Summit High School
Summit, NJ

Grade Level/Content Area: 11th Grade Science
Length of Course: 1 year
(Revised Summer 2017)

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Course of Study

Unit 1: Study of Matter Using Experimental Methods
- Categorization of matter
- Laboratory techniques and Safety
- Scientific measurement
- Dimensional analysis

Unit 2: Atomic Structure and Nuclear Chemistry
- Historical development of atomic structure
- Nuclear reactions, nuclear power
- Fission and fusion
- Radioactive decay

Unit 3: Periodicity and Atomic Emission Spectra
- Electromagnetic Radiation
- Behavior of electrons in atoms
- Arrangement of the elements in the periodic table
- Patterns of chemical properties

Unit 4: Bonding and Chemical Reactions
- Names, formulas, and structures of compounds
- Types of bonds
- Categorization of solids
- Chemical reactions

Unit 5: Calculations in Chemistry
- Dimensional analysis
- Empirical and Molecular Formula

Stoichiometry

Unit 6: Solids, Liquids, Gases and Aqueous Solutions

Kinetic Molecular Theory
Gas Laws
Phase Changes
Solutions

Unit 7: Thermochemistry, Reaction Rates and Equilibrium

Chemical kinetics
Chemical equilibrium
Spontaneity
Thermochemistry

Unit 8: Independent Projects in Chemistry

Course Description:

Chemistry is the central science that connects concepts from physics and biology. Chemistry is the study of the composition, structure and properties of matter and the changes it undergoes. Honors Chemistry is an inquiry based learning approach to developing the major chemistry concepts. As an honors course, it is distinguished from the standard chemistry course by the depth at which concepts are examined. In order to achieve this deeper understanding a higher level of mathematical aptitude is expected. Students apply their knowledge of mathematics including algebra, geometry and algebra II to test models, evaluate data and to solve chemistry problems. This course enables students to develop their quantitative skills and their communication skills. It incorporates laboratory experiments and classroom discussion as well as traditional lectures and hands on activities. Atomic theory, the nature of matter in its various phases, chemical periodicity, and the mole concept are studied early in the course. Among the basic principles included are energy, reaction rates, reaction equilibrium, and characteristics of chemical reactions, acid-base behavior, oxidation-reduction reactions and electrochemistry. Students will be able to demonstrate an understanding of how chemical principles are applied to "real world" problems and processes. Topics in the media and popular culture will be used a platform for discussing chemistry principles.

Unit 1
Study of Matter Using Experimental Methods

NEXT GENERATION SCIENCE STANDARDS HS-PS1 MATTER AND ITS INTERACTIONS

HS-ESS1 Earth's Place in the Universe ***Science and Engineering Practices***
Big Ideas: *Course Objectives / Content Statement(s)* **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),(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 precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3) **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** 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 trade off considerations. (HS-PS1-6)

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the Big Ideas?* **Cross Cutting Concepts**
● Which science is the most important: Physics, Biology or Chemistry? ● What determines whether a substance will be a solid, liquid, or gas? ● How is the separation of mixtures critical to our economy and standard of living? ● What is the source of elements and what does that mean about the history of the universe? ● Could there be undiscovered elements existing in outer space? ● Why is it important to differentiate between elements and compounds? ● Can the history of the Earth be told with Chemistry?	Students will understand that… **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-PS1-2),(HS-PS1-3),(HS-PS1-5) **Energy and Matter** ● In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) ● 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)

Areas of Focus: Proficiencies (Cumulative Progress Indicators) **Disciplinary Core Ideas**	**Examples, Outcomes, Assessments**
PS1.A: Structure and Properties of Matter ● Each atom has a charged substructure consisting of a nucleus, which is made of protons	**Instructional Focus** ● Name and characterize the three states of matter ● Describe how the physical properties of solids, liquids, and gases depend on the ways in which the atoms, ions, or

and neutrons, surrounded by electrons. (HS-PS1-1) ● The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1),(HS-PS1-2) ● The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3),(secondary to HS-PS2-6) ● A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)	molecules of the substances are arranged, and by the strength of the forces of attraction between the atoms, ions, or molecules. ● Use quantitative and qualitative descriptors to describe matter ● Distinguish between a physical and chemical change ● Classify matter substances or mixtures and as homogeneous or heterogeneous ● Identify laboratory techniques used to separate mixtures ● Explain the difference between an element and a compound. ● Know that the properties of compounds are different from the properties of the individual elements that comprise the compound ● There is a vast history of discovering elements that continues with laboratory work today. ● Distinguish between an element symbol and a chemical formula. Know the names and symbols of common elements. ● Describe the ways in which elements are assigned names and symbols, and some ways in which new elements have been discovered ● Identify the planetary location of different elements. ● Explain which elements are found in each layer of the Earth. ● The history of the Earth's formation can be explained using scientific reasoning and evidence from earth materials, meteorites and other planetary surfaces ● Identify the different layers of the Earth and the composition of each. ● Begin to discuss how the composition of some of those layers is changing.

