CHEMISTRY

COURSE OUTLINE		
Unit One	*Introduction to Chemistry and Lab Safety*	*3 weeks*
Unit Two	*Scientific Measurement & Data Collection*	*2 weeks*
Unit Three	*Properties of Matter*	*4 weeks*
Unit Four	*Structure of Matter*	*4.5 weeks*
Unit Five	*Waves and Electromagnetic Radiation*	*3 weeks*
Unit Six	*Understanding Chemical Reactions*	*6 weeks*
Unit Seven	*Modifying Chemical Reactions*	*7 weeks*
Unit Eight	*Conservation of Energy & Energy Transfer*	*3.5 weeks*
Unit Nine	*Introduction to Organic Chemistry*	*3 weeks*

School-wide Academic Expectations Taught In This Course

- Communication
- Collaboration
- **Analysis**
- Literacy

School-wide Social and Civic Expectations Taught in This Course

- Resiliency
- Responsibility
- Respect

Performance Expectations Taught in This Course		
UNIT 1	HS-ETS1-3.	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts
UNIT 2	HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
	CCSS.Math.Content.HSN.Q.A.1	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.
	CCSS.Math.Content.HSN.Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
	CCSS.Math.Content.HSN.Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
UNIT 3	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.
	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. *(chemical*

		bond lab)
	HS-ESS2-5	Plan and conduct an investigation of the properties of water.
UNIT 4	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-PS1-8	Develop models to illustrate the changes in the composition of the nucleus of the atom.
	HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
UNIT 5	HS-PS4-1	Use mathematical representations to support a claim regarding relationships among frequency, wavelength, and speed of waves traveling through various media.
	HS-PS4-3	Evaluate the claims, evidence and reasoning behind the idea that electromagnetic radiation can be describes by either a wave model or a particle model, and that for some situations, one model is more useful than the other.
	HS-PS4-4	Evaluate the validity and reliability of claims in published material of the effects that different frequencies of electromagnetic radiation have when absorbed by matter
	HS-PS4-5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
	HS-ESS1-2	Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distance galaxies, and composition of matter in the universe. *(Flame Test Lab)*
UNIT 6	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.
	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 on 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** of reacting particles on the rate at which a reaction occurs. *Fire extinguisher Lab*
UNIT 7	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.
	HS-PS1-5	Apply scientific principles and evidence to provide an explanation about the effects of changing the **temperature** or concentration of 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 *(Le Chatelier's Principle)*
	HS-PS1-7	Use mathematical representation to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. *(Conservation of Mass Lab)*
UNIT 8	HS-PS3-3	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. *(electrochemistry lab)*
	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 in a more uniform energy distribution among the components in the system *(second law of thermodynamics)*
UNIT 9	HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy
	HS-LS1-6	Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

Unit 1: Introduction to Chemistry and Lab Safety

Introduction: Chemicals, even water can cause harm. The challenge is to know how to use chemicals and equipment properly, to ensure success and safety in the laboratory setting.

Next Generation Science Standard: OSHA and HS-ETS1-3

Science & Engineering Practices: Constructing Explanation and Designing Solutions

Crosscutting Concepts: Cause and Effect, Structure and Function

Common Core Standard(s):

ELA/Literacy -

- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-3)
- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-3)
- RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-3)

Mathematics –

- MP.2 Reason abstractly and quantitatively. (HS-ETS1-3)
- MP.4 Model with mathematics. (HS-ETS1-3)

Essential Question(s):

- What tools are used in the laboratory and how should these tools be used properly?
- What safety precautions should be taken in the laboratory setting?

Key Terms/Concepts: Safety is the top priority in the lab. The proper equipment must be used correctly to ensure safety and good experimental results.

LEARNING PLAN

Performance Expectation	Disciplinary Core Ideas (DCI):	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
HS ETS1-3	**ETS1.B: Developing Possible Solutions** 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.	Notes & Class Discussion – Importance of Lab Safety and Standard Laboratory Protocol LAB(s) • Equipment Identification Activity • Introduction to Standard Laboratory Techniques DVD – Lab Safety	Oral Response Performance Based Assessment On-going Assessment
			Unit Quiz

Suggested Resources and Texts:

Modern Chemistry: Holt Rinehart & Winston (2012), *ChemFile Lab Program*: Holt Rinehart & Winston

Suggested Technology: Computer & Epsom Board

Unit 2: Scientific Measurement & Data Collection

Introduction: Most scientific discoveries come about through the carefully planned investigation. The process scientists used is often referred to as the scientific method. This method is a general approach to problem solving and requires accurate measurements, computational thinking, and proper communication of data and ideas.

