Science Pacing Guide
Chemistry

Time Frame: September – January
Unit 1: Structure and Properties of Matter

Science & Engineering Practices	Crosscutting Concepts	Literacy Standards	Mathematics Standards
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-8) • Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the	**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. (HS-PS1-1), (HS-PS1-3) **Energy and Matter** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) **Structure and Function** Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)	**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), (HS-PS2-6) **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS2-6) **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)	**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-PS1-3), (HS-PS1-8), (HS-PS2-6) **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-8), (HS-PS2-6) **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-3), (HS-PS1-8), (HS-PS2-6)

*Denotes a traditional science content integrated with engineering through a Practice or Disciplinary Core Idea.

Science & Engineering Practices	Crosscutting Concepts	Literacy Standards	Mathematics Standards
precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)		**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 following a standard format for citation. (HS-PS1-3) **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3)	

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
Students who demonstrate understanding can: **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. [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and	**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. (HS-PS1-1) The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar	How can one explain the structure, properties, and interactions of matter? What is the most useful type of information obtained by the	**Before:** KWL – Students will list what they know and what they want to know about atoms. This will be repeated with each concept throughout the unit. (periodic table, fusion, decay, etc) Quick Writes – Before each lesson students will be asked	Absorbance spectrum Actual mass Atomic bonding principles Atomic mass Atomic motion Atomic nucleus Atomic number Atomic theory Atomic weight Avogadro's hypothesis Avogadro's	http://periodic.lanl.gov/index.shtml Interactive periodic table – good for learning about elements http://www.chem4kids.com/map.html - has many chemistry topics including matter, atoms, periodic table, elements, reactions, and biochemistry. Has simple explanations and interactive activities.

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
reactions with oxygen.] [*Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.*] **HS-PS1-3** 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. [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [*Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.*] **HS-PS1-8** Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy release during the processes of fission,	chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1) The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3),(secondary to HS-PS2-6) **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. (HS-PS1-8) **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	organization of the periodic table? How is energy related to fusion, fission and radioactive decay? How do the properties of the atomic particles affect the interactions of those atoms?	to write their thoughts and questions for the day pertaining to the objectives. Pretest – Students will be given an assessment to understand their knowledge on the unit before instruction is given. **<u>During</u>:** Think/Pair/Share – Students will work in pairs to practice and reinforce rules as they are introduced. Conferences – Check for understanding by meeting with students during work time. Lab Investigations – Students will be responsible for developing and implementing one or more lab investigation(s) exploring the periodic table, nuclear processes, and properties of	number Binary Binary compound Bond energy Bright line spectrum Carbon atom Carbon atom Carbon dioxide Charged object Chemical bond Chemical properties of elements Covalent bond Crystalline solid Decay rate Double bond Earth's elements Electric force Electrical conductivity Electrically neutral Electromagnetic field Electromagnetic radiation Electromagnetic spectra Electromagnetic wave Electron Electron cloud Electron configuration Electron sharing	http://misterguch.brinkster.net/chemfiestanew.html - a Chemistry teacher's website with links to many activities and labs. Useful for ideas. **Periodic Table**: http://www.chem4kids.com/files/elem_intro.html - describes the periodic table, groups and families, characteristics, and offers interactive quizzes at the end of each section. http://education.jlab.org/elementflashcards/index.html - interactive site with flashcards on learning the elements – can be easy to very challenging. http://environmentalchemistry.com/yogi/periodic/crystal.html - interactive periodic table sorted by crystal structure http://periodic.lanl.gov/default.htm - basic interactive periodic table – includes history, properties, uses of the elements http://www.ptable.com/ - very informative interactive periodic table – includes groupings, properties, orbitals, and isotopes. http://www.webelements.com/ - very detailed interactive periodic table – has 19 different tabs -such as history, uses, biology, orbital properties – for each element

