Passaic County Technical Institute

Wayne, NJ

Chemistry Curriculum

Course # 0073

5 Credits

August 2016

Chemistry Curriculum

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I. Course Description

Chemistry is a full year course designed to enhance the students' science literacy as well as prepare them for college or technical school. By studying chemistry, the students will be able to understand the nature of materials in this world and the changes they undergo. Investigative and problem solving skills will be developed in order to better ready students for college and careers. The inquisitive world of science should grow interest and curiosity in the minds of students as they study more than just the basics of chemistry.

Chemistry investigates matter and energy and the ways in which these two quantities interact. This course covers the basic concepts of chemistry including describing the common states of matter, making chemical solutions, atomic structure, and organization of the periodic table. A more in-depth look will be given to the characteristics of chemical compounds, including acids and bases, according to how chemical bonds are formed and nomenclature. Types and driving forces of chemical reactions will be investigated, as well as oxidation-reduction and neutralization reactions. Computational skills are developed in order to learn how to approach and solve chemical formula problems and stoichiometric calculations. Furthermore, students will develop and explain models and theoretical frameworks that have evolved over time. All of these topics will be in terms of real-life applications of chemistry concepts.

A hands-on lab-based inquiry experience will complement each major area of study with the correct and safe use of laboratory equipment. This aspect of the course is designed so that students engage in scientific and engineering practices and apply crosscutting concepts to deepen their understanding of core ideas. In addition to designing and observing experiments, a group process of reflection and discussion will provide a platform for further theoretical investigations and an appreciation for the greater research being done today.

Beyond the field of chemistry, all students will become more proficient in literacy, given reading and writing assignments to bolster this subject. Relevant articles and videos will be used as a research tool to expand the resources a student normally uses in their problem-solving skill set. These informational texts and writing assignments will assure a more comprehensive and balanced student upon exiting the course.

II. Course Objectives/Outline

Content Area: Chemistry	Grade (s): 10, 11
Unit 1: Structure and Properties of Matter	Time Frame: 16 weeks

NJ Student Learning Standards

- Use the periodic table as a model to predict the relative properties of elements based on patterns of electrons in the outermost energy level of atoms. *[Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.]* [*Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.*] (HS-PS1-1)

- 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. *[Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.]* [*Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.*] (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	**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)	**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.

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. • 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)	**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, properties, and transformations of matter. (SLO 2, 5 & 7)	
NJSLS		
WHST.9-12.2, WHST.9-12.5, WHST.9-12.7, WHST.11-12.8, WHST.9-12.9 RST.9-10.7, RST.11-12.1 See APPENDIX I		

Content Area: Chemistry	**Grade (s): 10, 11**
Unit 2: Conservation of Matter	**Time Frame: 9 weeks**
NJ Student Learning Standards	
• 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. *[Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.]* (HS-PS1-2) • 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. *[Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include complex*	

chemical reactions.] (HS-PS1-7)

- **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.** *[Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational fields.]* HS-PS3-1

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	**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	**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. (HS-PS3-1) **Systems and System Models**

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. (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) **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	underlie many important biological and geophysical phenomena. (SLO 6) **PS3.A: Definition of Energy** (pp. 120-124, NRC, 2012) • 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) **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	• When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4) • 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. (HS-PS3-1)

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)	system (HS-PS3-1) • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4) • Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) • Uncontrolled systems always evolve toward more stable states – that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4) **PS3.D: Energy in Chemical Processes** • Although energy cannot be destroyed, it can be converted to less useful forms – for example, to thermal energy in the surrounding environment. (HS-PS3-4)	
NJSLS		
WHST.9-12.9, WHST.11-12.8, WHST.9-12.7, WHST.9-12.5, WHST.9-12.2 RST.11-12.1, RST.9-10.7 See APPENDIX I		

Content Area: Chemistry	**Grade (s): 10, 11**
Unit 3: Reaction Rates and Chemical Equilibrium	**Time Frame: 7 weeks**
NJ Student Learning Standards	
• 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. *[Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]* (HS-PS1-4) • 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. *[Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] [Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.]* (HS-PS1-5)

- Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. *[Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.]* (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 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	**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	**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 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.

