Passaic County Technical Institute

Wayne, NJ

Honor Chemistry Curriculum

August 2015

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I. Course Description

Chemistry Honors is a full year study designed primarily as a preparation course for college. It is a body of systematized knowledge gained from observation, study and experimentation. By studying chemistry you will be able to understand the nature of the materials around you and the changes they undergo. An appreciation of how chemistry is related to the other physical sciences such as physics and mathematics will be explored. Students will be made aware of how science is part of your everyday life, as well as understand how people of various cultures have contributed to the advancement of science and technology.
Students of honors chemistry will study the historical theories concerning the makeup of matter, the periodicity of the elements, concepts of chemical bonding, and how and why compounds form. The correct use of laboratory equipment will be learned, and laboratory experiments will complement each major area of study.

II. Course Objective/Outlin

Content Area:	**Chemistry Honors**	Grade(s)	10-11
Unit Plan Title:	Structure and Properties of Matter.	Time Frame:	13 Weeks

Learning Objectives

- Provide evidence that the number of protons determine an element, and that neutrons and electrons do not. (PS1.A; PS1.C; & PS2.B)
- Explain how the patterns of outermost (valence) electrons justify the organization of the periodic table and how these patterns influence the number and types of bonds formed by an element and between elements. (PS1.A)
- Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. (HS-PS1-1)
- 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. (PS1.A)
- Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. (HS-PS1-3)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (pp. 56-59, NRC, 2012) 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. (SLO 1, 2) Use a model to predict the relationships between systems or between components of a system. (SLO 1, 2, & 5) **Planning and Carrying Out Investigations** (pp. 59-61, NRC, 2012) 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 trials, cost, risk, time), and refine the design accordingly. (SLO 7) **Analyzing and Interpreting Data** (pp. 61-63) Analyze data using a model (Periodic table) in order to make a valid scientific claim. (SLO 4) **Constructing Explanations and Designing Solutions** (pp. 67-71, NRC, 2012) 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.	**PS1.A: Structure and Properties of Matter** (pp. 106-109, NRC, 2012) • Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (SLO 1) 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. (SLO 4, 5 & 6) • The repeating patterns of this table reflect patterns of outer electron states. (SLO 4, 5 & 6) • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (SLO 1, 3 & 7) **PS1.B: Chemical Reactions** (pp. 109-111, NRC, 2012) • 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. (SLO 6) **PS1.C: Nuclear Processes** (pp. 111-113, NRC, 2012) • Strong and weak nuclear interactions determine nuclear stability and processes. (SLO 2) **PS2.B: Types of Interactions** (pp. 116-118, NRC, 2012) Attraction and repulsion between electric charges at the atomic scale explain the structure,	**Patterns** (pp. 85-87, NRC, 2012) • 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. **Stability and Change** (pp. 56-59, NRC, 2012) • Much of science deals with constructing explanations of how things change and how they remain stable. ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** (pp. 96-101, NGSS Appendix H, NRC, 2013) Science assumes the universe is a vast single system in which basic laws are consistent.

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. (SLO 3, 6)	properties, and transformations of matter. (SLO 2, 5 & 7)	

Common Core

- **Common Core Writing Standards:**

WHST.9-12.2, **WHST.9-12.5, WHST.9-12.7,** WHST.9-12.9WHST.11-12.8,

- **Common Core Reading Standards:**

RST.9-10.7, RST.11-12.1, RST.11-12.7, RST.11-12.8

- **Mathematics**

  HSN-Q.A.1, HSN-Q.A.3

Content Area:	**Chemistry Honors**		Grade(s)	10-11
Unit Plan Title:	Conservation of Matter	Time Frame:	12Weeks	

Learning Objectives

- Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. (HS-PS1-2)
- Write a balanced chemical equation that symbolically represents the description of a chemical reaction and classify it as synthesis, decomposition, single replacement or double replacement. (PS1.B)
- Express the law of conservation of mass qualitatively using symbolic representations and drawings. (PS1.B)
- Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Determine the mass of reactants required to produce the desired mass of product for a given reaction. (HS-PS1-7)
- Connect the number of particles, moles, mass, and volume of substances to one another, both qualitatively and quantitatively. (PS1.A)
- Describe and give analogies of dynamic equilibrium where changes are always occurring, but overall numbers remain constant. (PS1.B)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts

Developing and Using Models (pp. 56-59, NRC, 2012) 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. (SLO 1, 4, & 5) • Use a model to predict the relationships between systems or between components of a system. (SLO 1, 2, 4, & 5) **Planning and Carrying Out Investigations** (pp59-61, NRC, 2012) Students planning and carrying out 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. (SLO 6) **Using Mathematics and Computational Thinking** (pp. 64-67, NRC, 2012) 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	**PS1.A: Structure and Properties of Matter** (pp. 106-109, NRC, 2012) • 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. (SLO 2) • 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. (SLO 4) **PS1.B: Chemical Reactions** (pp. 109-111, NRC, 2012) • 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. (SLO 1, 3, & 5) • 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. (SLO 6) • 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. (SLO 1, 2, & 3) • Chemical processes and properties of materials underlie many important biological and geophysical phenomena. (SLO 6) **PS3.A: Definition of Energy** (pp. 120-124, NRC, 2012)	**Patterns** (pp. 85-87, NRC, 2012) • 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** (pp. 94-96, NRC, 2012) • 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** (pp. 98-101, NRC, 2012) • Much of science deals with constructing explanations of how things change and how they remain stable. ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** (pp. 96-101, NGSS Appendix H, NRC, 2013) Science assumes the universe is a vast single system in which basic laws are consistent.

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. (SLO 3) **Constructing Explanations and Designing Solutions** (pp. 67-71, NRC, 2012) 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. (SLO 6) • 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. (SLO 5) Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (SLO 6)	• 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. (SLO 4) • "Chemical energy" generally is used to mean the energy that can be released or stored in chemical processes. (SLO 4) **PS3.D: Energy in Chemical Processes** (pp. 128-130, NRC, 2012) • Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (SLO 4) **ETS1.B: Developing Possible Solutions** (pp. 206-208, NRC, 2012) • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (SLO 6) **ETS1.C: Optimizing the Design Solution** (pp. 208-210, NRC, 2012) 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 (trade-offs) may be needed. (SLO 6)	

Common Core
• **Common Core Writing Standards:** WHST.9-12.2, **WHST.9-12.5, WHST.9-12.7** • **Common Core Reading Standards:** RST.9-10.7, RST.11-12.1 • **Mathematics** HSN-Q.A.1, HSN-Q.A.3, MP.2, MP.4

Content Area:	**Chemistry Honors**		Grade(s)	10-11
Unit Plan Title	Reaction Rates and Chemical Equilibrium	Time Frame:	10 weeks	

Learning Objectives

- Explain that the amount of energy per bond depends on the strength of the bond, and how the energy release or absorbed affects the internal motion of atoms and molecules in the system. (PS1.A)
- Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. (HS-PS1-4).
- Connect the rate law to the frequency and success of molecular collisions, considering the sufficient energy needed to overcome the activation energy barrier. (PS1.B)
- 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. (HS-PS1-5).
- Cite ways to disturb equilibrium and the corrective shifts that occur. (PS1.B)
- Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. (HS-PS1-6)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (pp. 56-59, NRC, 2012) 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	**PS1.A: Structure and Properties of Matter** (pp. 106-109, NRC, 2012) • 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. (SLO 2) • A stable molecule has less energy than the	**Patterns** (pp. 109-111, NRC, 2012) • 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** (pp. 94-96, NRC, 2012) • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is

illustrate the relationships between systems or between components of a system. (SLO 1, 4, & 5) • Use a model to predict the relationships between systems or between components of a system. (SLO 1, 2, 4, & 5) **Planning and Carrying Out Investigations** (pp. 56-59, NRC, 2012) Students planning and carrying out 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. (SLO 6) **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	same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (SLO 4) **PS1.B: Chemical Reactions** (pp. 109-111, NRC, 2012) • 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. (SLO 1, 3, & 5) • 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. (SLO 6) • 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. (SLO 1, 2, & 3) • Chemical processes and properties of materials underlie many important biological and geophysical phenomena. (SLO 6) **PS3.A: Definition of Energy** (pp. 120-124) • 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	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** (pp. 98-101, NRC, 2012) • Much of science deals with constructing explanations of how things change and how they remain stable. ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** (pp. 96-101, Appendix H, NGSS, NRC, 2012) Science assumes the universe is a vast single system in which basic laws are consistent.

