury High School Introduction to Chemistry & Physics
Type : Consensus

Duration: October/Week 7 - December/Week 13					
UNIT NAME: 2C - Atomic Structure and Bonding					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
Patterns 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. **Model Systems** Theories are developed off of visual models. Interpretation of visual models incorporate many levels to describe both the macroscopic and microscopic world. **Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. **Nature of Science** Science assumes the universe is a vast single system in which basic laws are consistent.	• What is an atom? • What is the structure of the atom and what does it tell us? • What are the particles of an atom and what do each contribute to the overall structure of the atom. • How do we know what an atom looks like? • How do atomic structures differ? • Do we really know all the subatomic particles? • What is a model and how do we use them to learn? • What is the atomic theory? • How and why was atomic theory developed? • What are the atomic theories flaws? • What can we learn from flaws in theories and models?	• Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. • The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. • The repeating patterns of this table reflect patterns of outer electron states. • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. • The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.	**Developing and Using Models -** Students use, synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. • Use a model to predict the relationships between systems or between components of a system. **Planning and Carrying Out Investigations -** • Students plan investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • 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		HS-PS TOPIC: Structure and Properties of Matter (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS1.1.DCI.PS1.A.1-Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (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)] DCI-Disciplinary Core Ideas (09-12) [Regional:Next Generation Science Standards (NGSS)] PS1.A-Structure and Properties of Matter (09-12)[Regional:Next Generation Science Standards (NGSS)]

			trials, cost, risk, time), and refine the design accordingly.) **Analyzing and Interpreting Data -** • Analyze data using a model (Periodic table) in order to make a valid scientific claim. **Constructing Explanations and Designing Solutions** • Students construct explanations and design solutions that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own 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.PS1.3.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)]
Plans:					

Title : Roxbury High School Introduction to Chemistry & Physics
Type : Consensus

Duration: October/Week 7 - December/Week 13					
UNIT NAME: 2P Types of Interactions					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
Gravitational Forces Calculate the gravitational force two objects exert on each other in a uniform field. **Newton's Law of Gravitational Forces** Use mathematical representations of Newton's Law of Gravitation to describe and predict the gravitational forces between objects. **Contact Forces** Explain contact forces (tension, friction, normal) as arising from inter-atomic electric forces and their certain directions. **Material Design** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. **Patterns** • Different patterns may be	Determine/calculate the gravitational forces between 2 bodies of mass How can Newton's law of gravitation be used to predict and calculate the gravitational forces between bodies of mass? How contact forces (tensions, friction, normal) created by inter-molecular forces?	Gravity exists between bodies of mass Predict and Calculate the gravitational force between bodies of mass Inter-molecular forces create the forces of a. tension b. friction c. normal Materials can be created and designed based on molecular composition and structure	**Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.		PS2.B-Types of Interactions (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)] PS1.A-Structure and Properties of Matter (09-12)[Regional:Next Generation Science Standards (NGSS)] HS.PS2.6-Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* (09-12) [Regional:Next Generation Science Standards (NGSS)]

observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. **Structure and Function** • 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. **Scale, Proportion, and Quantity**			• 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). **PS2.A: Forces and Motion** • Newton's second law accurately predicts changes in the motion of macroscopic objects. **PS1.A: Structure and Properties of Matter** • Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. **PS2.B: Types of Interactions** • Newton's law of universal gravitation and Coulomb's law provide the		

• Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs.exponential growth). **Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. • Laws are statements or descriptions of the relationships among observable phenomena.			mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. • 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. • 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.		
Plans:					