Next Generation Science Standard: HS-PS1-7, CCSS.Math.Content.HSN. Q.A.1-3

Science & Engineering Practices: Using Mathematics and Computational Thinking

Crosscutting Concepts: Patterns, Systems and System Models, Scale, Proportion and Quantity

Common Core Standard(s):

ELA/Literacy –

- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1)
- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1)
- RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1)

Mathematics –

- MP.2 Reason abstractly and quantitatively. (HS-PS1-7)
- MP.4 Model with mathematics. (HS-ETS1-1)
- HSN-Q.A.1 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-PS1-7)
- HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-7)
- HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-7)

Essential Question(s):

- What are the standard units of measurement, used in chemistry?
- How does one adjust the scale of various measurements?
- How is matter qualitatively and quantitatively measured?
- What is the proper method for recording and presenting data?
- What are the components of a properly constructed graph?

Key Terms/Concepts: Metric System, Conversion Factors, Independent v Dependent Variables, Experimental Controls, Accuracy v Precision, Significant Figures, Scientific Notation.

LEARNING PLAN

Performance Expectation	Disciplinary Core Ideas (DCI):	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
HS PS1-7	**PS1.B: Chemical Reactions** 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.	Notes & Class Discussion – Measurement and Data Collection in Science Skills: • Metric Conversion • Reading a Ruler • Reading a Graduated Cylinder	Oral Responses Performance Task
CCSS.Math.Content.HSN.Q.A.1	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.	POGIL – Fundamentals of Experimental Design Practice Problems: • Unit conversion Analyze Graphs – format and presentation of information	Embedded Assessment Performance Task: on-going Performance Task: on-going
CCSS.Math.Content.HSN.Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.	POGIL – Significant Digits and Measurement	Embedded Assessment Performance Task: on-going
CCSS.Math.Content.HSN.Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	LAB(s) • Accuracy & Precision	Performance Task
			Unit Test

Suggested Resources and Texts:

Modern Chemistry: Holt Rinehart & Winston (2012), *ChemFile Lab Program*: Holt Rinehart & Winston, *Low-Risk Chemistry Labs*: David Dougan (1997), Flinn – POGIL Chemistry Activities

Suggested Technology: Computer & Epsom Board, Calculators

Unit 3: Properties of Matter

Introduction: Chemistry is the study of the composition, structure and properties of matter and the changes it undergoes. Chemistry is central to all sciences – living and nonliving matter have a chemical structure.

Next Generation Science Standard: HS–PS1-1, HS-PS1-3, HS-ESS2-5

Science & Engineering Practices: Developing and Using Models; Planning and Carrying Out Investigations; Obtaining, Evaluating and Communicating Information

Crosscutting Concepts: Patterns; Energy and Matter; Structure and Function

Common Core Standard(s):

ELA/Literacy –

- 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. (HS-PS1-1)
- 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-PS1-3)
- 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. (HS-PS1-3), (HS-ESS2-5)
- WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3)
- 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. (HS-PS1-3)

Mathematics -

- HSN-Q.A.1 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-PS1-3)
- HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-3), (HS-ESS2-5)

Essential Question(s):

- How can we describe and measure the properties of matter?
- What causes different materials to have different properties?
- How can we infer the structure of matter at the atomic scale from properties of matter observed?

- How can the periodic table be used as a tool to determine the properties of matter?