	● Discuss elements and the possibility of unknown elements present in our solar system and beyond. ● Distinguish between accuracy and precision of scientific measurements. ● Use statistical analysis such as percent error and standard deviation to characterize error in an experiment ● Know the SI units of measurement ● Use dimensional analysis and conversion factors to convert between different units of measurements. **Sample Assessments:** ▪ At home activity: ice cube melting experiment ▪ Activity: determining density graphically ▪ Lab: Separation of a Mixture ▪ Lab: Density Determination ▪ Lab: Measurements of mass and volume ▪ Lab: Observing a Chemical Reaction ▪ Activity: Core Sampling-create a model formation and "drill" for samples. ▪ Chapter Quizzes, Unit Test **Instructional Strategies:** **Interdisciplinary Connections** ● Writing: sufficient technical writing to achieve procedural objective ● Language: element names and symbols based on foreign languages ● History: How scientific techniques have evolved to allow the isolation of even more elements ● Earth Science: Identifying the different layers of the Earth and the composition of each. **Media Literacy Integration** ● Use the "elements" video to stimulate interest in the topic ● Use the "Hindenburg" article to relate Chemistry to a historical event

	● NOVA video on core sampling ● NOVA video: Life's Rocky Start **Global Perspectives** ● Examine how composition of different layers of Earth has changed in different parts of the world and why.

Texts and Resources:

- Prentice Hall: "Chemistry" Wilbraham et al, Boston, MA, 2008. Chapters: 1, 2 and 3.
- Composition and Names of Earth's layers: https://www.space.com/17777-what-is-earth-made-of.html
- How the EArth was formed: https://www.khanacademy.org/science/biology/history-of-life-on-earth/history-life-on-earth/v/earth-formation
- Core Sampling Video: https://www.youtube.com/watch?v=yiVoRsWzI3c

Unit 2
Atomic Structure and Nuclear Chemistry

NEXT GENERATION SCIENCE STANDARDS HS.Structures and Properties of Matter HS. Waves and Electromagnetic Radiation HS.Space Systems
Big Ideas: *Course Objectives / Content Statement(s)* **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),(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 precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3) **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

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 trade off considerations. (HS-PS1-6)

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the Disciplinary Core Ideas?*
• How do we know what we cannot see? • Is all matter the same? • How do surprises advance understanding? • Are all forms of radiation harmful? • Is nuclear power worth the risk? • How does nuclear chemistry affect your everyday life? • Why is nuclear power essential for many fields of medicine?	**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-PS1-2),(HS-PS1-3),(HS-PS1-5) **Energy and Matter** • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) • 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

- How can nuclear power be useful as a future source of energy? - What happens when matter absorbs different types of radiation? - How is radiation converted into thermal and electrical energy through technology?	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) **PS1.A: 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. **PS1.C**: **Nuclear Processes** Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. **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. (HS-ESS1-2),(HS-ESS1-3) The Big Bang theory is supported by observations of distant galaxies receding from 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. (HS-ESS1-2) Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all

	atomic nuclei lighter than and including iron, and the process releases electromagnetic energy . Heavier elements are produced when certain massive stars achieve a supernova stage and explode (HS-ESS1-2),(HS-ESS1-3)

Areas of Focus: Proficiencies (Cumulative Progress Indicators)	Examples, Outcomes, Assessments
Students will:	**Instructional Focus: (3 Weeks)**
HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. **HS-ESS1-3.** Communicate scientific ideas about the way stars, over their life cycle, produce elements	● Describe the evolution and refinement of modern atomic theory with a focus on benchmark experiments (CRT, gold foil, AES, and Milikan oil drop) and the scientific process. ● Define nuclear reactions and identify the three different types of radiation that can be given off; alpha, beta and gamma radiation. ● Distinguish between protons, electrons and neutrons in terms of their location in the atom, their, mass and their charge. Apply these ideas to the mass number, atomic number, isotopes and nuclear symbol. ● Use a band of stability graph to predict the stability of a given nucleus based on its numbers of protons and neutrons and to predict the most likely form of decay for an unstable nucleus. ● Write and balance nuclear reactions to show the conservation of mass and distinguish between chemical equations and nuclear equations applying the matter energy relationship. ($e=mc^2$) ● Calculate the amount of nuclear material remaining using half-life and first order decay equations. List examples of how the half-life of an isotope can determine its usefulness applications like radioactive dating, medicine etc.