Duration: December/Week 14 - January/Week 20					
UNIT NAME: 3C - Chemical Reactions					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
Patterns • 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. **Energy and Matter** • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. • The total amount of energy and matter in closed systems is conserved. • 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. **Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable.	• How do elements combine to make everything in the universe? • What is the law of conservation of mass? • What are the 5 major types of reactions and how can you figure out what type they are? • How do you balance a chemical reaction?	**Structure and Properties of Matter** • An atom's electron configuration, particularly the outermost electrons, determines how the atom can interact with other atoms. Atoms form bonds to other atoms by transferring or sharing electrons. • A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. **Chemical Reactions** • Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.	**Unit Skills** • Write a balanced chemical equation that symbolically represents the description of a chemical reaction and classify it as a synthesis, decomposition, single replacement or double replacement. • Construct an explanation for products of a chemical reaction based on the valence electrons, atomic trends, and chemical properties. • Students will be able to express the conservation of mass qualitatively using correct chemical symbology.		PS1.B-Chemical Reactions (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS1.2.DCI.PS1.B.2-The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7) (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.PS1.B.1-In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6) (09-12)[Regional:Next

• Science assumes the universe is a vast single system in which basic laws are consistent.		• In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. ◦ The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. ◦ Chemical processes and properties of materials underlie many important biological and geophysical phenomena.	• Use mathematics representation s to support atoms, and therefore mass are conserved during a chemical reaction. Determine the mass of reactants required to produce the desired mass of a given reaction. **Developing and Using Models** Students synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. • Use a model to predict the relationships between systems or between components of a system. **Planning and Carrying Out Investigations** Students planning and carrying out investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.		Generation Science Standards (NGSS)] HS.PS1.7-Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. (09-12) [Regional:Next Generation Science Standards (NGSS)]

			• 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. **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to support claims. **Constructing Explanations and Designing Solutions**		

			Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.		

			• Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own 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. • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.		
Plans:					

Title : Roxbury High School Introduction to Chemistry & Physics
Type : Consensus

Duration: December/Week 14 - January/Week 20					
UNIT NAME: 3P Energy					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
Types of Energy 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. ***Kinetic Energy/ Potential Energy*** Calculate changes in kinetic energy and gravitational potential energy of a system using representations of that system. ***Thermodynamics*** Construct an explanation, using atomic-scale interactions and probability, of how a closed system approaches thermal equilibrium when after energy is transferred to it or from it in a thermal process.	What are the 4 types of energy of a body/system? What are the differences in the types of energy of a body/system ? What is the formula to determine/calculate Kinetic Energy? What is the formula to determine/calculate Potential Energy? How is energy transferred between bodies in a closed system? How does and what signs can be identified that a closed system has achieved an equilibrium during heat transfer ? What is the relationship between the potential energy and kinetic energy of a system?	Identify, define and explain a. Potential Energy 1. Gravitational 2. Elastic b. Kinetic Energy c. Thermal (heat) Energy Calculate and determine a. Kinetic Energy b. Potential Energy Identify and explain the flow of heat between bodies in a closed system	**Developing and Using Models** Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide		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.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)] PS2.B-Types of Interactions (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

Kinetic verse Potential Energy 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). ***Conservation of Energy*** 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. **Cause and Effect** • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. **Systems and System**	How is energy transferred between potential energy and kinetic energy in a closed system? How is energy conserved in closed system? What is the relationship of potential and kinetic energy to the total energy of a closed system?		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. **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9– 12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Create a computational model or simulation of a phenomenon, designed device, process, or system. **Constructing**		current. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.6-Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* (09-12) [Regional:Next Generation Science Standards (NGSS)]

Models • 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. • 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. **Energy and Matter** • 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. • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. **Connections to Engineering, Technology,**			**Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas,principles, and theories. • 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. **PS3.A: Definitions of Energy** • 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		

and Applications of Science **Influence of Science, Engineering and Technology on Society and the Natural World** • 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. **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes the universe is a vast single system in which basic laws are consistent.			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. • 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. **PS3.B: Conservation of Energy and Energy Transfer** • 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 systems. • 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. • The availability of energy limits what can occur in any system. **PS3.C: Relationship Between Energy and Forces** • When two objects interacting through a field change relative position, the energy stored in		

			the field is changed. **ETS1.A: Defining and Delimiting an Engineering Problem** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.		
Plans:					

