Conceptual Chemistry

Summit High School
Summit, NJ

Grade Level / Content Area:

10th Grade
Conceptual Chemistry

Developed by
Tina Lee, Tom O'Dowd
Summit High School
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Length of Course: 1 year

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Course Description: Conceptual Chemistry (414) is an inquiry based learning approach to developing the major chemistry concepts. It incorporates laboratory experiments, classroom discussion and authentic projects as well as traditional lectures and hands on activities. The atomic theory, the nature of matter in its various phases, chemical periodicity, and the mole concept are studied early in the course. Among the basic principles included are energy, reaction rates, reaction equilibrium, and characteristics of chemical reactions, acid-base behavior. Students apply their knowledge of algebra to solve chemistry problems. This course enables students to develop their quantitative skills and their communication skills. Students will be able to demonstrate an understanding of how chemical principles are applied to "real world" problems and processes. Topics in the media and popular culture will be used as a platform for discussing chemistry principles. In order to enhance scientific literacy and communication skills, each student will write a research paper and communicate their findings to the class.

Course of Study

Unit I: Analysis of matter and the elements

1. **Classification of matter**
    a. **Phases**
    b. **Chemical and physical changes**
    c. **Mixtures vs. Pure Substances**
2. **Elements and an introduction to the periodic table**
    a. **Subatomic particles**
    b. **Isotopes and ions**
    c. **General organization of the Periodic Table**

Unit II: Stellar Chemistry, Development of Atomic Theory and Nuclear chemistry

1. **Atomic Structure**
    a. **Development of the modern atomic theory (Dalton → Schrodinger)**
    b. **Electromagnetic radiation and matter**
    c. **Photoelectric effect**
2. **Periodic Table**

    a. Electron organization
    b. Properties of elements
    c. Periodic trends
3. Stellar Chemistry
    a. Formation of elements and the life cycle of a star.
    b. Formation of the Universe “Big Bang theory”
4. The Nucleus
    a. Radioactivity
    b. Energy from the nucleus
    c. Uses of radiation
    d. Radiation in the center of the Earth and plate tectonics

Unit III: Bonding and combining elements

1. The nature of chemical bonds
    a. Ionic bonding (Patterns in bonding)
    b. Covalent Bonding
    c. Metallic Bonding
2. Intermolecular forces (solids and liquids)
    a. Structure of molecules
    b. Properties of molecules
3. Solutions and their behavior
    a. Water
    b. Solution process

Unit IV: Chemical reactions

1. Conservation of matter
    a. Balancing chemical equations
    b. Stoichiometry
2. Thermodynamics
    a. Enthalpy change
    b. Entropy and the second law
3. Chemical kinetics
    a. Collision theory
    b. Factors that influence Rates of chemical reactions
4. Chemical equilibrium
    a. Reversible reactions
    b. Le Chatelier's principle

Unit V: Environmental Chemistry "Chemistry in everyday life"

1. **Gases and the Atmosphere**
    a. **Gas Properties and Gas Laws**
    b. **Composition and function of the atmosphere**
    c. **The Greenhouse effect and Global Warming**
2. **Water and the Hydrologic Cycles**
    a. **Acid/ base characteristics and impact on biological systems**
    b. **Climate Change**
3. **Energy consumption and petroleum products**
    a. **Renewable energy**
    b. **Nonrenewable energy**
4. ***Natural resources***
    a. ***Sources***
    b. ***Extraction***

Unit 1

Study of Matter Using Experimental Methods

NEXT GENERATION SCIENCE STANDARD **PS1.A: Structure and Property of Matter** **PS2.B: Types of Interactions** **PS1.C: Nuclear Processes** **PS3.D: Energy in Chemical Processes and Everyday Life** **PS4-B: Electromagnetic Radiation** **HS-ESS3 Earth and Human Activity** **HS-ETS1 Engineering Design**
Big Ideas **Developing and Using Models** Students use, synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Use a model to predict the relationships between systems or between components of a system.

Planning and Carrying Out Investigations

Students plan investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Patterns

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.