	● Use radioactive dating to determine the age of objects found on Earth and relate to history of Earth's development ● Compare and contrast fission and fusion reaction ● Explain how elements are created in the sun, in super nova's or in the lab. ● Explain the processes that go on inside a nuclear reactor ● Consider the pro's and con's of nuclear power including its role as an energy source for the future. ● Explain how nuclear chemistry is used in different fields of medicine and the treatment of illnesses. **Sample Assessments:** ● Lab: Candium (use candy to demonstrate how an average atomic mass is calculated) ● Lab: Mass Spectrometry ● Lab: Radioactive Decay with Pennies ● Activity: Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. ● Activity: Class debate on nuclear power ● Activity: Calculate annual nuclear radiation exposure from different environmental sources ● Draw or label a diagram of a nuclear reactor. Explain each step in the process. ● Essay test on benchmark experiments including Rutherford Gold foil, Cathode Ray tube and Oil Drop experiment. ● Chapter Quizzes, Unit Test **Instructional Strategies:**

	Interdisciplinary Connections ● History: Connect scientific discoveries in various countries to the political and cultural climate in each location ● Mathematics: Statistical analysis of data collected. ● Earth Science: Use radioactive dating to determine the age of the Earth **Technology Integration** ● Use spreadsheet and other analysis tools to examine the relationships of atoms on periodic table ● Use video animations to show set up of historical experiments (Gold foil, Milikan oil drop) **Media Literacy Integration** ● Use video clips and articles to stimulate interest in the topic eg. Frontline Video: Radioactive Wolves, Fukushima Meltdown ● Compare scientifically reviewed articles (e.g. Nature) to popular literature (e.g. Newsweek) for the same breakthrough. Relate this to the development of atomic theory. **Global Perspectives** ● Discuss the use of nuclear power and other in various countries. ● Global sources of oil, uranium, plutonium

Prentice Hall: "Chemistry" Wilbraham et al, Boston, MA, 2008. Chapters: 4 and 25

Unit 3
Electrons in Atoms, Atomic Emission and Periodicity

NEXT GENERATION SCIENCE STANDARDS HS.Structures and Properties of Matter HS.Waves and Electromagnetic Radiation HS.Space Systems

Big Ideas: *Course Objectives / Content Statement(s)*

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),(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 precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3)

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

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 trade off considerations. (HS-PS1-6)

Essential Questions	Enduring Understandings

What provocative questions will foster inquiry, understanding, and transfer of learning?	*What will students understand about the Big Ideas?* **Cross Cutting Concepts**
● How do we know what we cannot see? ● Is all matter the same? ● How do scientific surprises advance understanding? ● What is an atom and how has that definition changed over time? ● Is there evidence that exists that suggests our current model of the atom is not sufficient? ● Can scientists explain the processes that occur on the subatomic level? ● Is the use of trends as predictors in science useful or dangerous? ● Are all forms of radiation harmful? ● How can radiation emitted from stars be used to determine their composition?	Students will understand that… **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-PS1-2),(HS-PS1-3),(HS-PS1-5) **Energy and Matter** ● In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) ● 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-ESS1-6) ● Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1) **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) **Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-1) ● 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-PS4-4) Systems can be designed to cause a desired effect. (HS-PS4-5) **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 structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. **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. **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. **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. (HS-ESS1-2),(HS-ESS1-3) **ESS2.D: Weather and Climate** The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.

Areas of Focus: Proficiencies (Cumulative Progress Indicators) Disciplinary Core Ideas	**Examples, Outcomes, Assessments**
Students will: **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-PS4-1** Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. **HS-PS4-3** Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by 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 materials	**Instructional Focus:** ● Complete the development of atomic theory including the following models of the atom: Dalton, Thompson, Rutherford, Bohr, Quantum Mechanical ● Mathematically relate the energy, frequency and wavelength of different forms of electromagnetic radiation. ● Describe Einstein's explanation of the photoelectric effect and wave particle duality of electromagnetic radiation. ● Describe the discovery of the organization of electrons in atoms in the context of experimentation, the properties of light, quantum theory and the wave model of the atom. ● Relate the organization of electrons (configurations) to the properties of atoms and the arrangement of the periodic table.