Title : Roxbury High School Introduction to Chemistry & Physics
Type : Consensus

Duration: February/Week 21 - March/Week 26					
UNIT NAME: 4C - Atomic Structure and Electrons					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
Patterns • 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. **Energy and Matter** • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. • The total amount of energy and matter in closed systems is conserved. • 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. **Structure and Function** Investigating or designing new systems or structures requires a detailed examination of the properties of different	What is light? · Would we have light on earth if there weren't a sun? · What are Electromagnetic Waves? · Do atoms have colors? · How do materials have different colors? · What are electrons? · Where do electrons reside around the atom? · Does an atom's energy depend on where the electrons are in an atom? · What is a quantum? · What is an energy level? · What is a quantum number? · What is an electron configuration? · How do electron configurations change and what makes one electron configuration better than another? · What are valence electrons? · What is a Lewis Dot Diagram and what does it tell us for an atom?	**Energy and Waves** • Light is a form of energy • Electromagnetic waves are a combination of magnetic and electric waves. • The electromagnetic spectrum is all types light waves with different frequencies and wavelengths. • Wavelength is the length of the wave from peak to peak. • Frequency is the amount of waves in a second. • Wavelength and frequency of light are related to each other inversely and can be calculated if a variable is given. **Structure and Properties of Matter**	**Unit Skills** • Students will be able to determine the frequency, wavelength or speed of a wave with a given formula. • Students will be able to design an experiment to find the speed of waves, and explain the phenomenon of mechanical waves vs. light waves. • Students will evaluate the idea that electromagnetic radiation can be described as both a wave and a particle, and the models can be used for application • Evaluate the claims that different frequencies of EM radiation can be absorbed by matter and cause changes. **Developing and Using Models**		PS3.A-Definitions of Energy (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

materials, the structure of different materials, the structures of different components, and connections of components to reveal its function or solve a problem. **Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable. **Nature of Science** • Science assumes the universe is a vast single system in which basic laws are consistent.		• An atom's electron configuration, particularly the outermost electrons, determines how the atom can interact with other atoms. Atoms form bonds to other atoms by transferring or sharing electrons. • A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. **Definition of Energy** • 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. • "Chemical energy" generally is used to mean the energy that can be released or stored in chemical processes.	• Students synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. • Use a model to predict the relationships between systems or between components of a system. **Constructing Explanations and Designing Solutions**		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.PS3.4.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-PS3-4) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS4.1.SEP.1-Use mathematical representations of phenomena or design solutions to describe and/ or support claims and/or explanations. (HS-PS4-1)

			• Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.		(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.PS4.5.DCI.PS4.B.3- Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5) (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS4.5.DCI.PS3.D.1- Solar cells are human-made devices that likewise capture the sun’s energy and produce electrical energy. (secondary to HS-PS4-5) (09-12)[Regional:Next Generation Science Standards (NGSS)]

			• Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own 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. • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.		
Plans:					

Title : Roxbury High School Introduction to Chemistry & Physics
Type : Consensus

Duration: February/Week 21 - March/Week 26					
UNIT NAME: 4P Waves and Applications					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
Wave Mechanics Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. **Electromagnetic Spectrum (Light)** Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. **Wave / Particle Mechanics** Distinguish between models of radiant energy, and use the scale of the problem to determine at what regimes a particle or wave model is more appropriate Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by	What are the components of a wave? What are the different forms/types of light? How is the type of light related/determined by the wavelength an frequency observed? How does light/energy move as a a. wave b. particle Based on the light being emitted, which property of light is more useful for transmission?	Properties of a wave a. wavelength b. frequency c. speed in a medium The type of light in electromagnetic spectrum is determined by a. frequency b. wavelength Light has a dual property of wave and particle behavior. The transmission/ emission of data is related to the type/property of light	**Asking Questions and Defining Problems** Asking questions and defining problems in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. • Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to		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.PS4.4-Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. (09-12)[Regional:Next Generation Science Standards (NGSS)] PS4.B-Electromagnetic Radiation (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)