assumptions. Use mathematical representations of phenomena to support claims. (SLO 3) **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. (SLO 6) 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. (SLO 5) Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (SLO 6)	between its various possible forms. (SLO 4) • "Chemical energy" generally is used to mean the energy that can be released or stored in chemical processes. (SLO 4) **PS3.D: Energy in Chemical Processes** (pp. 128-130) • Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (SLO 4) **ETS1.B: Developing Possible Solutions** (pp. 206-208) • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (SLO 6) **ETS1.C: Optimizing the Design Solution** (pp. 208-210) 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 (trade-offs) may be needed. (SLO 6)	
Common Core		
• **Common Core Writing Standards:** WHST.9-12.2, WHST.9-12.5, WHST.9-12.7**,** WHST.9-12.9 • **Common Core Reading Standards:** RST.9-10.7, RST.11-12.1 • **Mathematics:** HSN-Q.A.1, HSN-Q.A.3, MP.2, MP.4		

Content Area:	**Chemistry Honors**		Grade(s)	10-11
Unit Plan Title:	Nuclear Chemistry	Time Frame:	2 weeks	

Learning Objectives

- Explain, using evidence, the very strong force holding the protons and neutrons of an atomic nucleus together. (PS1.C)
- Explain that the amount of energy per bond depends on the strength of the bond, and how the energy release or absorbed affects the internal motion of atoms and molecules in the system. (PS1.A)
- Develop a model to illustrate that the release or absorption of energy from a chemical reaction system Depends upon the changes in total bond energy. (HS-PS1-4)
- Compare and contrast chemical and nuclear reactions (PS1.B; PS1.C)
- Construct a graphic organizer, such as a chart, table, or concept map, to compare and contrast fission and fusion reactions with respect to reactants, products, and energy. (PS1.C)
- Explain the energy transformations and transfers occurring in a nuclear power plant. (PS1.C)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (pp. 56-59, NRC, 2012) Modelling 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 a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-8) **Planning and Carrying Out Investigations** (pp. 85-87, NRC, 2012) Planning and carrying out investigations in 9-12 builds on K-8 experiences and	**PS1.C: Nuclear Processes** (pp. 111-113, NRC, 2012) • Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8) • Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve changes in nuclear binding energies. The total number of neutrons plus protons does not change in any nuclear process. (SLO 1,2,3) • Strong and weak nuclear interactions determine nuclear stability and processes.	**Energy and Matter** (pp. 85-87, NRC, 2012) • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) ***Connections to Nature of Science*** Scientific Knowledge Assumes an Order and Consistency in Natural Systems (pp. 96-101, NGSS Appendix H, 2013) **Energy and Matter** (pp. 94-96, NRC, 2012) • Energy drives the cycling of matter within and between systems. (HS-ESS2-3) ***Connections to Engineering, Technology,and Applications of Science*** **Interdependence of Science, Engineering, 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. (HS-ESS2-5) **Obtaining, Evaluating, and Communicating Information** (pp. 74-77, NRC, 2012) 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). (HS-PS2-6) **Using Mathematics and Computational Thinking** (pp. 64-67, NRC, 2012)	(SLO 1) • Spontaneous radioactive decays follow a characteristic exponential decay law. (SLO 5) **PS1.B: Chemical Reactions** (pp. 109-111, NRC, 2012) 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. (SLO 1) **PS3.A: Definitions of Energy** (pp. 120-124, NRC, 2012) • 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. (SLO 6) • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (SLO 7) • These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be	**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. (HS-ESS2-3) **Cause and Effect** (pp. 87-89, NRC, 2012) • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3- 1) **Stability and Change** (pp. 98-101, NRC, 2012) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3) ***Connections to Nature of Science*** **Science is a Human Endeavour** Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

• Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1) • Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3) • Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) **Constructing Explanations and Designing Solutions** (pp. 67-71, NRC, 2012) 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 trade-off considerations. (HS-PS3-3) • Construct 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	modelled 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. (SLO 7) **PS3.B: Conservation of Energy and Energy Transfer** (pp. 124-126, NRC, 2012) • 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. (SLO 2,6) • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS1-8) • 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 behaviour. (HS-PS1-8) • The availability of energy limits what can occur in any system. (HS-PS1-8) • Uncontrolled systems always evolve toward more stable states—that is, toward	

describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS3-1) • Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations. (HS-ESS3-4) **Engaging in Argument from Evidence** (pp. 71-74, NRC, 2012) 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 the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7)	more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS1-8)	
Common Core		
Common Core Writing Standards: WHST.9-12.2, WHST.9-12.5, WHST.9-12.7 • **Common Core Reading Standards:** RST.11-12.1 • **Mathematics:** HSN-Q.A.1, HSN-Q.A.2, HSN-QA.3, MP.2, MP.4		

Content Area:	**Chemistry Honors**		Grade(s)	10-11
Unit Plan Title:	Applications of Chemistry	Time Frame	3 weeks	

Learning Objectives

- Describe, using information gathered from print and electronic resources, the advantages and disadvantages of utilizing different energy resources (fossil fuels, nuclear, hydroelectric, solar, biomass, etc.). Advantages and disadvantages should include the energy potential as well as the environmental impact of each source. (PS.1)
- Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy (HS-PS.3).
- Identify radioisotopes that are commonly used for medical and commercial purposes. Describe, based on the half-life of each radioisotope, the advantages and disadvantages of why certain radioisotopes are used for different purposes. (PS.1)
- Recognize that the strength of an aqueous acidic or basic solution is determined by the hydronium ion concentration. Predict whether the pH increases or decreases when conditions are modified. (PS.2B)
- Create a visual representation that displays a practical application, physiological process, or environmental concern related to acids, bases, or the systems that control them (for example, automobile antifreeze, blood pH, acid precipitation). (PS2.B; PS2.C)
- Design and conduct an investigation (PS2.C; ETS1.C)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (pp. 56-59, NRC, 2012) 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 a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-	**PS1.C: Nuclear Processes** (pp. 111-113, NRC, 2012) Strong and weak nuclear interactions determine nuclear stability and processes. (SLO 1) Spontaneous radioactive decays follow a characteristic exponential decay law. (SLO 3,4) Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and	**Energy and Matter** (pp. 111-113, NRC, 2012)In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) Energy drives the cycling of matter within and between systems. (HS-ESS2-3) **Cause and Effect** (pp. 87-89, NRC, 2012)Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3- 1) **Stability and Change** (pp. 98-101, NRC,

PS1-8) **Planning and Carrying Out Investigations** (pp. 59-61, NRC, 2012) 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 (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS3-3) 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-ESS2-5) **Obtaining, Evaluating, and Communicating Information** (pp. 74-77, NRC, 2012) Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and	other materials from the isotope ratios present. (SLO 4) **PS1.B: Chemical Reactions** (pp. 109-111, NRC, 2012)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. (SLO 1,5,6,7) **PS3.A: Definitions of Energy** (pp. 120-124, NRC, 2012) 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. (SLO 2) At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (SLO 1,2) **PS3.B: Conservation of Energy and Energy Transfer** (pp. 124-126, NRC, 2012) 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. (SLO 2)	2012)Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3) ***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 (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS2-3) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3) ***Connections to Nature of Science*** **Science is a Human Endeavour** Science is a result of human endeavours, imagination, and creativity. (HS-ESS3-3)

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). (HS-PS2-6) **Using Mathematics and Computational Thinking** (pp. 64-67, NRC, 2012) 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. (HS-PS3-1) Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3) .Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)	Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (SLO 1,2) The availability of energy limits what can occur in any system. (SLO 1) 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). (SLO 1,2)	

Constructing Explanations and Designing Solutions (pp. 67-71, NRC, 2012) 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 trade-off considerations. (HS-PS3-3) Construct 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-ESS3-1) Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations. (HS-ESS3-4) **Engaging in Argument from Evidence** (pp. 71-74, NRC, 2012) 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 the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7)		
Common Core		
• **Common Core Writing Standards:** WHST.9-12.2, WHST.9-12.5, WHST.9-12.7 • **Common Core Reading Standards:** RST.11-12.1 • **Mathematics:** HSN-Q.A.1, HSN-Q.A.2, HSN-QA.3, MP.2, MP.4		

III. Methods of Student Evaluation

Assessment can be divided into two general categories: formal (graded) and informal/classroom-based (both graded and ungraded). The key to effectively assessing a student's mastery of skills is to match the assessment method to the learning objective.