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.	● Determine how wavelength and frequency can be used to determine the properties of different forms of electromagnetic radiation. ● Explain how the study of light lead to the discovery of the quantum mechanical model of the atom. ● Discuss how AES can be used to determine the composition of stars by analyzing the spectra of light emitted. ● Introduce the astronomical evidence of the redshift of light from galaxies as an indication that the universe is currently expanding ● Explain how radiation of the sun heats the Earth's surface and how greenhouse gases can impact this process. ● Determine if the evidence produced by astronomical light spectra supports the Big Bang Theory. ● Describe the organization of the periodic table. Identify metals, nonmetals, metalloids, halogens, noble gases etc. by location on the periodic table. ● Explain and predict periodic properties and trends such as: atomic radii, ionic radii, ionization energies, electronegativity, chemical reactivity and metallic character using the concept of effective nuclear charge. **Sample Assessments:** ● Lab: Colorful Flames and Calculation of an Atomic Emission Spectrum ● Lab: Electron Configuration ● Lab: Periodic Trends ● Activity: Analyze line spectra from stars to determine composition of an unknown ● Project: Research different sources of radiation found on Earth and their uses. ● Chapter Quizzes, Unit Test

	Instructional Strategies: **Interdisciplinary Connections** ● History: Connect scientific discoveries in various countries to the political and cultural climate in each location ● Mathematics: Statistical analysis of data collected. ● Earth Science: Analysis of astronomical light spectra **Technology Integration** ● Use spreadsheet and other analysis tools to examine the relationships of atoms on periodic table **Media Literacy Integration** ● Use video clips and articles to stimulate interest in the topic ● Compare scientifically reviewed articles (e.g. Nature) to popular literature (e.g. Newsweek)for the same breakthrough. Relate this to the development of atomic theory. **Global Perspectives** ● Compare the development of atomic theory in other cultures as it relates to governmental structures. ●

Prentice Hall: "Chemistry" Wilbraham et al, Boston, MA, 2008. Chapters: 5 and 6

Unit 4

Bonding and Chemical Reactions

NEXT GENERATION SCIENCE STANDARDS **HS.Structures and Properties of Matter** **HS.Chemical Reactions**
Big Ideas: *Course Objectives / Content Statement(s)* **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),(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 precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3)

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

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 trade off considerations. (HS-PS1-6)

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the Big Ideas?*
● Why do substances react? ● How can we use the language of Chemistry to refer to substances by name or by formula? ● How can we visually represent what is happening when a bond forms?	**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-PS1-2),(HS-PS1-3),(HS-PS1-5)

- What determines the properties of substances, such as solubility in water and electrical conductivity? - How can we represent a chemical reaction both quantitatively and qualitatively? - What role does energy play in chemical reactions?	**Energy and Matter** - In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) - 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) **PS1.A: Structure and Properties of Matter** 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. **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. **PS2.B: Types of Interactions** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

Areas of Focus: Proficiencies (Cumulative Progress Indicators)	**Examples, Outcomes, Assessments**
Students will: **HS-PS1-2.** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties **HS-PS1-3.** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. **HS-PS1-4.** Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. **HS-PS1-5.** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. **HS-PS1-7.** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	**Instructional Focus**: ● Describe ion formation based on electron configuration ● Distinguish between ionic and covalent bonds in terms of electron behavior as well as the properties of compounds that contain each type. Recognize patterns of bonding from the periodic table. ● Describe metallic bonding and how it affects the properties of metals ● Describe properties and uses of different alloys ● Identify the differences in properties between elements and the compounds that they form. ● Predict chemical formulas of ionic compounds based on ion charges. ● Write chemical formulas for ionic compounds, binary molecular compounds and acids and bases. ● List the properties of acids and bases. ● State and distinguish between the Arrhenius definition and the Bronsted Lowry definition of acids and bases. ● Draw Lewis dot diagrams for atoms, monatomic ions, molecular compounds and polyatomic ions. ● Describe and name the forces that hold molecules together. ● Compare the strength of covalent bonds using bond dissociation data tables. Calculate the energy change associated with the breaking and forming of all of the bonds in one mole of a substance. ● Determine molecular polarity and describe its effect on the properties of a sample of matter.

