Bloomfield Public Schools
Bloomfield, New Jersey 07003

Curriculum Guide
Chemistry Honors
Grade 10

Prepared by:
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Conforms to the New Jersey Student Learning Standards and the Next Generation Science Standards - Standards Revision

Board Approved: July 18, 2017

COURSE:
GRADE LEVEL: 10

Introduction:

The Chemistry curriculum is designed to introduce the student to the elements of chemistry: reactions, quantitative and qualitative analysis, thermodynamics, matter, energy relationships, and the principles. Laboratory work is pure applications wherein the student observes and describes processes. This curriculum is aligned with New Jersey Student Learning Standards and the Next Generation Science Standards.
This document is a tool that will provide an overview as to what to teach, when to teach it, and how to assess student progress. As well, with considerations made for altered pacing, modifications, and accommodations; this document is to be utilized for all students enrolled in this course, regardless of ability level, native language, or classification. It is meant to be a dynamic tool that we, as educators, will revise and modify as it is used during the course of the school year.

Pacing: See each individual unit

Unit 1: Safety, Measurement and Modeling
Unit 2: Structure and Properties of Matter
Unit 3: Bonding Concepts
Unit 4: Mass Relationships (Stoichiometry)
Unit 5: Reactions in Aqueous Solutions
Unit 6: Gases
Unit 7: Thermochemistry
Unit 8: Entropy, Free Energy and Rate Laws
Unit 9: Nuclear Chemistry

Resources: Electronic and text resources are listed in each unit. Teachers will be able to access the curriculum document on the district website.

Textbook:

Established Goals: New Jersey Student Learning Standards
Science: **http://www.nextgenscience.org/next-generation-science-standards**
Mathematics: **http://www.nj.gov/education/aps/cccs/math/**
English Language Arts: **http://www.nj.gov/education/aps/cccs/lal/**
Technology: **http://www.nj.gov/education/aps/cccs/tech/**

Modifications:

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.
- Restructure lesson using UDL principles (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA).

Unit #: 1	Unit Name: Safety, Measurement and Modeling	Unit Length: 15 days

ESSENTIAL QUESTIONS:

1. How important is safety in the chemistry laboratory?
2. What does “Safety first!” demand from us?
3. Why is the scope of chemistry so vast?
4. What are the general reasons for studying chemistry?
5. What is an element?
6. Can atoms combine together?
7. What is a mixture?
8. What are solids and liquids?
9. What is a gas?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	Students will be able to use their learning of safety and lab procedures to make informed decisions when selecting and using equipment or tools.	HS-ETS1-3
2	Students will be able to transfer their learning of the scientific method and data analysis to solve problems and identify sources of error.	HS-ETS1-4
3	Students will be able to use their prior knowledge to identify general reasons for studying chemistry.	HS-ETS1-4
4	Students will be able to 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.	HS-ETS1-4

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1) **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. (HS-PS1-3) **Using Mathematics and Computational Thinking** Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)	**ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)	**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) **Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World** New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)

New Jersey Student Learning Standards Connections:

ENGLISH LANGUAGE ARTS:

RST.11-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-PS1-3)

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

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),(HS-ETS1-3)

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-3)

WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3), (HS-ETS1-3

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3), (HS-ETS1-3)

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4)

MATHEMATICS: MP.2 Reason abstractly and quantitatively. (HS-ETS1-3),(HS-ETS1-4) MP.4 Model with mathematics. (HS-ETS1-3),(HS-ETS1-4) 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-PS1-3)
Technology & Career Standards: **8.1 Educational Technology:** All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Vocabulary on the following topics: 1. Safety and equipment 2. Topics - Matter, chemistry, organic chemistry, inorganic chemistry, biochemistry,	Solid, liquid, gas, pollution, experiment, observation, conclusion, addition, subtraction, multiplication, division., Thermometer, color, Fahrenheit, Celsius	Text: Lab manual General lab equipment Apron and goggles Meter stick

analytical chemistry, physical chemistry, pure chemistry, applied chemistry, technology, macroscopic, microscopic, biotechnology, pollutant, scientific method, hypothesis, experiment, manipulated and responding variables, theory, scientific law, significant figures, scientific notation, dimensional analysis, mixture, homogeneous mixture, heterogeneous mixture, element. Compound, physical property, chemical property, extensive property, intensive property, density, mass, volume, temperature,		