<u>Formal Assessments</u>

- Evaluation
- Class participation
- Creative assignments
- Homework and classwork assignments
- Reports and presentations
- Research methodology
- Technological applications
- Unit tests
- Various speaking and listening assignments

- Multiple choice exams
- Quizzes (announced and unannounced)
- Essays
- Formal lab reports
- Scientific journal reviews
- Projects
- Short answer and problem solving tests
- Tests and quizzes on blackboard
- Case Study analysis

Informal Assessments

- Instructor's observations of note-taking, and organization of notebooks and assignments
- Cooperative learning activities, including labs
- Creative project assignments
- Laboratory behavior
- Observing citizenship and appropriate social responses
- Instructor's observations of time management skills
- Smart Board and Clicker's activities
- Exits card

Mastering of the core proficiencies of Biology shall be evaluated in accordance with the general grading policies as listed in the student handbook:

- Tests – 40%
- Laboratory Reports and Projects – 20%
- Quizzes – 20%
- Class Participation – 10%

IV. Instructional Strategies Based on Instructional Goals

- Graphs and other visuals
- Engaging in discussions
- Reading silently and aloud

- Listening and speaking activities
- Watching and responding to media
- Brainstorming
- Listening
- Mapping
- Revising and editing
- Participating in small and large groups
- Researching to make connections to texts and classroom discussions
- Collaborative projects
- Answering questions (oral and written)
- Summarizing
- Debating
- Analyzing texts, discussions, etc.
- Peer teaching
- Competing in teams/debating
- Playing games
- Creating games
- Note taking and note making
- Writing

V. Scope and Sequence

Key: I – Introduced, D-developed in Depth, R-Reinforced

Skill/Concepts to be Learned	9*	10**	11	12
Develop mathematical and physical tools to build models and pose theories	I	DR	DR	
Use scientific theories to present evidence in a logical manner	I	DR	DR	
Design investigations and collect data to generate evidence and explanations	I	DR	DR	
Use scientific tools, instruments and supplies correctly and safely	I	DR	DR	
Build and represent evidence using physical, mathematical and computational tools	I	DR	DR	
Explain how the properties of isotopes, including half-lives and decay modes result in	I	DR	DR	

Represent ideas using literal representations, such as graphs or tables	I	DR	DR	
Use empirical evidence to construct and defend arguments	I	DR	DR	
Evaluate and interpret data patterns and conclusions using scientific reasoning	I	DR	DR	
Consider multiple theories to evaluate evidence-based arguments	I	DR	DR	
Differentiate among gases, liquids, and solids based on their properties		IDR	DR	
Describe the phases of matter using the kinetic molecular theory		DR	DR	
Describe and model how solutes dissolve in solvents		IDR	DR	
Explain trends of melting and boiling points in compounds			IDR	
Predict the behavior of atomic interactions using various models		DR	DR	
Investigate useful applications of isotopes given their specific properties		IDR	DR	
Model the outermost electrons of elements and describe how they influence chemical bonds			IDR	
Write out balanced chemical equations, predicting reasonable products and using the law of conservation of matter.	I		DR	
Balance equations for simple chemical reactions			DR	
Perform stoichiometry calculations using balanced chemical equations			DR	
Understand the meaning of limiting reagent			DR	
Describe exothermic and endothermic reactions and their potential uses	I	DR	DR	
Understand the nature and characteristics of chemical equilibria			I	
Understand the concept of LeChatliers principle			I	
Understand the concept of entropy and its relationship to spontaneity and predict whether a process will be spontaneous.			I	
Describe how acid and base concentration is related to the pH scale		ID	DR	
Identify and describe oxidation-reduction reactions			IDR	
Describe the components and operation of galvanic cells			IDR	
Determine decay mode and write nuclear equations showing alpha and beta decay			I	