	● Categorize solids as ionic, molecular, metallic, or network covalent. ● Represent chemical change with balanced chemical equations. ● Classify chemical reactions as combination, decomposition, combustion, single replacement, or double replacement (including neutralization reactions). ● Distinguish between electron transfer reactions and ion exchange reactions. ● Write molecular equations, complete ionic equations and net ionic equations. ● Given a set of reactants, predict the products formed and write a balanced chemical equation for the reaction. ● Show how human activity impacts the formation of acid rain. Write balanced chemical equations for these reactions ● Discuss the synthesis of new compounds such as pharmaceuticals through chemical reactions **Sample Assessments**: ● Lab: Identify an Unknown Metal ● Lab: Chemical Names and Formulas ● Lab: Molecular Geometry ● Lab: Types of Solids ● Lab: Writing an Equation for a Chemical Reaction ● Lab: Types of Chemical reactions ● Activity: Balancing chemical reactions ● Demonstrations for types of chemical reactions ● Chapter Quizzes, Unit Test **Instructional Strategies:** **Interdisciplinary Connections** ● Mathematics: balancing chemical equations ● History: context of work by Antoine Lavoisier (French Revolution), other early chemists

	• Earth Science: Identify chemical reactions that occur in the atmosphere that produce pollution • Biology: As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. **Media Literacy Integration** • Compare scientific fact to popular beliefs or representation in the media. For example. Read peer reviewed article on hydrofluoric acid then watch episode of ER about this acid—look for misleading info in ER episode—compare fiction vs. non-fiction representation of the topic • Video clips: examples of chemical reactions that could not be performed in the classroom **Global Perspectives** • Compare different naming systems used around the world

Prentice Hall: "Chemistry" Wilbraham et al, Boston, MA, 2008. Chapters: 7, 8, 9, 11, 19 and 20

Unit 5
Mole Conversion Problems and Stoichiometry

NEXT GENERATION SCIENCE STANDARDS **HS.Structures and Properties of Matter** **HS.Chemical Reactions**
Big Ideas: *Course Objectives / Content Statement(s)* **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),(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 precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3) **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** 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 trade off considerations. (HS-PS1-6)

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the Big Ideas?*
● How can the interpretation or manipulation of quantitative data be used to determine the chemical composition of a substance? ● How are balanced chemical equations used to calculate	**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-PS1-2),(HS-PS1-3),(HS-PS1-5)

quantities of substances in chemical reactions? • Why is it important that we are able to determine a limiting reactant? • How can you choose a level of accuracy that is appropriate to limitations on measurement when reporting quantities?	**Energy and Matter** • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) • 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) **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
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	**Examples, Outcomes, Assessments**
Students will: **HS-PS1-7**. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. **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 **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling	**Instructional Focus:** • Define the mole as a chemical quantity equal to Avogadro's number of representative particles. • Determine the molar mass of a substance • Relate mass, volume, particles and moles of a substance quantitatively and qualitatively • Perform multi-step problems to convert between units of mass, volume, representative particles and density • Use balanced chemical equations to determine the mole ratio of substances in chemical reactions.

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities	● Use stoichiometry to identify the limiting reactant and excess reactant in a chemical reaction. Calculate theoretical yield and percent yield. ● Given percent composition or mass data, determine the empirical and molecular formula of a compound. ● Calculate the percent composition for a sample of material ● Use balanced chemical equations to show the conservation of mass throughout a reaction ● Choose a level of precision appropriate to limitations on measurement when reporting quantities. Report quantities with correct number of significant figures and correct units. ● Analyze data and experimental techniques to appropriately discuss the error in a quantitative experiment. **Sample Assessments:** ● Lab: Limiting Reactant and Percent Yield ● Lab: Counting by Measuring Mass ● Lab: Empirical Formula of an Oxide or Empirical Formula of a Hydrate ● Lab: Decomposition of Baking Soda ● Chapter Quizzes, Unit Test **Instructional Strategies:** **Interdisciplinary Connections** ● Mathematics: Use mathematical representations of phenomena to support claims. ● Mathematics: Reason abstractly and quantitatively; Use units as a way to understand problems and to guide the solution of multi-step problems **Technology Integration** ● Online tutorials and virtual labs can be used to for differentiation. ● Use spreadsheet and other analysis tools to examine data collected **Global Perspectives**

	● Compare expectations of accuracy and precision for data collection and calculations from different parts of the world ● Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.