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
Demonstrations	A. Solid or Liquid – Cornstarch, bowl, water, and tablespoon. Measure 3 tbsps. of cornstarch into a bowl and add 3 tbsps. of water. Mix and allow the mixture to stand for 5 minutes. Test by slowly inserting a finger or fist. Retest by quickly inserting finger or fist. Take a handful of the mixture and form it into a ball. Squeeze and release several times. Discuss results with the students. (Chemistry – Wilbraham, Staley, Matta, Waterman – Prentice Hall)	Asking Questions and Defining Problems Analyzing and Interpreting Data SLO # 1, 2, 3
	Boiling 200 mL of water in a 1 L beaker with a lid to demo a cycle.	Asking Questions and Defining Problems Developing and Using Models SLO # 2, 3
EXPLORE	**Examples of Exploring Activities:**	
Safety	Allow students to see and touch personal safety equipment. Give a tour of the Laboratory, making sure that students know where additional safety equipment is located (fire blanket, eye wash, emergency shower, fire extinguisher).	Asking Questions and Defining Problems Developing and Using Models SLO # 1, 3
	Lab – Bubbles – To test the hypothesis that bubble making can be affected by adding chemicals to a bubble – blowing mixture.	Asking Questions and Defining Problems

		Developing and Using Models SLO # 1, 2, 3
	Demo – Placing a jar over a lit candle. Discuss in terms of the scientific method	Asking Questions and Defining Problems Developing and Using Models Planning and Carrying Out Investigations Analyzing and Interpreting Data SLO # 1, 2, 3, 4
EXPLAIN	**Examples of Explaining Activities:**	
Using personal safety equipment.	Experiment – 1 + 2 + 3 = Black (practice using safety equipment and apparatus)	Asking Questions and Defining Problems Analyzing and Interpreting Data Constructing Explanations and Designing Solutions

		Obtaining, Evaluating, and Communicating Information SLO # 1, 2, 3
ELABORATE	**Examples of Elaborating Activities:**	
Practice using safety and laboratory equipment by performing experiments	Experiments: - Measurements – To make precise and accurate measurements and to use fundamental data to calculate derived quantities. - Density of liquids - Density of solids - Separation of mixtures - Dimensional analysis	Asking Questions and Defining Problems Analyzing and Interpreting Data Using Mathematics and Computational Thinking Engaging in Argument from Evidence Obtaining, Evaluating, and Communicating Information SLO # 1, 2, 3, 4
EVALUATE	**Examples of Evaluating Activities:**	
Safety Test - practicum	Flinn Safety video test. Students are required to identify safety violations.	Obtaining, Evaluating, and Communicating Information SLO # 1, 2, 3, 4

Unit #: 2	Unit Name: Components of Matter	Unit Length: 30

ESSENTIAL QUESTIONS:
1. How does an atom differ from a molecule? 2. What developments have changed our understanding of atoms and molecules since Dalton’s proposed atomic theory? 3. How do elements differ at the atomic level? 4. Are all atoms of a given element identical? 5. How are electrons arranged in an atom? 6. What is the difference between a ground state atom and an excited atom? 7. How does the pattern created by the quantum mechanical model aid in understanding the atom? 8. Why does each element have a unique atomic emission spectrum? 9. How can a periodic table tell me about the subatomic structure of a substances? 10. How can I use the periodic table to predict if I need to duck before mixing two elements? 11. How is the periodic table organized? 12. What are valence electrons and their significance to the chemical properties of elements? 13. How can I use the properties of something (in bulk quantities) to predict what is happening with the subatomic particles? 14. What trends are present within the periodic table?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
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 reactions with oxygen.] [Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.]*	**HS-PS1-1**
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-PS1-2**
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-PS1-3**
4.	**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*	**HS-PS2-6**