VI. Pacing Chart

Marking Period 1

Unit 1

- **Applications of Chemistry**
  (2.5 weeks) Students will be able to evaluate and apply the scientific method and organize data. Justify the use of mathematics in chemistry. Solve problems by using the metric system and dimensional analysis with significant figures correctly. Select from various instruments to make measurements. Justify the appropriate safety techniques to be used in the laboratory. Develop logical thinking patterns. Write lab reports in a timely manner and organize, graph and analyze data gathered from laboratory activities or other sources. Compare accuracy and precision; calculate percentage of error in measurements
- **Structure and properties of matter:**
  (3 weeks) Students will be able to revise simple particle model to differentiate among properties of a solid, a liquid, and a gas. Differentiate among elements, compounds, and mixtures and assess different methods of separating mixtures. Identify physical and chemical changes and properties.

Unit 2

- **The atoms and its development**
  (2 weeks) Students will be able to explain Early Models of the atom: Dalton, Thomson, Rutherford, and Bohr. Explain the Wave Mechanical Model. Calculations of wavelength, frequency, and Energy of an electron. Describe the key experiments that led to the discovery of electrons and to the nuclear model of the atom. Determine atomic number and mass number and describe how they apply to isotopes. Calculate the average mass of different isotopes.
- **Electron arrangement**
  (2 weeks) Students will be able to perform calculations of wavelength, frequency, and energy of an electron. Analyze emission spectra's and the Bohr model of the atom. Explain the Quantum Mechanical model of the atom. Write and draw electron configurations and orbital filling diagrams. Draw a Lewis electron- dot structure of an atom and justify the shape of different molecules.
- **The periodic law**
  (1.5 weeks) Students will be able to explain the arrangement of the modern periodic table. Compare and contrast properties of elements within a group or a period for Groups 1, 2, 13- 18 on the Periodic Table. Analyze the trends patterns in the periodic table in terms of

atomic size, electronegativity, ionization energy and valence electrons.

Unit 3

- **Chemical bonding**
  (2 weeks) Students will be able to distinguish among ionic, molecular, and metallic substances, given their properties. Explain chemical bonding in terms of the behavior of electrons. Demonstrate bonding concepts, using Lewis dot structures.

Marking Period 2

Unit 3

- **Chemical names and formulas**
  (2.5 weeks) Students will be able to form cations and anions write and name ionic and molecular compounds. Explain the properties of ionic and molecular compound. Draw Lewis structures of molecular compounds and polyatomic ions.
  Students will use molecular models to analyze molecular formulas in terms of bond capacity, and orientation. The overall shape of the molecule is determined from this and VSEPR. Polarity is investigated in the context of this analysis
- **Chemical equations and reactions**
  (2 weeks) Students will be able to translate word equations into chemical equations. Balance chemical equations and relate the process to the law of conservation of matter. Classify reactions according to several categories – combustion, synthesis, decomposition, single replacement, double replacement. Predict the products of chemical reactions.

Unit 4

- **Mole**
  (2.5 weeks) Students will be able to Convert: Mole-mass & mass to mole: mole to atom and to mass. Determine the molecular formula, given the empirical formula and molecular mass determine the molecular formula. Calculate percent composition.
- **Stoichiometry**
  (3 weeks) Students will be able to calculate simple mole- mole stoichiometry problems given a balanced equation. Conclude on the limiting and excess reactant in a process by performing simple calculations. Perform mass to mass stoichiometry calculations. Calculate percent yield of salt produced from reactions.

Marking Period 3

Unit 5

- **Characteristics of gas**
  (2.5 weeks) Students will be able to Convert between units of pressure. Perform calculations using gas laws. Use a phase diagram to determine that state of matter a substance is in given temperature and pressure. Characterize a solid by the type of attractions that exist between the atoms that make it up. Perform specific heat and heat of fusion calculations
- **Kinetic molecular theory**
  (2 weeks) Students will be able to evaluate collision theory to explain how various factors, such as temperature, surface area, and concentration, influence the rate of reaction. Explain the Kinetic – molecular Theory. Average molecular speeds in relation to mass and temperature. Determine Graham's law of Effusion.
- **Solutions**
  (2.5 weeks) Students will be able to evaluate: Concentration units, saturated solutions, factors affecting solubility and colligative properties

Unit 6

- **Energy and chemical change**
  (3 weeks) Students will be able to use conservation of energy and its implications, distinguish between endothermic and exothermic reactions. Explain enthalpy of phase changes: fusion and vaporization. Explain enthalpy of temperature changes and calorimetry. Calculate specific heat and enthalpy changes during reactions. Use Hess's Law of heat. Determine entropy of reactions. Calculate Gibbs Free energy and spontaneity.