Key Terms/Concepts:

Atom, States of Matter, Physical vs Chemical Properties, Physical v Chemical Changes, Properties Related to Placement on Periodic Table, Valence Electrons, Gas Laws

LEARNING PLAN

Performance Expectation	Disciplinary Core Ideas (DCI):	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
HS PS1-1	**PS1.A: Structures and Properties of Matter** Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. 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.	*Phenomenon* – Hungry Dragon demonstration (Flinn) Notes & Discussion – Composition and Structure of Matter LAB(s) • Phase Change (PhET) • Conservation of Mass **(self-designed)** • Mixture Separation **(self-designed)** • Rutherford's Experiment – BYU Virtual Lab Activity - 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 DVD – Periodic Table	Exploration Slip Oral Response Performance Task On-going Performance Task
HS-PS1-3.	**PS2.B: Types of Interactions** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and	Notes & Discussion – Atomic Structure POGIL – Atomic & Electron Structure	Oral Responses Written Responses

	transformations of matter, as well as the contact forces between material objects.		
HS-ESS2-5	**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...	Notes & Discussion – Properties of Water LAB(s) • Heat of Fusion of Ice	Oral Responses Performance Task
			Unit Test

Suggested Resources and Texts:
Modern Chemistry: Holt Rinehart & Winston (2012), *ChemFile Lab Program*: Holt Rinehart & Winston, *Low-Risk Chemistry Labs*: David Dougan (1997), Flinn – POGIL Chemistry Activities

Suggested Technology: Computer & Epsom Board, Virtual Lab – Brigham Young University, PhET Interactive Simulations

Unit 4: Structure of Matter

Introduction: All matter, whether a solid, liquid, or gas, is composed of atoms. Therefore, the atom is the basic building block of matter. However, atoms are almost always grouped together with other atoms to form what is called a molecule. It is these molecules that make up the matter we interact with in our everyday world.

Next Generation Science Standard: HS-PS1-1, HS-PS1-8, HS-PS2-6

Science & Engineering Practices: Developing and Using Models; Obtaining, Evaluating and Communicating Information

Crosscutting Concepts: Structure and Function, Energy and Matter

Common Core Standard(s):

ELA/Literacy –

- 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-PS2-6)
- WHST.11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS2-6)

Mathematics –

- MP.4 Model with mathematics. (HS-PS1-8)
- HSN.Q.A.1 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-PS2-6), (HS-PS1-8)
- HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-6), (HS-PS1-8)
- HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-6), (HS-PS1-8)

Essential Question(s):

- How is matter structured or organized?
- What is the structure of the atom?
- How do we know the structure of an atom?
- What information can be obtained from the various atomic models?

Key Terms/Concepts:
Atoms v Molecules, Protons, Neutrons, Electrons, Electron Arrangement, Quarks, Thompson Experiment, Rutherford Experiment, Bohr Model of the Atom.

LEARNING PLAN

Performance Expectation	Disciplinary Core Ideas (DCI):	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
HS-PS1-1	**PS1.A: Structure and Properties of Matter** Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.	Notes & Discussion – Development of Atomic Theory DVD – Atomic Structure Engineering Activity – Build & Research Element/Atom LAB(s) • Growing Crystals in Gel (Flinn)	Oral Responses 3D Model of Atom & Research Presentation
HS-PS1-8	**PS1.C: Nuclear Processes** 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.	Notes & Discussion – Nuclear Chemistry LAB(s) • M&M Half-Life Simulation • PhET Simulations: Fission & Fusion Practice Problems – Identify types of nuclear reaction and write nuclear equations	Oral Responses Embedded Task Quiz
HS-PS2-6	**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.	Notes & Discussion – Ions vs Isotopes POGIL – Ions & Isotopes Practice Problems – Determine number of subatomic particles, mass and charge	Oral Responses Embedded Task Exit Slip
			Unit Test

Suggested Resources and Texts:
Modern Chemistry: Holt Rinehart & Winston (2012), *ChemFile Lab Program*: Holt Rinehart & Winston, Model Building Kits, Flinn – POGIL Chemistry Activities

Suggested Technology: Computer & Epsom Board, PhET Interactive Simulations

Unit 5: Waves and Electromagnetic Radiation

Introduction: Much of what we know about the structure of the atom was determined by observing the interaction of atoms with various forms of radiant, or transmitted, energy. The development of our current atomic model begins by describing the properties of waves and the various forms of electromagnetic radiation.

Next Generation Science Standard: HS-PS4-1, HS-PS4-3, HS-PS4-4

Science & Engineering Practices: Asking Questions and Defining Problems; Using Mathematics and Computational Thinking; Engaging in Argument from Evidence; Obtain, Evaluating, and Communicating Information.