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. (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)	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 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)	
NJSLS		
WHST.9-12.2, WHST.9-12.5, WHST.9-12.7, WHST.11-12.8, WHST.9-12.9 RST.9-10.7, RST.11-12.1 See APPENDIX I		

Content Area: Chemistry	Grade (s): 10, 11
Unit 4: Nuclear Chemistry	**Time Frame: 7 weeks**

NJ Student Learning Standards

- 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. *[Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.]* [Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.*]* (HS-PS1-8)

- Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation. *[Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.] [Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.]* (HS-ESS1-1)

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-PS1-8) **Planning and Carrying Out Investigations** (pp. 85-87, NRC, 2012) Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan and conduct an investigation individually	**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. (SLO 1) • Spontaneous radioactive decays follow a characteristic exponential decay law. (SLO 5) **PS1.B: Chemical Reactions** (pp. 109-111, NRC,	**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 Technology**

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) • 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	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 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. (SLO 7) **PS3.B: Conservation of Energy and Energy Transfer** (pp. 124-126, NRC, 2012)	• 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) • 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*** **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 Endeavor** • Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

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)	• 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 behavior. (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 more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS1-8)	
NJSLS		
WHST.9-12.2, WHST.9-12.5, WHST.9-12.7 RST.11-12.1		

See APPENDIX I

Content Area: Chemistry	**Grade (s): 10, 11**
Unit 5: Applications of Chemistry	**Time Frame: Over the course of the year.**

NJ Student Learning Standards

- Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. *[Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]* (HS-PS3-3)
- Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. *[Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]* (HS-ESS1-6)
- **Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*** *[Clarification Statement: Emphasis is on the contact forces that determine the functioning of the material. Examples could include why flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provide molecular structures of specific designed materials.]* HS-PS2-6

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-PS1-8) **Planning and Carrying Out Investigations** (pp. 59-61, NRC, 2012) Planning and carrying out investigations in 9-12	**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 other materials from the isotope ratios present. (SLO 4) **PS1.B: Chemical Reactions** (pp. 109-111, NRC, 2012)	**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, 2012)

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 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

- 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)
- 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

- Change and rates of change can be quantified and modelled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3)

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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)

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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)

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) **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 tradeoff 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	uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (SLO 1,2) **Types of Interactions** • 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-PS2-6) ESS1.B:	

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) **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). (HS-PS2-6)		
NJSLS		
WHST.9-12.2, WHST.9-12.5, WHST.9-12.7 RST.11-12.1 See APPENDIX I		

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.

Formal Assessments

- Unit tests
- Marking Period Post Assessments
- Class participation
- Creative assignments
- Homework and classwork assignments
- Reports and presentations
- Research methodology
- Technological applications
- Multiple choice exams
- Quizzes (announced and unannounced)
- Essays/Research Stimulation Tasks
- Formal lab reports
- Scientific journal reviews
- Projects
- Short answer and problem solving tests and quizzes
- Tests and quizzes on blackboard

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

IV. Instructional Strategies Based on Instructional Goals

The development of interest in chemistry students will be greatly influenced by implementing various instructional techniques. Successful understanding and mastery of the subject can be determined by a number of methods:

- Lecture/traditional format
- Discussion
- Concept mapping or diagrams
- Demonstrations
- Project-based learning
- Laboratory activities

- Laboratory reports
- Inquiry and experimental design
- Technology (Power Point, BlackBoard, SmartBoard, Computers, Internet, Chromebooks)
- Critical thinking and problem-solving exercises
- Reading silently and aloud
- Watching and responding to media
- Small and large group activities
- Researching to make connections to texts and classroom discussions
- Debating
- Analyzing texts, discussions, etc.
- Peer teaching
- Competing in teams/debating
- Playing games
- Creating games
- Note taking and note making
- Writing
- Research Stimulation Tasks (RSTs

V. Textbooks:

Chemistry: Matter and Change; 1st edition, 2013; By: Buthelezi, Dingrando, Hainen, Wistrom, & Zike; McGraw-Hill; 978-0-07-896405-3

A Natural Approach to Chemistry; 1st Edition; 2010; By: Hsu, Chaniotakis, Carlisle, & Damelin; Lab-Aids Inc.; 978-1-60301-313-0