Marking Period 4

Unit 6

- **Reaction Rates and Equilibrium**
  (2.5 weeks) Students will be able to identify examples of physical equilibria as solution equilibrium and phase equilibrium, including the concept that a saturated solution is at equilibrium. Students will be able to calculate the equilibrium constant: forward and reverse rates of reaction. Research Le Chatelier's Principle and the effects of changes in pressure, concentration and temperature in exothermic and endothermic reactions and different systems.

Unit 7

- **Acid, bases, and titrations**
  (2.5 weeks) Students will be able to differentiate between the Arrhenius model and the Bronsted-Lowry model. Generate the auto ionization of water and the pH scale. Analyze the properties of strong acids and strong bases and weak acids and weak bases. Write

simple neutralization reactions when given the reactants. calculate the concentration or volume of a solution, using titration data. Interpret changes in acid- base indicator color during titration.

Unit 8

- **Oxidation and reduction**

  (2.5 weeks) Students will be able to assign oxidation numbers. Calculate oxidation numbers in a compound and identify oxidized and reduced species. Balance oxidation-reduction reactions.

Unit 9

- **Nuclear chemistry**

  (2.5 weeks) Students will be able to compare and contrast fission and fusion reactions. Calculate the initial amount, the fraction remaining, or the half-life of a radioactive isotope. Determine decay mode and write nuclear equations showing alpha, gamma and beta decay. Identify specific uses of some common radioisotopes. Discussion on nuclear energy and radioactivity

VII. Proficiencies

Students will demonstrate the ability to:

- Use information from laboratory manuals to carry out experiments in the laboratory.
- Research how the study of honors chemistry relates to future careers in science, medicine and engineering.
- Use the proper units in presenting data and reporting results.
- Evaluate the concept of the mole and relate it correctly to the other units used to determine materials' quantities and concentration.
- Explain the role of energy in changes in matter.
- Describe the Kinetic Molecular Theory and use it to explanation the properties and behavior of solids, liquids and gases.
- Justify the use mathematical principles to solve chemistry problems.
- Represent ideas using graphs, tables, concept maps and diagrams.
- Reflect and revise understandings as new evidence emerges.
- Balance chemical equations by applying the law of conservation of matter.
- Use the instruments and technologies of chemistry correctly and safely.
- Judge the importance of handling chemicals safely and how to interpret the information contained in their MSDS.
- Refer to the properties of gases conceptually and mathematically and use established laws to solve problems involving their behavior.
- Know that matter is made up atoms, that atoms have an internal structure and describe the history leading to their discovery.
- Describe the electronic structure of elements using the quantum model and relate it to the older “Shell Model”.

- Write the electronic structure of elements in “orbital notation”.
- Validate the layout of the periodic table and describe the periodic trends.
- Explain the formation of ions and ionic compounds and be able to write net ionic equations
- Describe the formation of covalent bonds in covalent compounds and use Lewis structures to predict molecular shapes.
- Use the kinetic molecular theory to describe and explain the properties of solids, liquids, and gases.
- To solve problems involving stoichiometry and determine percent yield and efficiency of chemical reactions.
- Differentiate between mixtures and true solutions and understand colligative properties.
- Explain how the properties of isotopes lead to useful applications of those isotopes.
- Describe oxidation-reduction reactions and explain their role in electrochemistry.
- Explain Le Chatelier’s principle and use it to determine the direction of equilibrium shifts.
- Relate the pH scale to the concentrations of various acids and bases and pollution.
- Describe the nature of radioactivity and nuclear changes, balance equations of nuclear reactions and understand nuclear fission and fusion.