Energy and Matter

In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons are conserved.

The total amount of energy and matter in closed systems is conserved.

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Stability and Change

Much of science deals with constructing explanations of how things change and how they remain stable.

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
● Can concepts and theories presented in the classroom be observed in the laboratory?	Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)

● What determines whether a substance will be a solid, liquid, or gas? ● Can the properties of an element be predicted? ● What is the most important subatomic particle?	The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1), (HS-PS1-2) The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3), (secondary to HS-PS2-6) 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. (HS-PS1-4) 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. (secondary to HS-PS1-1), (secondary to HS-PS1-3) Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) 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. (secondary to HS-ESS3-2), (secondary HS-ESS3-4)

Areas of Focus: Proficiencies (Cumulative Progress Indicators)	**Examples, Outcomes, Assessments**
HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.	**Instructional Focus** ● Recognize and safely use a variety of laboratory equipment

HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. **HS-PS1-3.** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. **HS-PS1-7.** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. **HS-ESS3-2.** Evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios. **HS-ESS3-4.** Evaluate or refine a technological solution that reduces the impacts of human activities on natural systems. **HS-ETS1-1.** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	● Review units, standards, and appropriate recording of data in tables and graphs ● Name and characterize three common states of matter. ● Classify matter as mixtures or pure substances, as homogeneous or heterogeneous ● Explain the difference between an element and a compound ● Recognize and interpret symbols for elements and formulas for compounds ● Distinguish between chemical and physical properties and changes ● Describe the ways in which elements are assigned names and symbols, and some ways in which new elements have been discovered ● Explain that electrons, protons and neutrons are parts of the atom and have measurable properties including mass and charge. ● Understand that there is a vast history of discovering elements that continues with laboratory work today. **Sample Assessments:** Lab: Observing a Chemical Reaction Lab: Isotopic Analysis of Candium Lab: Periodic Trends. Quizzes and Tests **Instructional Strategies:** **Interdisciplinary Connections** RST.9-10.7 Translate quantitative or technical information expressed in worse in a text into visual form or mathematically into words. RST.11-12.1 Cite Specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. WHST.9-12.2 Write informative/explanatory texts, including the

	narration of historical events, scientific procedures/ experiments, or technical processes. WHST.9-12.5 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. **Technology Integration** ● Use spreadsheet, graphing calculator and other analysis tools to examine mathematical relationships. **Media Integration** ● Use the "elements" video to stimulate interest in the topic ● Use the "Hindenburg" article to relate Chemistry to a historical event.. **Global Perspectives** ● Examine periodic tables from other countries to see how the study of Chemistry is similar and is different across the globe

Unit 2

Atomic Structure, Nuclear Chemistry and Stellar Chemistry

NEXT GENERATION SCIENCE STANDARD **PS1.A: Structure and Property of Matter** **PS2.B: Types of Interactions** **PS1.C: Nuclear Processes** **PS3.D: Energy in Chemical Processes and Everyday Life** **PS4-B: Electromagnetic Radiation** **HS-ESS3 Earth and Human Activity** **HS-ETS1 Engineering Design**
Big Ideas **Developing and Using Models**

Students use, synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Use a model to predict the relationships between systems or between components of a system.

Planning and Carrying Out Investigations

Students plan investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Patterns

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.

Energy and Matter

In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons are conserved.

The total amount of energy and matter in closed systems is conserved.

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Stability and Change

Much of science deals with constructing explanations of how things change and how they remain stable.

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
● How and why did atomic theory change over time? ● What is the most important subatomic particle? ● What force in the atom is the most important? ● If energy can never be created or destroyed, why is there an "energy crisis"? ● Are nuclear power plants a solution to the energy crisis? ● Is radioactivity good or bad for the human race? ● How do scientists "date" old objects? What are the limits of those techniques?	Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1) 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. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1), (HS-PS1-2) The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3), (secondary to HS-PS2-6) 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. (HS-PS1-4) 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. (secondary to HS-PS1-1), (secondary to HS-PS1-3) 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) Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (HS-PS4-B)

	Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy . Heavier elements are produced when certain massive stars achieve a supernova stage and explode.(HS -ESS1-2),(HS-ESS1-3) Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) 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. (secondary to HS-ESS3-2), (secondary HS-ESS3-4)

Areas of Focus: Proficiencies (Cumulative Progress Indicators)	**Examples, Outcomes, Assessments**
HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. **HS-PS1-2.** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. **HS-PS1-3.** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.	**Instructional Focus** ● Describe the discovery of the organization of electrons in atoms in the context of experimentation with Rutherford, Thompson and Bohr. ● Use the organization of the Periodic Table to illustrate the commonality and patterns of physical and chemical properties among the elements. ● Describe the composition of the atomic nucleus in various isotopes. ● Understand that energy cannot be created or destroyed but is constantly being transferred and converted in the natural world and that during energy conversions some energy is lost to disorder. ● Describe two of the four fundamental forces of nature: the strong force, responsible for binding the nucleus, and the weak force, which is involved with some radioactivity.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. **HS-PS1-8.** Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. **HS-ESS1-3.** Communicate scientific ideas about the way stars, over their life cycle, produce elements. **HS-ESS3-2.** Evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios. **HS-ESS3-4.** Evaluate or refine a technological solution that reduces the impacts of human activities on natural systems. **HS-ETS1-1.** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	● Distinguish between three different types of radiation: alpha, beta, and gamma. ● Describe radioactive decay and how half-life allows scientists to "date" archaeological objects. ● Distinguish between fission and fusion. ● Describe the formation of elements in the life cycle of a star. ● Present the Big bang theory and the evidence that supports this theory. ● Describe how nuclear power plants utilize controlled chain reactions, while nuclear bombs rely on uncontrolled chain reactions. **Sample Assessments:** Lab: Atomic spectrum Lab: Radioactive Decay Describe the schematics and inner-workings of a fission based nuclear plant. Short persuasive essay arguing for or against increased or decreased use of nuclear power in the United States. (Examine the burdens and benefits for the use of nuclear energy.) Use radioactivity knowledge to date an artifact in a hypothetical archaeological situation. Quizzes and Tests **Instructional Strategies: Interdisciplinary Connections** RST.9-10.7 Translate quantitative or technical information expressed in worse in a text into visual form or mathematically into words. RST.11-12.1 Cite Specific textual evidence to support analysis of science and technical texts, attending to important

	distinctions the author makes and to any gaps or inconsistencies in the account. WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.9-12.5 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. **Technology Integration** ● Use spreadsheet, graphing calculator and other analysis tools to examine mathematical relationships. ● Use online simulations to build atoms, observe phase changes and transfer of energy during nuclear/chemical reactions. **Media Integration** ● Use the “Hindenburg” article to relate Chemistry to a historical event. ● Investigate the nuclear power plant disasters of Chernobyl and Fukushima; discuss causes, preventions and future implications. **Global Perspectives** ● Examine periodic tables from other countries to see how the study of Chemistry is similar and is different across the globe ● Discuss scientific involvement from other countries in the discovery of the atom and its subatomic particles. ● Investigate use of Nuclear Power around the world.

Unit 3
Bonding and Combining Elements

NEXT GENERATION SCIENCE STANDARD PS1.A: Structure and Property of Matter PS2.B: Types of Interactions ESS2.C: The Roles of Water in Earth's Surface Processes
Big Ideas **Developing and Using Models** Students use, synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Use a model to predict the relationships between systems or between components of a system. **Planning and Carrying Out Investigations** Students plan investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. **Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. **Energy and Matter** The total amount of energy and matter in closed systems is conserved.

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Stability and Change

Much of science deals with constructing explanations of how things change and how they remain stable.