VI. Scope and Sequence

Key: I = Introduced; D= Explored in Depth, R=Reinforced

Suggested Grade Levels

Skill/Concepts to be Learned	**9**	**10**	**11**	**12**
Develop mathematical and physical tools to build models and pose theories	I	DR	DR	
Use the metric system to communicate in a universal scientific language	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 and instruments correctly and safely	I	DR	DR	
Build and represent evidence using physical, mathematical and computational tools	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	IDR	
Differentiate between physical and chemical properties and changes.		IDR	IDR	
Describe the phases of matter using the kinetic molecular theory		IDR	IDR	
Describe and model how solutes dissolve in solvents		IDR	IDR	
Explain trends of melting and boiling points in compounds		IDR	IDR	
Gain knowledge and understanding of the periodicity of elements	I	DR	DR	
Predict the behavior of atomic interactions using various models		IDR	IDR	
Investigate useful applications of isotopes given their specific properties		IDR	IDR	
Model the outermost electrons of elements and describe how they influence chemical bonds		IDR	IDR	
Write out balanced chemical equations, predicting reasonable products and using the law of conservation of matter		IDR	IDR	
Describe exothermic and endothermic reactions and their potential uses		IDR	IDR	
Study nuclear chemistry and its impact on society		IDR	IDR	
Describe how acid and base concentration is related to the pH scale		IDR	IDR	
Identify and describe oxidation-reduction reactions		IDR	IDR	
Gain an understanding of the mole concept and counting atoms and molecules		IDR	IDR	
Use a balanced chemical equation to calculate chemical quantities used and produced		IDR	IDR	

VII. Pacing Chart (with Learning Objectives)

Color Coded Key: Unit 1 Objectives, Unit 2 Objectives, Unit 3 Objectives, Unit 4 Objectives, Unit 5 Objectives

Marking Period 1: Structure and Properties of Matter

Science of Chemistry (Weeks 1-2): Students will learn how to apply the scientific method and the metric system to upcoming chemistry studies.

Describing and Classifying Matter (Weeks 3-4): Students will differentiate between elements, compounds, and mixtures to classify matter. Physical and chemical properties of matter will be explored.

- Use aspects of particulate models to reason about observed differences between solid, liquid and gas phases of certain materials. (PS1.A)

Atoms: The Building Blocks of Matter (Weeks 5-6): Students will explain how the different subatomic particles make up the structure of an atom.

- Provide evidence that the number of protons determine an element and that neutrons and electrons do not. (PS1.A; PS1.C; & PS2.B)

The Periodic Table (Weeks 7-10): Students will explore how and why elements are arranged in the periodic table.

- 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)

Marking Period 2: Structure and Properties of Matter (continued)

Electron Configurations (Weeks 11-12): Students will demonstrate how the electron structure determines the reactivity of an atom.

- Use the periodic table as a model to predict the relative properties of elements based on patterns of electrons in the outermost energy level of atoms. (HS-PS1-1)

Ions and Ionic Compounds (Weeks 13-14): Students will identify ionic charge and describe which elements form ionic bonds to make ionic compounds.

- 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)

Covalent Compounds (Weeks 15-16): Students will identify which elements form covalent compounds and how these bonds are formed.

- 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)

Marking Period 3: Conservation of Matter

Chemical Equations and Reactions (Weeks 17-19): Using the Law of Conservation of Mass, students will write balanced chemical equations. Students will also be able to identify various types of chemical reactions.

- 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)

The Mole and Stoichiometry (Weeks 20-23): Students will demonstrate how the relationship among mass, volume and particles can be calculated from a balanced equation.

- 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)

Acids and Bases (Weeks 24-25): Students will differentiate between acids and bases by the hydronium ion concentration.

- 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. (PS2.B)
- 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)

Marking Period 4: Reaction Rates, Chemical Equilibrium and Nuclear Chemistry

Energy of Reactions, Reaction Rates and Equilibrium (Weeks 26-29): Develop models to describe the release or absorption of energy in chemical reactions. Discuss methods to increase rates of reactions. Describe dynamic equilibrium and how to disturb equilibrium to control a reaction.

- 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)

- Describe and give analogies of dynamic equilibrium where changes are always occurring, but overall numbers remain constant. (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)

Solution Chemistry (Weeks 30-32): Describe solute and solvent interactions, and levels of concentration in a solution.

- Design and conduct an investigation to determine the salt concentration of a solution to determine if it would be suitable for a practical application (for example, an IV solution for patients under various circumstances or as a de-icing solution). (PS2.C; ETS1.C)

Fusion and Fission (Weeks 33-37): Students will investigate how large amounts of energy are obtained from small amounts of gas.