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
fusion, and radioactive decay. [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] [*Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.*] **HS-PS2-6** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [*Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.*] **HS-ETS1-2** Design a solution to			elements. **<u>After</u>:** Posttest: Students will be given a test after the unit has been completed and the Presentations have been given. Project: Students will create a presentation using multi-media (as a group) of this unit. This will include various concepts, experimental data, vocabulary, and applications in the "real world" and will focus on predictions of an imaginary element. Assessed by teacher created rubric.	Electron transfer Electro-negativity Element family Elementary particle Elements of matter Emission spectra Empirical formula Endothermic process Energy level Energy sublevels Enthalpy Excited state Exothermic process Fossil fuel Ground state Hydrocarbons Intermolecular force Ion Ionic bond Ionization energy Isomers Isotope Kernel Lewis structures Main energy level Main group elements	**Energy Levels**: http://www.colorado.edu/physics/2000/quantumzone/bohr2.html - simple site explaining energy levels from a physics point of view. http://education.jlab.org/qa/electron_config.html - explains electron configuration tables http://education.jlab.org/qa/electron_number.html - explains energy levels http://www.csun.edu/science/chemistry/ - Internet resources to accompany the Source Book for teaching Science. Has links to various topics. http://www.colorado.edu/physics/2000/quantumzone/bohr2.html Applet shows the Bohr model along with a diagram showing the energy level. **Electron Configuration**: http://education.jlab.org/qa/electron_config.html How to read an electron configuration table http://education.jlab.org/qa/electron_number.html How many electrons fit in each shell? http://www.lon-capa.org/%7Emmp/period/electron.htm Use this applet to explore

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.				Metallic bond Metalloids Mole Molecular formula Monomer Moving electric charge Neutron mass to energy conversion Nuclear reaction Orbital shape Orbitals Organic matter Outer electron Periodic table of the elements Polarity Potential energy Probability Protein Proton Quantum energy Quantum numbers Radioactive dating Radioactive decay Radioactive isotope Relative mass Release of energy Single bond Stable Strong force	in which order the atomic shells are filled with electrons http://library.thinkquest.org/10429/low/eleconfig/electron.htm Electron configuration, periodicity, atomic radius, ionization energy, electron affinity http://www.shodor.org/unchem/basic/nomen/index.html Review some of the rules and conventions of naming compounds http://www.visionlearning.com/library/module_viewer.php?mid=53 History and use of moles (Avogadro, Molar Mass, Atomic Weight, Molecular Weight, Mole/Weight relationships) http://www.matter.org.uk/Schools/Content/Reactions/BondEnergy.html Bond energy interactive site http://www.ptable.com/#Writeup/Wikipedia Interactive periodic table - includes properties, orbitals, isotopes http://education.jlab.org/elementflashcards/index.html Element Flash Cards - practice http://antoine.frostburg.edu/chem/senese/101/atoms/slides/sld001.htm Slides and notes on atomic

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
				Sublevel Synthetic polymer Thermal conductivity Transforming matter and/or energy Valence electrons Wave amplitude Wavelength Weight of subatomic particles	theory http://education.jlab.org/elementhangman/index.html Element Hangman http://www.pbslearningmedia.org/resource/phy03.sci.phys.matter.ptable/periodic-table-of-the-elements/ Interactive periodic table – games for predicting where elements belong http://www.ptable.com/#Writeup/Wikipedia Interactive periodic table - includes properties, orbitals, isotopes http://education.jlab.org/elementflashcards/index.html Element Flash Cards - practice http://antoine.frostburg.edu/chem/senese/101/atoms/slides/sld001.htm Slides and notes on atomic theory http://education.jlab.org/elementhangman/index.html Element Hangman http://www.pbslearningmedia.org/resource/phy03.sci.phys.matter.ptable/periodic-table-of-the-elements/ Interactive periodic table – games for predicting where elements belong

*Denotes a traditional science content integrated with engineering through a Practice or Disciplinary Core Idea.

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
					http://www.chemguide.co.uk/atoms/structures/molecular.html - This page describes how the physical properties of substances having molecular structures varies with the type of intermolecular attractions - hydrogen bonding or van der Waals forces.