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
● Why do substances react? ● *What can the formulas of substances tell us about the properties of that substance?* ● How can we visually represent what is happening when a bond forms? ● What determines the properties of substances, such as melting point, solubility in water and electrical conductivity?	**PS1.A: Structure and Properties of Matter** ● The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. ● 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. ● 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. **PS2.B: 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. **ESS2.C: The Roles of Water in Earth's Surface Processes** ● The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities

	and melting points of rocks. (HS-ESS2-5)

Areas of Focus: Proficiencies (Cumulative Progress Indicators)	Examples, Outcomes, Assessments
HS-PS1-1 Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. **HS-PS1-3** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. **HS-PS2-4** Use mathematical representations of Coulomb's Law to describe and predict the electrostatic forces between objects. **HS-PS2-6** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. **HS-ESS2-5** Plan and conduct an investigation of the properties of water and its effects on Earth's materials and surface processes.	**Instructional Focus:** ● Describe ion formation based on electron configuration. ● Distinguish between ionic and covalent bonds in terms of electron behavior as well as the properties of compounds that contain each type. ● Describe metallic bonding and how it affects the properties of metals. ● *Write chemical formulas and names for ionic and binary molecular compounds.* ● Draw Lewis structures for a variety of molecular compounds *and polyatomic ions*. ● Describe and name the forces that hold substances together as ionic, molecular, metallic, or network. ● Predict the properties of substances by the forces that hold them together. ● *Determine molecular polarity from structures and describe its effect on the properties of a sample of matter.* ● Describe the intermolecular attractions that hold water molecules together and the properties of water that is caused by those forces ● Describe the process of solution formation. Distinguish between electrolytes and non-electrolytes. **Sample Assessments:** ● Lab: Ionic Compounds ● *Activity: Ionic Bonding Puzzle* ● Lab: Lewis structures ● Lab: Types of Solids ● *Lab: Gold/Silver Pennies* ● Quizzes and Tests **Instructional Strategies:** **Interdisciplinary Connections**

	WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.9-12.5 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. RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. **Technology Integration** ● Use computer simulations to model the different types of bonds and the solvation process **Media Literacy Integration** ● Watch youtube video on the Physics on N95 Masks—describe how IMFs take a role in “blocking” microscopic particles from entering **Global Perspectives** ● Discuss the distribution and extraction of mining resources worldwide and their impact on the ecosystem.

Unit 4
Chemical Reactions

NEXT GENERATION SCIENCE STANDARDS

PS1.A: Structure and Properties of Matter
PS1.B: Chemical Reactions
PS2.B: Types of Interactions
PS3.A: Definitions of Energy
PS3.B: Conservation of Energy and Energy Transfer
PS3.D: Energy in Chemical Processes

Big Ideas: Bonding and Chemical Reactions

Energy and Matter

The total amount of energy and matter in closed systems is conserved.

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Stability and Change

Much of science deals with constructing explanations of how things change and how they remain stable.

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Science assumes the universe is a vast single system in which basic laws are consistent.

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the Big Ideas?*
● Why do substances react? ● Why do atoms rearrange in predictable patterns during chemical reactions?	Students will understand that… 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

● How can we visually represent what is happening when a bond forms? ● How can we represent a chemical reaction both quantitatively and qualitatively? ● What role does energy play in chemical reactions? ● Which factors determine whether a reaction occurs and how fast it occurs? ● How do you make more products?	sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS- PS1-4),(HS-PS1-5) 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. (HS-PS1-6) 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. (HS-PS1-2),(HS-PS1-7) 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), (secondary to HS-PS1-1),(secondary to HS-PS1-3) 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. (HS-PS3-1),(HS-PS3-2) Uncontrolled systems always evolve toward more stable states— that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4) Although energy cannot be destroyed, it can be converted to less useful forms for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4)
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	**Examples, Outcomes, Assessments**