Crosscutting Concepts: Cause and Effect; Systems and System Models; Stability and Change

Common Core Standard(s):

ELA/Literacy –

- RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-PS4-3), (HS-PS4-4)
- 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-PS4-3), (HS-PS4-4)
- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS4-1), (HS-PS4-4)
- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-PS4-3), (HS-PS4-4)
- 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. (HS-PS4-4)

Mathematics –

- MP.2 Reason abstractly and quantitatively. (HS-PS4-1), (HS-PS4-3)
- MP.4 Model with mathematics. (HS-PS4-1)

- HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS4-1), (HS-PS4-3)
- HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-1), (HS-PS4-3)
- HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1), (HS-PS4-3)

Essential Question(s):

- What is the relationship between wavelength, frequency and the speed of light?
- Describe the dual wave-particle nature of light.
- How can light be used to identify elemental composition?
- What are electron transitions and how do they relate to energy?
- How did the study of light help develop the model of the atom?
- How is the quantum model of the atom different from the Bohr model?

Key Terms/Concepts: Wavelength, Frequency, Speed of Light, Photoelectric Effect, Line Emission Spectrum, Energy (Joules), Quantum Model of Atoms, Electron Configurations.

LEARNING PLAN

Performance Expectation	Disciplinary Core Ideas (DCI):	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
HS-PS4-1	**PS4.A: Wave Properties** The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.	*Phenomenon* – Flame Test of Copper and Radiometer Demonstration Notes & Discussion – Modern Atomic Theory Practice Problems – determine the wavelength or frequency of various EM waves	Exploration Slip Oral Responses Embedded Task
HS-PS4-3	**PS4.B: Electromagnetic Radiation** Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of	Notes & Discussion – Electromagnetic Spectrum and Radiation LAB(s) • PhET Simulations – Waves • Slinky Lab	Oral Responses Embedded Task

	electromagnetic radiation, and the particle model explains other features.		
HS-PS4-4	**PS4.B: Electromagnetic Radiation** When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.	POGIL – Electron Energy & Light	Written & Oral Responses
HS-PS4-5	**PS3.D: Energy in Chemical Processes** Solar cells are human-made devices that capture the sun's energy and produce electrical energy. **PS4.B: Electromagnetic Radiation** Photoelectric materials emit electrons when they absorb light of a high-enough frequency	LAB(s) • PhET – Photoelectric Effect Notes & Discussion – Quantum Model POGIL – Electron Configurations Practice Problems – Electron Configurations	Embedded Task Oral Responses Embedded Task Quiz
HS-ESS1-2	**ESS1.A: The Universe and Its Stars** The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. The Big Bang theory is supported by observations of distant galaxies receding from	LAB(s) • Flame Test – Identification of Unknown Metals	Formal Lab Report

	our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. 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.		
			Unit Test

Suggested Resources and Texts:
Modern Chemistry: Holt Rinehart & Winston (2012), Flinn – POGIL Chemistry Activities

Suggested Technology: Computer & Epsom Board, PhET Interactive Simulations

Unit 6: Understanding Chemical Reactions

Introduction: Many substances react chemically with other substances to form new substances with different properties. Understanding chemical reactions and the properties of elements is essential not only to the physical sciences but also is foundational knowledge for the life sciences and the earth and space sciences. The cycling of matter and associated transfers of energy in systems, of any scale, depend on physical and chemical processes. (from *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* pages 109-110)

Next Generation Science Standard: HS-PS1-1, HS-PS1-2, HS-PS1-4, HS-PS1-5

Science & Engineering Practices: Developing and Using Models; Planning and Carrying Out Investigations; Using Mathematics and Computational Thinking; Constructing Explanations and Designing Solution

Crosscutting Concepts: Patterns, Energy and Matter, Stability and Change, Scale, Proportion & Quantity

Common Core Standard(s):

ELA/Literacy –

- 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. (HS-PS1-1)
- WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-2), (HS-PS1-5)
- 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. (HS-PS1-4)

Mathematics –

- MP.2 Reason abstractly and quantitatively. (HS-PS1-5)
- MP.4 Model with mathematics. (HS-PS1-4)
- HSN-Q.A.1 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-PS1-2), (HS-PS1-4), (HS-PS1-5)
- HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4)
- HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2), (HS-PS1-4), (HS-PS1-5)

Essential Question(s):

- How has the periodic table evolved over time?
- What information can be obtained from the periodic table and how can this information be used?
- How are chemical compounds represented and what information can be obtained from chemical formulas?