Prentice Hall: "Chemistry" Wilbraham et al, Boston, MA, 2008. Chapters: 10 and 12

Unit 6

Solids, Liquids, Gases and Aqueous Solutions

NEXT GENERATION SCIENCE STANDARDS **HS.Structures and Properties of Matter** **HS.Chemical Reactions** **HS.Energy** **HS.Weather and Climate**
Big Ideas: *Course Objectives / Content Statement(s)* **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),(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 precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3) **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
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 trade off considerations. (HS-PS1-6)

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the Big Ideas?*
● What factors affect the properties of the different states of matter? ● How can matter exist at different states at the same temperature and pressure? ● How is energy transferred between states of matter? ● Can changes in the behavior of matter be predicted? ● Has the composition of our atmosphere remained consistent over time? ● How is weather related to the energy transfer between different states of matter on Earth?	**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-PS1-2),(HS-PS1-3),(HS-PS1-5) **Energy and Matter** ● In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) ● 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**

• Why is water a unique chemical substance? • What steps of the water cycle are natural purification techniques? • What happens to a substance when it dissolves? • Why are some substances soluble in water and others aren't?	• Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6) **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. **PS1.A: Structure and Properties of Matter** The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. **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 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. **PS3.B: Conservation of Energy and Energy Transfer** Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.

	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. **PS2.B: Types of Interactions** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. **ESS2.D: Weather and Climate** The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate

Areas of Focus: Proficiencies (Cumulative Progress Indicators)	Examples, Outcomes, Assessments
Students will: **HS-PS1-3.** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. **HS-PS3-2.** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the	**Instructional Focus: (4 Weeks)** <u>Gases</u> ● Define the properties of a gas in terms of the Kinetic Molecular Theory. Identify and define the factors that affect gas pressure ● Describe how Torricelli's barometer measured atmospheric pressure. ● Convert between units of pressure using dimensional analysis.

motions of particles (objects) and energy associated with the relative position of particles (objects). **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. **HS-PS2-6.** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. **HS-ESS2-4.** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. **HS-ESS3-5.** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.	● Relate the Kelvin temperature scale to kinetic energy. ● Relate pressure, volume and temperature of a gas graphically and mathematically. ● Discuss the contribution of Boyle, Charles and Gay-Lussac in the derivation of the combined gas law. ● Evaluate Kinetic molecular theory by comparing real and ideal gases. ● Relate pressure, temperature, volume and moles of gas to the ideal gas law. Combine the ideal gas law with stoichiometry. ● Use Dalton's law to calculate partial pressures. ● Predict Relative Rates of Gas Diffusion Using Graham's Law. Relate this law to the Kinetic energy of a substance. ● Explain how the composition of the Earth's atmosphere has changed over time due to human activity ● Review the different chemical reactions involved in the production of carbon dioxide in our atmosphere ● Use models to explain how energy flow effects climate changes. ● Make predictions on climate change based on published data and global climate models. <u>Liquids</u> ● Describe the properties of a liquid on a particulate level. ● Use intermolecular forces of attraction to predict the vapor pressure, boiling point and rate of evaporation of different liquids. ● Show how a manometer is used to measure vapor pressure. ● Show how boiling point is related to external pressure, vapor pressure and temperature.

	- Describe how hydrogen bonding influences the various properties of water (surface tension, capillary action, heat capacity, viscosity, heat of vaporization and fusion, density). - Review the water cycle and the amount of fresh and salt water are found on Earth. Discuss how man's engineering systems are influencing this ratio. - Interpret vapor pressure curves <u>Solids</u> - Describe the organization and forces between particles in the solid phase - Define and give examples of an allotropes. - Describe the process of melting in terms of potential and kinetic energy. - Interpret a phase diagram and use it to determine state of matter at a specific temperature and pressure. <u>Aqueous Solutions</u> - Describe the process by which solutes dissolve in solvents. - Relate this process to the energetic considerations of the energy of solvation and the dissociation energy. - Identify the factors that affect the rate of dissolution. - Use the "like dissolves like" rule to predict the solubility of one substance in another. - Describe the temperature and pressure effect of gaseous and solid solutes. - Use solubility curves to answer questions about the saturation level of a solution. - Describe solutions as saturated, unsaturated or supersaturated and dilute or concentrated.

	● Distinguish between strong electrolytes, weak electrolytes and nonelectrolytes. ● Calculate the concentration of solution. ● Distinguish between a dilute and concentrated solution. Compare the properties of colloids, suspensions and solutions. ● Use Molarity and molality to quantitatively report solution concentration. ● Describe the process of making and aqueous solution from a solid solute. Describe the process of making dilute solutions from a stock solution. Use the dilution equations to calculate the resulting concentration of dilute solutions. ● Describe on a particulate level the effect of dissolved particles on the freezing point, vapor pressure and boiling point of a liquid. ● Calculate the freezing point and boiling point of liquids that containing dissolved particles. ● Use boiling point or freezing point data to determine the molar mass of an unknown molecular solute. ● Perform stoichiometric calculations using molarity of solutions. ● Show that the concentration of an unknown solution of acid or base can be determined via titration as long as an appropriate indicator is used. ● Use the pH scale to classify solutions as acidic, basic or neutral. Determine the pH of a solution from hydrogen ion concentration and vice versa. ● Construct a titration curve for a titration.