Science Pacing Guide
Chemistry

Time Frame: January – April
Unit 2: Chemical Reactions

Science & Engineering Practices	Crosscutting Concepts	Literacy Standards	Mathematics Standards
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to support claims. (HS-PS1-7) **Constructing Explanations and Designing Solutions**	**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. (HS-PS1-2), (HS-PS1-5) **Energy and Matter** The total amount of energy and matter in closed systems is conserved. (HS-PS1-7) Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4) **Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6) **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. (HS-PS1-7)	**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-PS1-5) **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) **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-PS1-2) **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)	**MP.2** Reason abstractly and quantitatively. (HS-PS1-5), (HS-PS1-7) **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), (HS-PS1-7) **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4), (HS-PS1-7) **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), (HS-PS1-7)

*Denotes a traditional science content integrated with engineering through a Practice or Disciplinary Core Idea.

Science & Engineering Practices	Crosscutting Concepts	Literacy Standards	Mathematics Standards
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5) • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-PS1-2) • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)		**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)	

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
Students who demonstrate understanding can: **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. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [*Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.*] **HS-PS1-4** 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. [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.]	**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. (HS-PS1-2) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.) 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) **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	How can one explain the structure, properties, and interactions of matter? How can one explain and predict interactions between objects and within systems of objects? How can you determine if a chemical reaction will occur?	**Before:** KWL – Students will list what they know and what they want to know about atoms. This will be repeated with each concept throughout the unit. (periodic table, fusion, decay, etc) Quick Writes – Before each lesson students will be asked to write their thoughts and questions for the day pertaining to the objectives. Pretest – Students will be given an assessment to understand their knowledge on the unit before instruction is given. **During:** Think/Pair/Share – Students will work in pairs to practice and reinforce rules as they are introduced. Lab Investigations – Students will be responsible for developing and	Acid rain Acid/base reaction Acidic Alkaline Atomic weight Basic Boiling point Bronsted-lowry Carboxyl group Chemical bond Delta (meaning change) Dipole-dipole bond Dispersion forces Endothermic process Endothermic reaction Exothermic process Exothermic reaction Hydrogen bonding Hydrogen ion Hydronium ion Hydroxide Ion Ionic solid (crystal) Kw Limiting reagent Melting point Metal Molar volume Network solid Neutral Neutralize	http://www.chemtutor.com/react.htm - website that offers explanations of reactions, including equations, balancing, and types of reactions **Balancing Equations**: http://funbasedlearning.com/chemistry/chemBalancer/default.htm - interactive site for practicing balancing equations http://education.jlab.org/elementbalancing/index.html - interactive site for practicing balancing equations http://www.wfu.edu/%7Eylwong/balanceeq/balanceq.html - tutorial on how to balance equations http://www.csun.edu/science/chemistry/ - Internet resources to accompany the Source Book for teaching Science. Has links to various topics. **Molecular and Empirical Formulas**: http://www.infoplease.com/ce6/sci/A0858195.html Explanation of molecular and empirical formulas http://science.jrank.org/pages/4403/Molecular-Formula.html Explanation on writing molecular formulas http://www.visionlearning.com/library/module_viewer.php?mid=53

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
[*Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.*] **HS-PS1-5** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. [Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] [*Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.*] **HS-PS1-6** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.* **[**Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the	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) 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) **ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically and	How can you prove that mass is conserved during a chemical reaction?	implementing one or more lab investigation(s) exploring the periodic table, nuclear processes, and properties of elements. Daily Assignments – Students will be given assignments that will check for understanding. Drawings – Students will be responsible for molecular drawing to show understanding. **<u>After</u>:** Posttest: Students will be given a test after the unit has been completed and the Presentations have been given. Project: Students will create a presentation using multi-media (as a group) of this unit. This will include various concepts, experimental data, vocabulary, chemical equations and applications in the	Oxidation Ph Pressure Product Properties of reactants Reactant Reagent Reduction reactions Relative mass Release of energy Temporary dipole	History and use of moles (Avogadro, Molar Mass, Atomic Weight, Molecular Weight, Mole/Weight relationships) https://www.youtube.com/watch?v=kjKyEdrVXJA Video on concentration and reaction rates – good as a demo or to show to students http://wps.prenhall.com/wps/media/objects/169/173125/MolecularEntropy.html - prentice hall media sites – this one is shows entropy – many others available http://www.matter.org.uk/Schools/Content/Reactions/BondEnergy.html Bond energy interactive site http://www.avogadro.co.uk/definitions/hbond.htm - Basic definition along with a table illustrating the relationship between bond length and bond enthalpy. http://id.mind.net/%7Ezona/mstm/physics/mechanics/energy/heatAndTemperature/changesOfPhase/changeOfState.html - This page covers some introductions about heat and temperature. At the end of this page, are some links to further material: **Ideal Gas Law**:

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [*Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.*] **HS-PS1-7** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.] [*Assessment Boundary: Assessment does not include complex chemical*	decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)		"real world" and will focus on predictions of reactions between real and imaginary elements, compounds, and mixtures. Assessed by teacher created rubric.		http://www.chemicool.com/idealgas.html - Interactive site for calculating gas law problems. http://hyperphysics.phy-astr.gsu.edu/hbase/kinetic/idegas.html - Explains the ideal gas law. Has links for necessary vocabulary. http://www.chem.ufl.edu/~itl/2045/MH_sims/gas_sim.html - Ideal Gas Law simulation http://www.funtrivia.com/playquiz/quiz2287571a312e0.html - Ideal Gas Law trivia quiz

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
reactions.] **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. **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.					

Science Pacing Guide
Chemistry

Time Frame: April – June
Unit 3: Energy

Science & Engineering Practices	Crosscutting Concepts	Literacy Standards	Mathematics Standards
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and dev eloping models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2), (HSPS3-5) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and	**Cause and Effect** Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS3-5) **Systems and System Models** When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4) Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models (HS-PS3-1) **Energy and Matter** Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS3-3) Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2)	**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), (HS-PS3-5) **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),(HS-PS3-5)	**MP.2** Reason abstractly and quantitatively. (HS-PS3-1), (HS-PS3-2), (HS-PS3-3), (HS-PS3-4), (HS-PS3-5) **MP.4** Model with mathematics. (HS-PS3-1), (HS-PS3-2), (HS-PS3-3), (HS-PS3-4), (HS-PS3-5) **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-PS3-1), (HS-PS3-3) **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS3-1), (HS-PS3-3) **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS3-1),(HS-PS3-3)

Science & Engineering Practices	Crosscutting Concepts	Literacy Standards	Mathematics Standards
refine the design accordingly. (HS-PS3-4)		**WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS3-4), (HS-PS3-5) **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-PS3-1), (HS-PS3-2), (HS-PS3-5)	

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
Students who demonstrate understanding can: **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. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [*Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.]*	**PS3.A: Definitions of Energy** Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1), (HS-PS3-2) At the macroscopic	How is energy transferred and conserved? How do you determine if a reaction will release or require energy? Where does that energy come from and/or go to?	**Before:** KWL – Students will list what they know and what they want to know about atoms. This will be repeated with each concept throughout the unit. (periodic table, fusion, decay, etc) Quick Writes – Before each lesson students will be asked to write their thoughts and questions for the day pertaining to the objectives. Pretest – Students	Activation energy Anode Boiling point elevation Calorie Cathode Cell Change of state Chemical bond Concentration Conduction Convection current Convection heating Crystalline solid Disorder Electrochemical Electrostatic attractions Endothermic reaction Energy	http://highschoolenergy.acs.org/content/hsef/en.html - teaching resources for the energy unit of chemistry – includes labs and videos, good for real-life uses as it was produced by bp http://www.csun.edu/science/chemistry/ - Internet resources to accompany the Source Book for teaching Science. Has links to various topics. **Electron Movement**: http://www.colorado.edu/physics/2000/quantumzone/fraunhofer.html Explains the differences between Absorption and Emission Spectrum http://chemistry.beloit.edu/blueligh t/pages/elements.html Graphic display of Emission and