HS-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. **HS-PS1-4** 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-PS1-5** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration on the reacting particles on the rate at which a reaction occurs. **HS-PS1-6** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. **HS-PS1-7** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. **HS-PS2-6** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* **HS-PS3-1** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. **HS-PS3-2** Develop and use models to illustrate the energy on the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects)and energy associated with the relative position of particles (objects)	**Instructional Focus**: ● Represent chemical reactions as chemical equations. ● Balance chemical equations as a consequence of conservation of matter and modern atomic theory. ● *Recognize patterns in order to predict the products for a given set of reactants.* ● Use balanced chemical reactions to quantitatively predict the masses of substances in chemical reactions. ● Explain the qualitative and quantitative energy changes that occur during a chemical reaction. (Enthalpy and the 1st Law of Thermodynamics) ● Use collision theory to explain the impact of temperature, concentration, catalysts and the energy of activation on the rates of chemical reactions. ● Describe how reversible chemical reactions have forward and reverse reactions occurring simultaneously and can establish a condition known as equilibrium. ● Explain how adjusting the conditions of a chemical reaction in equilibrium can maximize the production of product or reactant. (LeChatelier's principle) ● Define and qualitatively predict entropy changes in chemical reactions. ● Explain entropy and the 2nd Law of Thermodynamics **Sample Assessments**: ● Lab: Chemical Reactions ● Lab: Mass-mass lab $NaHCO_3$ + HCl ● Lab: Hot pack / Cold pack ● Lab: Heating/Cooling Curve (Identify and describe Potential and Kinetic energy in a variety of natural and designed contexts.) ● Lab: Calorimetry lab ● Lab: Factors affecting reaction rates or *Lab: Iodine clock lab* ● Lab: Le Chatelier's Principle ● *Lab: Entropy in the dissociation of* NH_4NO_3 ● Quizzes and Tests

HS-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). **HS-ES2-4** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	**Instructional Strategies:** **Interdisciplinary Connections** RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. WHST .9 -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 -12.7 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 over reliance on any one source and following a standard format for citation. WHST.11-12.8 Draw evidence from informational texts to support analysis, reflection, and research. WHST.9-12.9 SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. MP.2 Reason abstractly and quantitatively. MP.4 HSN-Q.A.1 Model with mathematics. Use units as a way to understand problems and to guide the solution of

	multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN-Q.A.2 HSN-Q.A.3 Define appropriate quantities for the purpose of descriptive modeling. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **Media Literacy Integration** ● Read article on hydrofluoric acid from scientific journal and then watch episode of ER or Breaking Bad about this acid—look for misleading info in ER episode—compare fiction vs. non-fiction representation of the topic **Global Perspectives** ● Compare safety requirements in chemical industries in different countries.

Unit 5

Chemistry in Everyday Life
(Environmental Chemistry)

NEXT GENERATION SCIENCE STANDARDS

PS1.A: Structure and Properties of Matter
PS1.B: Chemical Reactions
PS2.B: Types of Interactions
PS3.A: Definitions of Energy
PS3.B: Conservation of Energy and Energy Transfer
PS3.D: Energy in Chemical Processes
ESS2.C: The Roles of Water in Earth's Surface Processes
ESS2.D: Weather and Climate

Big Ideas:
Developing and Using Models

Students use, synthesize, and develop models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Use a model to predict the relationships between systems or between components of a system.

Planning and Carrying Out Investigations

Students plan investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Patterns

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

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 inv olv e scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-2),(HS-ESS1-4)

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
● What role does chemistry play in the world around us? ● Is chemistry the cause or the solutions to today's environmental problems?	Students will understand that… 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. (HS- PS1-4),(HS-PS1-5) 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.(HS-PS3-1), (HS-PS3-2) Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2- 6),(HS-ESS2-4) The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

	(HS-ESS2-5)
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	**Examples, Outcomes, Assessments**
HS-PS1-2: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. **HS-PS1-4:** 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-PS2-6**: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. **HS-ESS2-4:** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. **HS-ESS2-5** Plan and conduct an investigation of the properties of water and its effects on Earth's materials and surface processes. **HS-ESS3-1:** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. **HS-ESS3-4:** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* **HS-ESS3-5:** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate	**Instructional Focus**: ● Describe the properties of gases using kinetic molecular theory and the impact of pressure, temperature, and moles ● Conduct an investigation into the gases in the Earth's atmosphere and the changes of those components overtime. Explore the properties of each of these gases. Create and examine the relationships between those gases and climate of the planet. ● Describe the Greenhouse Effect. ● Describe the evidence, cause and effect of climate change. ● Analyze your ecological footprint and propose possible solutions to relieve climate change. ● 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). ● Describe 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. ● *Design and conduct an investigation into the various options for solving the increasing prevalence of drought issues across the globe. (e.g. Purification, desalination conservations etc.)* **Sample Assessments**: ● Lab: Investigating Properties of Gas ● Lab: Eudiometer lab Mg + HCl ● Lab: Titration of vinegar. ● Describe the process of energy transformation in a variety of natural and designed contexts.