a wave model or a particle model, and that for some situations one model is more useful than the other. **Analog Data Transfer** 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. **Digital Data Transfer** Evaluate questions about the advantages of using a digital transmission and storage of information. **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale			analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena or design solutions to describe and/ or support claims and/or explanations. **Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science. • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of		[Regional:Next Generation Science Standards (NGSS)] 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.* (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)]

mechanisms within the system. • Systems can be designed to cause a desired effect. **Systems and System Models** • 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. **Stability and Change** • Systems can be designed for greater or lesser stability. **Energy and Matter** • Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems **Interdependence of Science, Engineering, and Technology** • Science and engineering			arguments. **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. • Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions		

complement each other in the cycle known as research and development (R&D). **Influence of Engineering, Technology, and Science on Society and the Natural World** • 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. **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.			in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, 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. **PS3.D: Energy in Chemical Processes** • Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. **PS4.A: Wave Properties** • The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on		

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena • 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. **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. • Science assumes the universe is a vast single system in which basic laws are consistent.			the type of wave and the medium through which it is passing. • 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. • 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. **PS4.B: Electromagnetic Radiation** • 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.		

			• 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-rays, gamma rays) can ionize atoms and cause damage to living cells. • Photoelectric materials emit electrons when they absorb light of a high-enough frequency. **PS4.C: Information Technologies and Instrumentation** • Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.		

			PS4.B: Electromagnetic Radiation • Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities.		
Plans:					

Title : Roxbury High School Introduction to Chemistry & Physics
Type : Consensus

Duration: March/Week 27 - April/Week 32					
UNIT NAME: 5C - Solutions					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
Patterns • 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. **Energy and Matter** • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. • The total amount of energy and matter in closed systems is conserved. • 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. **Stability and Change**	• What is a solution? • What is the difference between a dilute, a saturated, and a supersaturated solution? • What is a solvent/ solute? • How do I dilute a solution? • Can I make a solution with a given amount of solute? • How do I calculate molarity/molality?	• A solution is composed of a solute and solvent in a homogenous liquid mixture. • A solute is what is dissolved inside of a solution. • A solvent is what is doing the dissolving of the solute. • Molarity is the amount of moles of a solute per liter of solution. • Molality is the amount of moles of a solute per kg of solvent. • Using Specific solvents, we measure with volumetric flasks and pipets. • A dilute solution contains less solute than maximum dissolved in a given amount of solvent. • A saturated solution contains max solute dissolved in a given amount of solvent. • A supersaturated solution contains more than the max amount of solute than dissolved in a given amount of solvent.	**Developing and Using Models** • Students synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. • Use a model to predict the relationships between systems or between components of a system. **Planning and Carrying Out Investigations** Students planning and carrying out investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.		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.PS1.5-Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. (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

• Much of science deals with constructing explanations of how things change and how they remain stable. **Nature of Science** • Science assumes the universe is a vast single system in which basic laws are consistent.		• Dilutions are carried out using volume and molarity correlation formulas.	• 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. **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.		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.PS1.7.SEP.1-Use mathematical representations of phenomena to support claims. (HS-PS1-7) (09-12) [Regional:Next Generation Science Standards (NGSS)] Using Mathematics and Computational Thinking (09-12)[Regional:Next Generation Science Standards (NGSS)] SEP-Science and Engineering Practices (09-12)[Regional:Next Generation Science Standards (NGSS)]

			• Use mathematical representations of phenomena to support claims. **Constructing Explanations and Designing Solutions** • Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.		
Plans:					