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
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). [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [*Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.]* **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. [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of	scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) (HS-PS3-3) These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) **PS3.B: Conservation of Energy and Energy Transfer**		will be given an assessment to understand their knowledge on the unit before instruction is given. **<u>During</u>:** Think/Pair/Share – Students will work in pairs to practice and reinforce rules as they are introduced. Lab Investigations – Students will be responsible for developing and implementing one or more lab investigation(s) exploring the periodic table, nuclear processes, and properties of elements. Daily Assignments – Students will be given assignments that will check for understanding.	Enthalpy Entropy Equilibrium Exothermic reaction Freezing point depression Gibb's free Hess's law Ionic motion Joules Kelvin temperature Keq Kinetic energy Kinetic molecular model Le chatelier Mass to energy conversion Order Oxidation Oxidation-reduction reactions Potential energy Pressure-temperature relationship Pressure-volume relationship Reaction rate Reduction Release of energy Rotational motion Solute Specific heat	Absorption spectrum of all elements (QuickTime) http://www.chem4kids.com/files/atom_intro.html Common elements that make up humans Chemical Potential Energy: http://www.chem1.com/acad/webtext/chembond/ Virtual textbook offers content and numerous concept maps and resources http://www.historyoftheuniverse.com/chemener.html Explanation of chemical energy http://www.biology.arizona.edu/biochemistry/tutorials/chemistry/page2.html Chemical bonds and attractive forces (tutorial) http://wps.prenhall.com/wps/media/objects/169/173125/MolecularEntropy.html - prentice hall media sites – this one is shows entropy – many others available http://www.shodor.org/unchem/advanced/thermo/index.html - explanation of thermodynamics – no interaction **Endothermic and Exothermic Reactions**: http://chemistry.about.com/cs/generalchemistry/a/aa051903a.htm - Provides basic definition and description of reaction. Good

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
renewable energy forms and efficiency.] [*Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]* **HS-LS1-5** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. [Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.] [*Assessment Boundary: Assessment does not include specific biochemical steps.*] **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. [Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [*Assessment Boundary:*	Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4) Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) The availability of		**<u>After</u>:** Posttest: Students will be given a test after the unit has been completed and the Presentations have been given. Project: Students will create a presentation using multi-media (as a group) of this unit. This will include various concepts, experimental data, vocabulary, and applications in the "real world" and will focus on all aspects of energy transferred during a given chemical reaction. Assessed by teacher created rubric.	Spontaneous Temperature-volume relationship Transforming matter and/or energy Translational motion Vibrational motion	resource for many inquiries related to chemistry. http://www.chem.umn.edu/outreach/EndoExo.html - Describes both types of reactions and contains an example of each type of reaction. http://www.chemguide.co.uk/atoms/structures/molecular.html - This page describes how the physical properties of substances having molecular structures varies with the type of intermolecular attractions - hydrogen bonding or van der Waals forces. **Enthalpy & Entropy**: http://www.avogadro.co.uk/definitions/hbond.htm - Basic definition along with a table illustrating the relationship between bond length and bond enthalpy. http://www.shodor.org/unchem/advanced/thermo/index.html - Good content site with links to other basic and advanced concepts.

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
Assessment does not include the details of the specific chemical reactions or identification of macromolecules.] **HS-LS1-7** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [*Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.*] **HS-ESS1-1** Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation. [Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to	energy limits what can occur in any system. (HS-PS3-1) Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4) **PS3.C: Relationship Between Energy and Forces** When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5) **PS3.D: Energy in Chemical Processes** Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4)				

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.] [*Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.*] **HS-LS2-5** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. [Clarification Statement: Examples of models could include simulations and mathematical models.] [*Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.*] **HS-PS4-5** Communicate technical information about how some technological devices use the principles of wave behavior and wave interaction with matter to transmit and capture information and energy. [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [*Assessment Boundary:*	**ETS1.A: Defining and Delimiting Engineering Problems** Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS3-3)				

Next Generation Science Standards	Disciplinary Core Ideas	Essential Questions	Assessments	Vocabulary	Resources
Assessments are limited to qualitative information. Assessments do not include band theory.] **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. **HS-ETS1-4** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.					