	*with specific receptors.] [*Assessment Boundary: Assessment is limited to provide molecular structures of specific designed materials.*]*	

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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) • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3) **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). (HS-PS2-6) **Using Mathematics and Computational Thinking** • Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)	matter, as well as the contact forces between material objects. *(secondary to HS-PS1-1),(secondary to HS-PS1-3)* **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)	aspect of decisions about technology. (HS-ETS1-1), (HS-ETS1-3)

New Jersey Student Learning Standards Connections:

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SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4) **MATHEMATICS:** MP.2 Reason abstractly and quantitatively. (HS-ETS1-3),(HS-ETS1-4) MP.4 Model with mathematics. (HS-ETS1-3),(HS-ETS1-4) 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-PS1-3)
Technology & Career Standards: **8.1 Educational Technology:** All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Vocabulary Atom, Electron, proton, neutron, nucleus, cathode ray, atomic number, mass number, isotopes, atomic mass unit (amu), atomic mass, Bohr Model, energy level, quantum , quantum mechanical model,	Number of, addition, subtraction, multiply, red, orange, yellow, green, blue, indigo, violet, x –ray, microwave, infrared, ultraviolet, visible	Text: Lab manual General lab equipment Apron and goggles

atomic orbital, electron configuration, valence electron, valence shell, Aufbau principle, Pauli exclusion principle, Hund's rule, ground state, excited state, quantum numbers, electromagnetic spectrum, photons, amplitude, wavelength, frequency, hertz, energy, Plank's constant, electromagnetic radiation, atomic emission spectrum, periodic table, period, group, periodic law, metal, nonmetal, metalloid, alkali metal, alkaline earth metal, halogen, noble gas, representative element, transition metal, inner transition metal, atomic radius, ionic radius, ionization energy, electronegativity, nuclear charge, shielding, ion, cation, anion.		

Structure of the Atom

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
Demo	Proof that atoms exist 1. 100 mL water, 100 mL of alcohol. Pour the water into a 250 mL graduated cylinder. Add the alcohol to the water. Read the measurement. 2. 250 mL cold water, 250 mL hot water, food coloring. Place 2 drops of food coloring into each set of water.	Analyzing and interpreting data Engaging in argument from evidence SLO # 3
EXPLORE	**Examples of Exploring Activities:**	
Discussion, Worksheets	- Make models of different atoms - Identify atomic numbers of different atoms - Identify isotopes	Developing and using models Analyzing and interpreting data SLO # 1
	- Calculate mass numbers - Calculate atomic mass	Using mathematics and computational thinking SLO # 4
EXPLAIN	**Examples of Explaining Activities:**	
Discussion Lab reports	- Candium	Developing and using models Using mathematics and computational thinking Obtaining, evaluating, and communicating information SLO # 4, 3

ELABORATE	**Examples of Elaborating Activities:**	
Problem sets	Websites Worksheets	Developing and using models SLO # 1, 3
EVALUATE	**Examples of Evaluating Activities:**	
Assessments	Lab report	Using mathematics and computational thinking Obtaining, evaluating, and communicating information SLO # 1, 3, 4
	Test	Using mathematics and computational thinking Obtaining, evaluating, and communicating information SLO # 1, 3, 4

Electrons in Atoms

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
Demo	Observing light emission from wintergreen mints. Discussion – What did you observe when the mints were crushed?	Asking questions and defining problems Analyzing and interpreting data SLO # 1, 4
	Discuss Electron arrangement in atoms using a ladder	Analyzing and Interpreting Data SLO # 1, 4
	Discuss Electromagnetic spectrum	Analyzing and Interpreting Data Using mathematics and computational thinking SLO # 1, 4
	View emission spectra of gases	Asking questions and defining problems SLO # 1, 4