- What are the three basic types of chemical bonds?
- How do the various chemical bonds form and behave?
- How can chemical reactions be classified?
- What evidence suggests a chemical reaction has occurred?
- How is a nuclear reaction different from a chemical reaction?
- How can a chemical equation be used to make predictions?

Key Terms/Concepts: Periodic Law, Chemical Formulas, Chemical Equations, Chemical Reactions, Nuclear Chemistry, Mole, Molar Conversions, Stoichiometry.

LEARNING PLAN

Performance Expectation	Disciplinary Core Ideas (DCI):	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
HS PS1-1	**PS1.A: Structure and Properties of Matter** 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.	Notes & Discussion – Chemical Bonds Activity – Use periodic table to predict types of chemical bond formation LAB(s) • Chemical Bonds	Oral Responses Performance Task Performance Task, Written & Oral Responses
HS-PS1-2	**PS1.A: Structure and Properties of Matter** 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.	POGIL – Cracking the Periodic Table Code	Embedded Task
HS-PS1-4	**PS1.B: Chemical Reactions** Chemical processes, their	Notes & Discussion – Types of Chemical Reactions, and Stoichiometry	Oral Response

	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.	Practice Problems • Naming Chemical Compounds • Writing Chemical Formulas Skill Development: • Determining Empirical Formulas • Solve Stoichiometric Problems LAB(s) • Types of Chemical Reactions • Naming Ionic Compounds • Determining Empirical Formulas • Target Stoichiometry (Flinn)	Exit Slips On-going Performance Task Performance Task
HS-PS1-5	**PS1.B: Chemical Reactions** Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules.	LAB(s) • Identification of 11Unknowns	Written responses
			Unit Test

Suggested Resources and Texts:

Modern Chemistry: Holt Rinehart & Winston (2012), *ChemFile Lab Program*: Holt Rinehart & Winston, *Low-Risk Chemistry Labs*: David Dougan (1997), Flinn – POGIL Chemistry Activities

Suggested Technology: Computer & Epsom Board

Unit 7: Modifying Chemical Reactions

Introduction: Whether it be a fire raging across a forest, the slow process of iron rusting in the presence of oxygen and water, or the delicate way in which fruit ripens on a tree, the process of converting one set of chemical substances to another set of substances is one known as a chemical reaction. Various factors affect rate of chemical reactions and can be used to modify the chemical reactions.

Next Generation Science Standard: HS-PS1-1, HS-PS1-5, HS-PS1-6, HS-PS1-7

Science & Engineering Practices: Developing and Using Models; Planning and Carrying Out Investigations; Using Mathematics and Computational Thinking; Constructing Explanations and Designing Solution

Crosscutting Concepts: Patterns, Energy and Matter, Stability and Change, Scale, Proportion & Quantity

Common Core Standard(s):

ELA/Literacy –

- 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. (HS-PS1-1)
- WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-5)
- 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. (HS-PS1-6)

Mathematics –

- MP.2 Reason abstractly and quantitatively. (HS-PS1-5), (HS-PS1-7)
- HSN-Q.A.1 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-PS1-5), (HS-PS1-7)
- HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-7)
- HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-5), (HS-PS1-7)

Essential Question(s):

- What factors will influence a chemical reaction and how will the reaction be influenced?
- What factors will influence gas production in a chemical reaction?
- What is the practical application of colligative properties and the heat of solution?
- What impact do acid/base reactions have on our lives?
- How is pH determined and calculated?

Key Terms/Concepts: Solutions & Colligative Properties, Molarity, Molality, Gas Laws, Acid/Base Reactions, pH, Boiling Point Elevations, Freezing Point Depression, Osmotic Pressure, Vapor Pressure, Heat of Solution, Le Châtelier's Principle, Henry's Law.