change and associated future impacts to Earth systems.	● Cost benefit analysis of petroleum as a source of energy. ● Coin design ● Cradle to grave analysis of metallic ore from the standpoint economic benefit and environmental costs **Instructional Strategies: Interdisciplinary Connections** ● RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS2-2),(HS-ESS2-3) ● RST.11-12.2: Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2) ● WHST.9-12.1 WHST.9-12.7: Write arguments focused on discipline-specific content. (HS-ESS2-7) ● SL.11-12.5: 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. (HS-ESS2-5) Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4) Mathematics: ● MP.2 Reason abstractly and quantitatively. (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)

	● MP.4 HSN-Q.A.1: Model with mathematics. (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6) ● HSN-Q.A.2 HSN-Q.A.3: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6) ● HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6) ● HSN-Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6) **Technology Integration** New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS2-2) **Global Perspectives** ● Investigate the geopolitical effects of energy policy.

Curricular Addendum

Career-Ready Practices **CRP1**: Act as a responsible and contributing citizen and employee. **CRP2**: Apply appropriate academic and technical skills. **CRP3**: Attend to personal health and financial well-being. **CRP4**: Communicate clearly and effectively and with reason.	**Interdisciplinary Connections** ● Close Reading of works of art, music lyrics, videos, and advertisements ● Use Standards for Mathematical Practice and Cross-Cutting Concepts in science to support debate/inquiry across thinking processes **Technology Integration**

CRP5: Consider the environmental, social and economic impacts of decisions.
CRP6: Demonstrate creativity and innovation.
CRP7: Employ valid and reliable research strategies.
CRP8: Utilize critical thinking to make sense of problems and persevere in solving them.
CRP9: Model integrity, ethical leadership and effective management.
CRP10: Plan education and career paths aligned to personal goals.
CRP11:. Use technology to enhance productivity.
CRP12: Work productively in teams while using cultural global competence.

Ongoing:

- Listen to books on CDs, Playaways, videos, or podcasts if available.
- Use document camera or overhead projector for shared reading of texts.

Other:

- Use Microsoft Word, Inspiration, or SmartBoard Notebook software to write the words from their word sorts.
- Use available technology to create concept maps of unit learning.

Instructional Strategies:
Supports for English Language Learners:

Sensory Supports	Graphic Supports	Interactive Supports
Real-life objects (realia)	Charts	In pairs or partners
Manipulatives	Graphic organizers	In triads or small groups
Pictures & photographs	Tables	In a whole group
Illustrations, diagrams, & drawings	Graphs	Using cooperative group structures
Magazines & newspapers	Timelines	With the Internet (websites) or software programs
Physical activities	Number lines	In the home language
Videos & films		With mentors
Broadcasts		
Models & figures		

from https://wida.wisc.edu

Media Literacy Integration

- Use multiple forms of print media (including books, illustrations/photographs/artwork, video clips, commercials, podcasts, audiobooks, Playaways, newspapers, magazines) to practice reading and comprehension skills.

Global Perspectives

- The Global Learning Resource Library

Differentiation Strategies:

Accommodations	Interventions	Modifications
Allow for verbal responses	Multi-sensory techniques	Modified tasks/ expectations
Repeat/confirm directions	Increase task structure (e.g., directions, checks for understanding, feedback)	Differentiated materials
Permit response provided via computer or electronic device	Increase opportunities to engage in active academic responding (e.g., writing, reading aloud, answering questions in class)	Individualized assessment tools based on student need
Audio Books	Utilize prereading strategies and activities: previews, anticipatory guides, and semantic mapping	Modified assessment grading