	Use two bar magnets to model and explain Pauli Exclusion principle. Compare the conditions needed to bring the two magnets together so they will remain in contact with electron spins required to fill an orbital.	Asking questions and defining problems Developing and using models SLO # 1, 4
EXPLORE	**Examples of Exploring Activities:**	
Website, Problem sets and experiment	Websites - showing atomic orbitals - showing electron configuration - behavior of electrons - Rutherford's experiment	Asking questions and defining problems Developing and using models Analyzing and interpreting data SLO # 1, 4
	Problem sets – on all topics	Asking questions and defining problems Developing and using models Analyzing and interpreting data Using mathematics and computational thinking Constructing explanations and designing solutions Obtaining, evaluating and communicating information SLO # 1, 4

	Experiment – View emission spectra of gases eyes and spectroscope.	Obtaining, evaluating and communicating information SLO # 1, 4
	Make models of atoms	Developing and using models SLO # 1, 3
EXPLAIN	**Examples of Explaining Activities:**	
Discussion	Problem sets and practice problems on electron configurations, calculating wavelengths, frequencies, and energy	Asking questions and defining problems Using mathematics and computational thinking SLO # 1, 3, 4
	Make models of atoms	Developing and using problems SLO # 1, 3
ELABORATE	**Examples of Elaborating Activities:**	
Experiments	Lab - Flame test - Electron Configurations of atoms and ions.	Asking questions and defining problems Obtaining, evaluating and communicating information SLO # 1, 3
Flash cards	Create a series of flash cars that illustrate the wavelength, amplitude, crest, trough and origin of a typical wave. On the back of each card label the wave characteristic being illustrated and for the wavelength and amplitude, list the values.	Asking questions and defining problems Obtaining, evaluating and communicating information SLO # 1, 3, 4

EVALUATE	**Examples of Evaluating Activities:**	
Assessments	Lab reports Test Projects Problem sets	Asking questions and defining problems Obtaining, evaluating and communicating information SLO # 1, 3, 4

Organizing the Elements

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
Demo	Trends in Physical Properties - Make 2 Tables with columns. - Table A – Label the columns – Group 1 elements, atomic number, melting point, boiling point and density (include units where appropriate). - Table B – Label the columns – Group 17 elements, atomic number, melting point, boiling point and density (include units where appropriate). - Observe the trends shown in each column.	Asking questions and defining problems Analyzing and interpreting data SLO # 1
EXPLORE	**Examples of Exploring Activities:**	
Discussion, Worksheets and experiment	- History of the Periodic table. - Organization of the modern periodic table - The broad classes of elements - The type of information that can be displayed in a periodic table - How the elements are classified based on their electron configuration - Periodic trends - How ions are formed	Asking questions and defining problems Analyzing and interpreting data SLO # 1
EXPLAIN	**Examples of Explaining Activities:**	
Discussion	- The type of information that can be displayed in a periodic table - How the elements are classified based on their electron configuration	Asking Questions and Defining Problems

Lab reports	- Periodic trends - How ions are formed - The underlying cause of periodic trends	Planning and Carrying Out Investigations SLO # 1
ELABORATE	**Examples of Elaborating Activities:**	
Labs Performance	Lab - Periodic trends in ionic radii - Periodicity in three dimensions - Periodic Properties	Planning and Carrying Out Investigations Using Mathematics and Computational Thinking SLO # 1
	Performance - Using flash cards	Asking Questions and Defining Problems Developing and Using Models SLO # 1
EVALUATE	**Examples of Evaluating Activities:**	
Assessments	Lab report Test Projects – see next page	Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions SLO # 1

Projects

1. Do some research to identify the metalloid elements. Write a report on your findings, including answers to questions such as: What characteristics do these elements share with metals? With nonmetals? What are some modern uses of these elements?

2. The noble gases were originally called inert because they were not known to react with other chemicals. Prepare a report describing the steps taken by scientists in discovering that these elements can react with others. Include information on the noble gases that are still not known to be involved in any chemical reactions.