- Explain, using evidence, the very strong force holding the protons and neutrons of an atomic nucleus together. (PS1.C)
- 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)
- Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. (HS-PS1-8)
- Construct representations, at the particle level and graphically, of the changes that occur in a given radioactive sample (e.g., 64 particles decaying over four half-lives). (PS1.C)
- Explain the energy transformations and transfers occurring in a nuclear power plant. (PS1.C)
- Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation. (HS-ESS1-1)
- 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. (PS1.C)
- Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. (HS-PS3-3)
- 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. (PS1.C)

- Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. (HS-ESS1-6)

Unit 5: Applications of Chemistry

This unit includes extensions to the topics that are discussed in Units 1-4. Consequently, it is more appropriate to address the learning objectives of Unit 5 when contextually appropriate during the year. This will result in 4 major units, with Unit 5 scattered throughout the covered topics. In this way students are more deeply engaged by reflecting and discussing the real world application of the content immediately, rather than waiting for the end of the year before becoming exposed to the various applications of chemistry. It often the hard questions that often trigger wonder, interest and appreciation for the seemingly intangible aspects of science, without which we would lack the ability to imagine solutions to the world's problems.

Additional Topics to Explore in Depth if Time Permits

Gas Laws: Students will use the kinetic molecular theory to explain the relationship among pressure, temperature, volume, and particle quantity in gases.

Redox Reactions: Students will explore the potential applications of oxidation and reduction reactions.

VIII. Student Handout

Chemistry is a full year course designed to enhance the student's science literacy as well as prepare them for college or technical school. By studying chemistry, the students will be able to understand the nature of materials in this world and the changes they undergo. Investigative and problem solving skills will be developed in order to better ready students for college and careers. Main topics covered will include, but are not limited to, matter, the atom, the periodic table, chemical bonding, chemical reactions, and chemical conversions. Technology and science literacy will be integrated in the daily routine of instruction and learning.

Proficiencies

Students will demonstrate the ability to:

a. Reflect and revise understandings as new evidence emerges.
b. Design investigations and collect evidence to determine relationships.
c. Use the instruments and technologies of chemistry correctly and safely.
d. Identify the benefits which the study of chemistry would serve in many career opportunities.
e. Understand the foundations of chemical concepts in natural and man-made materials.
f. Use scientific skills and processes in solving chemistry problems.
g. Engage in discussion in order to process and learn from others' ideas and experiences.
h. Represent ideas using graphs, tables, concept maps and diagrams.
i. Evaluate information about current chemistry issues.
j. Account for the differences in the physical properties of solids, liquid, and gases.
k. Use the kinetic molecular theory to describe and explain the properties of solids, liquids, and gases.
l. Account for various trends in the melting points and boiling points of various compounds.
m. Use atomic models to predict the behaviors of atoms in interactions.
n. Predict the placement of elements on the periodic table based on physical and chemical properties.
o. Explain how the properties of isotopes lead to useful applications of those isotopes.
p. Describe the products and potential applications of fission and fusion reactions.
q. Model how the outermost electrons determine the reactivity of elements.
r. Model how the outermost electrons determine the nature of the chemical bonds elements tend to form.
s. Balance chemical equations by applying the law of conservation of matter.
t. Describe the potential applications of exothermic and endothermic processes.
u. Relate the pH scale to the concentrations of various acids and bases.
v. Describe the process by which solutes dissolve in solvents.
w. Use empirical evidence to construct and defend arguments.
x. Use scientific reasoning to evaluate and interpret data patterns and scientific conclusions.
y. Model the rate of change of a reaction due to outside factors such as temperature and particle size.

APPENDIX I

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

A. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
B. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
C. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
D. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
E. Establish and maintain a style and tone appropriate to the audience and purpose (e.g. formal and objective for academic writing) while attending to the norms and conventions of the discipline in which they are writing.
F. Provide a concluding paragraph or section that supports the argument presented.

WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

A. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
B. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
C. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
D. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
E. . Provide a concluding paragraph or section that supports the argument presented.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.11-12.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

WHST.11-12.9. Draw evidence from informational texts to support analysis, reflection, and research.

WHST.11-12.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
RST.11-12.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.