Duration: March/Week 27 - April/Week 32					
UNIT NAME: 5P Electricity and Magnetism					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
Electric/Magnetic Fields 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 **Coulomb's Law** Use mathematical representations of Coulomb's Law to describe and predict the electrostatic forces between objects. **Net Charge** Make predictions about the sign and relative quantity of net charge of objects or systems after various charging processes. **Electrical Charge** Construct an explanation of a model of electric charge, and make a qualitative prediction about the distribution of positive and negative electric charges within neutral	What is the difference between an electrical field and magnetic field? How are electrical field and magnetic fields similar? What is Coulomb's law? How can Coulomb's law be used to calculate and predict electrostatic forces between bodies? How does the mathematical sign of solution of Coulomb's law determine the type of electrostatic force? How can a model of the distribution of positive and negative charge demonstrate the net charge of a body? How can a moving electrical current produce a magnet?	Magnetic and electrical fields are created/exist between 2 bodies Coulomb's law can be used to calculate an electrostatic force between bodies The mathematical sign the calculation of Coulomb's law determines a. force of Attraction b. force of repulsion The location and distribution of charges determines the net charge of body Moving magnetic fields create electric currents Moving electrical currents create magnetic fields	**Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. • 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. **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9–12 level builds on K–		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.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)] PS2.B-Types of Interactions (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

systems as they undergo various processes **Electricity/Magnetism** 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 **Material Design** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials **Patterns** • 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. **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	How can a moving magnetic force produce an electric current?		8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs • 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).		current. (09-12) [Regional:Next Generation Science Standards (NGSS)] HS.PS2.6-Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* (09-12) [Regional:Next Generation Science Standards (NGSS)]

• Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. **Structure and Function** • 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. **Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. • Laws are statements or descriptions of the relationships among observable phenomena.			**Developing and Using Models** Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. **PS2.B: Types of Interactions** • 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. • 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. • 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. **PS3.A: Definitions of Energy** • "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. **PS3.C: Relationship Between Energy and Forces** • When two objects interacting through a field change relative position, the energy stored in the field is changed		
Plans:					

Title : Roxbury High School Introduction to Chemistry & Physics
Type : Consensus

Duration: May/Week 33 - June/Week 38					
UNIT NAME: 6 C/P Nuclear Chemistry					
Enduring Understandings	**Essential Questions**	**Knowledge**	**Skills**	**Assessment**	**Standards**
Energy and Matter In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. **Energy and Matter** Energy drives the cycling of matter within and between systems. ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** Science and engineering complement each other in the cycle known as research and development. Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **Stability and Change** • Change and rates of change can be quantified and	• What are the 4 fundamental forces? • What are the nuclear forces and how do they work? • What is the difference between a nuclear reaction and a chemical reaction? • What are the different types of decay? • What are the different types of decay particles? • How does mass change after each type of decay? • What is a half life and how is it calculated? • How do nuclear power plants work and how are they regulated? • What is nuclear fall out?	***Nuclear Forces*** Explain, using evidence, the very strong force holding the protons and neutrons of an atomic nucleus together. ***Nuclear Reaction Mechanism*** Compare and contrast chemical and nuclear reactions. ***Parent Daughter Isotope Structure*** Model the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. ***Half Life*** Construct representations, at the particle level and graphically, of the changes that occur in a given radioactive sample ***Nuclear Power*** Explain the energy	**Developing and Using Models** Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence,		PS1.C-Nuclear Processes (09-12)[Regional:Next Generation Science Standards (NGSS)] PS1.B-Chemical Reactions (09-12) [Regional:Next Generation Science Standards (NGSS)] 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. (09-12) [Regional:Next Generation Science Standards (NGSS)]

modeled over very short or very long periods of time. Some system changes are irreversible. **Influence of Science, Engineering, and Technology on Society and the Natural World** • Modern civilization depends on major technological systems. **Connections of Nature of Science** • Science is a result of human endeavors, imagination, and creativity		transformations and transfers occurring in a nuclear power plant.	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. **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9– 12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Create a computational model or simulation of a phenomenon, designed device, process, or system.		

			Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas,principles, and theories. • 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. • 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. **ETS1.A: Defining and Delimiting an Engineering Problem** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.		
Plans:					