3. The alkali metals react very vigorously with water. They tarnish quickly on contact with air. Prepare an informative pamphlet on alkali metals for your classmates. Be sure to answer the following questions: How are these materials stored and shipped? Does the shipping company need any special instructions? Suppose you had a small, pure sample of one of these metals and needed to transport it. How could you pack it to prevent contact with air or water?

4. Because astronomers cannot go to the stars, they can study only the light from these stars. Find out how astronomers use atomic spectra to study stars. What kinds of information can scientists learn from these atomic spectra? Write a report summarizing your findings and list several important discoveries that were based on atomic spectra analysis.

5. Write a letter to a friend who has asked you to explain how atoms fill their electrons shells. Be sure to include explanations of the Aufbau principle, the Pauli Exclusion Principle, and Hund's rule. After reading your letter, your friend should be able to draw electron configurations.

6. Neon is not the only gas used inside neon signs. Research the various gases that can be used in this type of sign and the colors given off by the excited gas molecules. Also research the electrical power requirements and longevity of the signs. Present your findings in a report.

Unit #: 3	Unit Name: Bonding Concepts	Unit Length: 20 days

ESSENTIAL QUESTIONS:

1. Why do bonds form?
2. What are the major similarities and differences between ionic and covalent bonds?
3. How do shape, electronegativity, and polarity relate to one another?
4. How can the shape, bond angles, and polarity be predicted using VSEPR theory?
5. How does metallic bonding structure affect the properties of a metal?
6. How does the shape of compound particles affect their properties?
7. What are the rules for ionic, covalent, and acid naming and formula writing?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**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*	**HS-PS1-7**

	memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include complex chemical reactions.]	
2	**Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.**	**HS-ETS1-2**
3	**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 reactions with oxygen.] [Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.]*	**HS-PS1-1**
4.	**Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.** *[Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.]* [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.*]*	**HS-PS1-2**
5	**Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.** *[Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite).* Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [*Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.*]	**HS-PS1-3**

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models ● 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** ● 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** ● Use mathematical representations of phenomena to support claims. (HS-PS1-7)	**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 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) **PS2.B: Types of Interactions** ● Attraction and repulsion between electric charges at the atomic scale explain 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-PS1-2),(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)

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. (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) **Asking Questions and Defining Problems** ● Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) **Using Mathematics and Computational Thinking**	structure, properties, and transformations of matter, as well as the contact forces between material objects.*(secondary to HS-PS1-1),(secondary to HS-PS1-3)* **ETS1.C: Optimizing the Design Solution** ● Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6) **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. (HS-ETS1-1) ● Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global	- ***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)

• Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4) **Constructing Explanations and Designing Solutions** • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3))	challenges also may have manifestations in local communities. (HS-ETS1-1) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) • Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) **ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)	

New Jersey Student Learning Standards Connections:

ENGLISH LANGUAGE ARTS:

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 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-PS1-5)

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1), (HS-ETS1-3)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1), (HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1), (HS-ETS1-3)

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

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-6)

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4)

MATHEMATICS: MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7),(HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) MP.4 Model with mathematics. (HS-PS1-4), (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4) 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-PS1-4), (HS-PS1-5),(HS-PS1-7),(HS-PS1-8) 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-PS1-4), (HS-PS1-5), (HS-PS1-7)
Technology & Career Standards: **8.1 Educational Technology:** All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Electron dot structure, octet rule, halide ion, anion, cation, ionic compound, ionic bond, chemical formula, formula unit,	Exception, positive, negative, attraction, sea, melting, mixing,	Text: Lab manual General lab equipment

metallic bond, alloy, covalent bond, molecule, diatomic molecule, molecular compound, molecular formula, single covalent bond, double covalent bond, triple covalent bond, coordinate covalent bond, structural formula, unshared pair, polyatomic ion, bond dissociation energy, resonance, molecular orbital, bonding orbital, sigma bond, pi bond, tetrahedral angle, VSEPR theory, hybridization, bonding angles, nonpolar covalent bond, polar covalent bond, polar bond, polar molecule, monatomic ion, binary compound, acid, base		Apron and goggles Ball and stick kits