	● Define a buffer solution and describe the biological significance of these mixtures. **Sample Assessments:** ● Lab: Creating a Heating and Cooling Curve for Lauric Acid Lab ● Lab: Thinking About Gases ● Lab: Investigation of Gas Properties Lab ● Lab: Collecting a Gas over Water Lab ● Activity: Developing the Kelvin Temperature Scale ● Lab: Absorption Spectrum of Cobalt (II) Chloride Lab ● Lab: Electrolytes or Making a Solution ● Lab: Titration of Vinegar ● Lab: Colligative Properties (MM determination) ● Demonstrations: surface tension, chromatography...etc ● Activity: What is Oobleck? ● Activity: Station Models; barometer, wind vane, anemometer and sling psychrometer ● Activity: Highs and Lows, where does the weather go? ● Chapter Quizzes, Unit Test **Instructional Strategies:** **Interdisciplinary Connections** ● Determine the advantage of high-elevation training used by many professional athletes. ● Investigate the benefits of using a pressure cooker in the kitchen. ● Determine the effect of temperature and pressure on global weather patterns and ocean currents. ● Investigate the cause of sinkholes and formation of limestone caves. **Technology Integration** ● Excel used for data analysis and graphing.

	● Online tutorials and virtual labs can be used to for differentiation. **Media Literacy Integration** ● Compare and contrast scientific articles on global warming and/or acid rain from Times magazine and Scientific America magazine. **Global Perspectives** ● Identify filtration techniques used to purify dirty water around the world. ● Compare and contrast the amount of air pollution produced by different countries and determine what actions are being taken to reduce the amount. ● Investigate and determine the cause of fish kills that occur in different parts of the country.

Prentice Hall: "Chemistry" Wilbraham et al, Boston, MA, 2008. Chapters: 13, 14, 15, 16 and 20

Unit 7
Thermochemistry, Reaction Rates and Equilibrium

NEXT GENERATION SCIENCE STANDARDS **HS. Energy** **HS. Chemical Reactions**
Big Ideas: *Course Objectives / Content Statement(s)* **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),(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 precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3) **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** 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 trade off considerations. (HS-PS1-6)

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
● What is energy? ● How can a chemical reaction release or absorb energy? ● What is the difference between heat and temperature? ● Why don't all substances change temperature at the same rate when heated?	Students will understand that… **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-PS1-2), (HS-PS1-3), (HS-PS1-5) **Energy and Matter**

● Why are some acids and bases more dangerous than others? ● Are chemical and physical changes reversible? ● What factors affect the amounts of product formed in a chemical reaction? ● How can the rate of a chemical reaction be measured? ● What factors determine whether or not a chemical reaction will happen? ● How do the rates of chemical reactions directly impact our lives?	● 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) **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. **PS3.B: Conservation of Energy and Energy Transfer** Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. 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. 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 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 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.

Areas of Focus: Proficiencies (Cumulative Progress Indicators)	Examples, Outcomes, Assessments
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. **HS-PS1-6.** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. **HS-PS3-1.** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. **HS-PS3-2.** Develop and use models to illustrate that energy at the macroscopic	**Instructional Focus** <u>Chemical Kinetics</u> ● Interpret and express the rate of a chemical reaction. ● Define collision theory. Identify and analyze experimentally the factors that affect rate. ● Use initial rate data tables to determine the order/s or reactant/s in a chemical reaction. Write the rate law and determine the value of the rate constant. Write rate laws for chemical reactions. ● Calculate half-lives for first order reactions. <u>Chemical Equilibrium</u> ● Define chemical equilibrium in terms of the rates of forward and reverse reactions.

scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). **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. **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).	● Apply Le Chatelier's Principle to predict the effect of stress on a system at equilibrium. ● Use the value of the equilibrium constant, K, to determine the position of equilibrium. ● Calculate K using equilibrium concentrations of reactants and products. ● Use ICE diagrams to determine the equilibrium concentrations of reactants and products. ● Calculate equilibrium constants for acids and bases (K_a and K_b). Compare the strengths of acids and bases based on K_a and K_b values. ● Define K_{sp}. Quantitatively describe the common ion effect using K_{sp} calculations. ● Describe the significance of K_{sp} values to water quality. <u>Thermodynamics</u> ● Define and distinguish between heat and thermal energy. ● Distinguish between the system, surroundings and the universe. ● Identify exothermic and endothermic reactions ● Calculate the amount of heat (q) released during a chemical or physical change ● Solve for variables using the $q=mC\Delta T$ ● Define calorimetry ● Define enthalpy of reaction ● Find the amount of heat absorbed or released during a heating or cooling processes by combining $q=n\Delta H$ and $q=mC\Delta T$ calculations. Draw and label heating and cooling curves. ● Explain why heat is constant during a phase change. ● Draw and interpret potential energy diagrams for chemical reactions.