LEARNING PLAN

Performance Expectation	Disciplinary Core Ideas (DCI):	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
HS PS1-1	**PS1.A: Structure and Properties of Matter** 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.	*Phenomenon* – Hot Pack Demo Notes & Discussion – Factors Influencing Chemical Reactions LAB(s) • Oxygen & Hydrogen Production Notes & Discussion – Gas Laws Practice Problems – Mathematics of Gas Laws Video Clip Analysis – make a prediction based on application of Graham's Law of Effusion LAB(s) • Biggest Bang **(self-designed)**	Exploration Slip Performance Task Oral Response Embedded Task Performance Task
HS-PS1-5	**PS1.B: Chemical Reactions** Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.	*Phenomenon* – Laser & Canned Fog (Tyndall Effect) Notes & Discussion – Solutions, Suspensions & Colloids Skill Development: • Interpreting Solubility Guidelines and Solubility Graphs • Determining Concentrations	Exploration Slip Oral Responses Performance Task & on-going assessment

		LAB(s) • Solutions, Suspensions & Colloids • Temperature v Solubility • Predicting Boiling Points Notes & Discussion – Acids & Bases Skill Development: • Determine $[H_3O^+]$, $[OH^-]$, pH and pOH • Determine Molarity of Unknown Acid/Base LAB(s) • Exploration of Acid/Base Indicators • Determining pH of Unknown Solution • How Much $CaCO_3$ is in an Eggshell • Which Antacid is the Best? **(self-designed)**	Performance Task Sub Unit Quiz Oral Response Embedded Task Embedded Task Performance Task Formal Presentation Sub Unit Quiz
HS-PS1-6	**PS1.B: Chemical Reactions** 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.	Notes & Discussion - Equilibrium Skill Development: • Predict result of reactions when stress is applied LAB(s) • Le Châtelier's Principle (Flinn)	Oral Responses Written Responses Performance Task
HS-PS1-7	**PS1.B: Chemical Reactions** Atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict	LAB(s) • Fire Extinguisher (CAPT) **(self-designed)**	Formal Written Report

	chemical reactions.		
			Sub Unit Quiz

Suggested Resources and Texts:
Modern Chemistry: Holt Rinehart & Winston (2012), *ChemFile Lab Program*: Holt Rinehart & Winston, *Low-Risk Chemistry Labs*: David Dougan (1997), Flinn – POGIL Chemistry Activities

Suggested Technology: Computer & Epsom Board

Unit 8: Conservation of Energy & Transfer of Energy

Introduction: It is common for energy to be converted from one form to another; however, the law of conservation of energy, a fundamental law of nature, states that although energy can be changed in form it can be neither created nor destroyed. Many transformations of energy are of practical importance. Combustion of fuels results in the conversion of chemical energy into heat and light. In the electric storage battery chemical energy is converted to electrical energy. In the photosynthesis of starch, green plants convert light energy from the sun into chemical energy.

Next Generation Science Standard: HS-PS3-3, HS-PS3-4

Science & Engineering Practices: Planning and Carrying Out Investigations; Constructing Explanations and Designing Solutions

Crosscutting Concepts: Systems and System Models, Energy and Matter, Stability & Change

Common Core Standard(s):

ELA/Literacy -

- 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-PS3-4)
- 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. (HS-PS3-3), (HS-PS3-4)
- 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. (HS-PS3-4)
- WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS3-4)

Mathematics -

- MP.2 Reason abstractly and quantitatively. (HS-PS3-3), (HS-PS3-4)
- MP.4 Model with mathematics. (HS-PS3-3), (HS-PS3-4)
- HSN.Q.A.1 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-PS3-3)
- HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS3-3)
- HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS3-3)

Essential Question(s):

- How is matter different from energy?
- How can matter be used to produce energy?
- How does changing the heat of a system affect a reaction?
- What is a redox reaction and what are the practical applications of redox reactions?
- How can electricity be produced from a chemical reaction?

Key Terms/Concepts: Oxidation-Reduction Reactions, Oxidizing/Reducing Agents, Thermochemistry, Enthalpy, Exothermic v Endothermic Reactions, Hess's Law.

LEARNING PLAN

Performance Expectation	Disciplinary Core Ideas (DCI):	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
HS-PS3-3	PS3.A: **Definitions of Energy** At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light and thermal energy PS3.D: **Energy in Chemical Processes** Although energy cannot be destroyed, it can be converted to less useful forms.	Notes & Discussion – Redox Reactions & Electrochemistry Practice Problems - Determine Cell Potentials POGIL – Batteries LAB(s) • Oxidation-Reduction Reactions • Virtual Lab - Electrolytic Cell • Electroplating Lab **(self-**	Oral Response Embedded Task Written Response Performance Task Exit Slip &

		designed)	Product
HS-PS3-4	PS3.B: **Conservation of Energy and Energy Transfer** Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. PS3.B: **Conservation of Energy and Energy Transfer** Uncontrolled systems always evolve toward more stable states – that is, toward more uniform energy distribution.	*Phenomenon* - Drinking Bird Notes & Discussion- Thermodynamics LAB(s) • Hot Pack/Cold Pack **(self-designed)** • Thermodynamics— Enthalpy of Reaction and Hess's Law (Flinn)	Exploration Slip Oral Response Formal Presentation Performance Task
			Unit Test

Suggested Resources and Texts:
Modern Chemistry: Holt Rinehart & Winston (2012), Flinn – POGIL Chemistry Activities

Suggested Technology: Computer & Epsom Board

Unit 9: Introduction to Organic Chemistry

Introduction: Organic chemistry is the chemistry of carbon, an element that forms strong chemical bonds to other carbon atoms as well as to many other elements. Because of its versatility in forming covalent bonds, more than a million carbon compounds are known. Biological molecules in living systems are largely organic compounds. In this unit, both structure and composition of various hydrocarbons and biological compounds are introduced.

Next Generation Science Standard: HS-LS1-5, HS-LS1-6

Science & Engineering Practices: Developing and Using Models; Constructing Explanations and Designing Solutions

Crosscutting Concepts: Energy and Matter, Structure and Function, Systems & System Models

Common Core Standard(s):

ELA/Literacy -

- WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-6)
- 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. (HS-LS1-6)
- WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-6)
- 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. (HS-LS1-5), (HS-LS1-7)

Mathematics -

NONE

Essential Question(s):

- What is an organic compound?
- Why can carbon form so many compounds?
- What are polymers, how do they form and why are they important?
- How are the four biomolecules structurally different?
- How does each of the four biomolecules function in living things?
- How are macro-molecules are formed and how are they broken apart?

Key Terms/Concepts: Hydrocarbon Names & Structures, Alcohols, Aldehydes, Ketones, Esters, Ethers, Organic Acids, Biochemistry, Amino Acids, Fatty Acids, Proteins.

LEARNING PLAN

Performance Expectation	Disciplinary Core Ideas (DCI):	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
HS-LS1-5	LS1.C: **Organization for Matter and Energy Flow in Organisms** The sugar molecules thus formed contain carbon, hydrogen, and oxygen; Their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules.	Notes & Discussion Types of Organic Compounds Skill Development: • Name & Draw Structural Formulas LAB(s) • Model Building of Organic Compounds	Oral Responses Written & Oral Responses Performance Task
HS-LS1-6	LS1.C: **Organization for Matter and Energy Flow in Organisms** As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.	Notes & Discussion – Organic Reactions LAB(s) • Formation of Esters (Flinn) • Polymers • Modeling, Inquiry & Analysis – Biochemistry (Flinn)	Oral Responses Performance Tasks
			Unit Test

Suggested Resources and Texts:

Modern Chemistry: Holt Rinehart & Winston (2012), Model Building Kits, Flinn – POGIL Chemistry Activities

Suggested Technology: Computer & Epsom Board

APPENDIXES

Link to NGSS:
https://www.google.com/search?q=next+generation+science+standards&sourceid=ie7&rls=com.microsoft:en-us:ie-searchbox&ie=&oe=&safe=active&ibss=1&gws_rd=ssl

Crosscutting Concepts:

1. **Patterns**.
Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

2. **Cause and Effect: Mechanism and Explanation**.
Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

3. **Scale, Proportion, and Quantity.**
In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

4. **Systems and System Models**.
Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

5. **Energy and Matter: Flows, Cycles, and Conservation**.
Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

6. **Structure and Function**.
The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

7. **Stability and Change**.
For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Science and Engineering Practices

Asking Questions and Defining Problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

Planning and Carrying Out Investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

Constructing Explanations and Designing Solutions

The products of science are explanations and the products of engineering are solutions.

Engaging in Argument from Evidence

Argumentation is the process by which explanations and solutions are reached.

Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

POGIL (Process Oriented Guided Inquiry Learning): A student–centered, group-learning instructional strategy.