	Identify the molar heat of reaction, activation energy, activated complex, and classify the reactions as endothermic or exothermic. ● Calculate the heat of reaction using Hess's Law or standard heat of formation tables. ● Recognize the second Law of thermo-dynamics as it refers to the inevitable increase in entropy for the universe. ● Relate the second law to the environmental impact of a high use consumer society. ● Recognize that based on the third law of thermodynamics all substances have a positive entropy. ● Calculate ΔS for chemical reactions using standard entropy values. ● Predict the sign of ΔS for a physical or chemical change. ● Define free energy. Show that reaction spontaneity is dependent on both the enthalpy change and entropy change of a system. Perform calculations using the equation $\Delta G = \Delta H - T\Delta S$. **Sample Assessments:** ● Lab: Calorimetry ● Lab: Specific heat of an unknown metal ● Lab: Heat of Formation of MgO ● Lab: Burning Food ● Lab: Factors that Affect Rate Lab ● Iodine Clock Reaction Lab ● Lab: Disturbing Equilibrium ● Lab: Spontaneity ● Activity: Specific Heat and Hurricanes ● Demonstrations for specific heat ● Chapter Quizzes, Unit Test **Instructional Strategies**: **Interdisciplinary Connections**

	● Mathematics: Statistical and/or graphical analysis of kinetic data set and calculate compound half-lives for first order reactions. ● Weather: How specific heat is related to hurricanes ● Food and Nutrition: analyze how dietary Calories are measured and calculated **Technology Integration** ● Excel used for data analysis and graphing. Vernier or Pasco probes can be used to acquire concentration data. **Media Literacy Integration** ● Analyze how meteorologists use knowledge of thermal energy to determine the weather in their reports ● Use online tutorials to explain reaction rates, specific heat and equilibrium **Global Perspectives** ● Use knowledge of specific heat, thermal energy and pressure of gases to analyze weather patterns around the world

Prentice Hall: "Chemistry" Wilbraham et al, Boston, MA, 2008. Chapters: 17, 18 and 19

Unit 8
Independent Projects in Chemistry

NEXT GENERATION SCIENCE STANDARDS **HS.Structures and Properties of Matter** **HS. Chemical Reactions** **HS. Forces and Interactions** **HS. Energy** **HS.Waves and Electromagnetic Radiation**
Science and Engineering Practices **Planning and Carrying Out Investigations** Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on

the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly **Developing and Using Models** Develop a model based on evidence to illustrate the relationships between systems or between components of a system. = **Using Mathematics and Computational Thinking** Use mathematical representations of phenomena to support claims. **Constructing Explanations and Designing Solutions** Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. **Obtaining, Evaluating, and Communicating Information** 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).

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings**
What is the purpose for studying the field of chemistry? Can information covered in the classroom be applied to everyday life experiences? Are all resources good resources? What are the ways in which we influence the environment through chemistry?	Students will understand that… ● Chemistry content covered in the classroom can be applied to real-life experiences. ● Being able to gather, comprehend, evaluate, synthesize and report on information and ideas is a necessary skill that students should have. ● It may be necessary to conduct original research from a variety of resources in order to answer questions or solve problems.

	● Topics covered in class can often be further researched more in depth. ● The ever-changing field of technology influences new scientific discoveries that may cause scientists to modify existing theories and/or lead to new ones.

Areas of Focus: Proficiencies (Cumulative Progress Indicators)	Examples, Outcomes, Assessments
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. **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 **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes	**Instructional Focus:** ▪ Identify a topic of interest ▪ Use appropriate sources to conduct research on the topic ▪ Conduct independent laboratory experiments as needed ▪ Present work in written and oral format **Sample Assessments:** ● Oral presentation with visual component ● Written component in student-selected format **Instructional Strategies:** **Interdisciplinary Connections** ● Varies depending on topic chosen **Media Literacy Integration** ● Read scientifically reviewed articles and literature for information on research topic. **Technology Integration** ● Excel for graphing and analyzing data collected during student- designed experiments. Powerpoint or Prezi used for presentations. Laboratory

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.	instruments needed for student-designed experiments. **Global Perspectives** ● Varies depending on topic chosen