Ionic and Metallic Bonding

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
Demos	Inquiry Activity – Shapes of crystalline materials	Asking Questions and Defining Problems Analyzing and Interpreting Data SLO # 2
	Show samples of metals	Asking Questions and Defining Problems SLO # 2
	Demo – Two bar magnets to demo ionic bonding	Asking Questions and Defining Problems Developing and Using Models SLO # 2
EXPLORE	**Examples of Exploring Activities:**	

Experiments Worksheets	Lab – Solutions containing ions	Obtaining, Evaluating, and Communicating Information SLO # 3, 5
	Problem sets – - Naming cations and anions - Formation of ionic compounds - Properties of ionic compounds - Alloys	Asking Questions and Defining Problems Developing and Using Models Planning and Carrying Out Investigations SLO # 3, 5
EXPLAIN	**Examples of Explaining Activities:**	
Film clips Problem sets	Film clip on - Formation of ions - ionic bonding - metallic bonding - alloys Graphics using the macroscopic scale to explain the microscopic scale	Analyzing and Interpreting Data SLO # 3, 5
ELABORATE	**Examples of Elaborating Activities:**	
Experiment	Analysis of anions and cations	Engaging in Argument from Evidence Obtaining, Evaluating, and Communicating Information SLO # 3, 5
EVALUATE	**Examples of Evaluating Activities:**	
	Tests	Obtaining, Evaluating, and Communicating Information

Assessments		SLO # 3, 5
	Lab reports	Obtaining, Evaluating, and Communicating Information SLO # 3, 5

Covalent Bonding

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
Demos	Demo – Shapes of molecules using balloons	Asking Questions and Defining Problems Developing and Using Models SLO # 3
EXPLORE	**Examples of Exploring Activities:**	

Experiments Worksheets	Lab – Making covalent compound models	Asking Questions and Defining Problems Developing and Using Models SLO # 3
EXPLAIN	**Examples of Explaining Activities:**	
Film clips worksheets	Film clips	Asking Questions and Defining Problems SLO # 3
	Problem sets	Analyzing and Interpreting Data SLO # 3
	Graphics	Constructing Explanations and Designing Solutions Engaging in Argument from Evidence SLO # 3
ELABORATE	**Examples of Elaborating Activities:**	
Experiments	Paper chromatography of food dyes	Engaging in Argument from Evidence Obtaining, Evaluating, and Communicating Information SLO # 3, 5
	Strengths of covalent bonds	Engaging in Argument from Evidence Obtaining, Evaluating, and Communicating Information SLO # 3
	Uses of covalently bonded compounds in today's world	Asking Questions and Defining Problems SLO # 3

EVALUATE	Examples of Evaluating Activities:	
Assessments	Tests	Constructing Explanations and Designing Solutions SLO # 3
	Lab reports	Obtaining, Evaluating, and Communicating Information SLO # 3

Nomenclature of Ionic and Covalent Compounds

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
Demos	Inquiry Activity – Element name search	Obtaining, Evaluating, and Communicating Information SLO # 3, 5
	Show samples of ionic compounds Show samples of covalent compounds Show samples of acids and bases	Asking questions and defining problems SLO # 5, 3
	Demo – Laws for Definite and Multiple Proportions	Asking questions and defining problems Analyzing and interpreting data SLO # 1
EXPLORE	**Examples of Exploring Activities:**	
Experiments Worksheets	Lab – Names and Formulas for Ionic Compounds	Obtaining, Evaluating, and Communicating Information SLO # 1, 2, 5
	Problem sets – - Writing ionic formulas - Writing covalent formulas - Writing names of ionic formulas - Writing names of covalent formulas - Names and formulas of acids and bases - Electron dot structures - Octet rule and its exceptions	Asking questions and defining problems Developing and using models Analyzing and interpreting data Using mathematics and computational thinking.

		SLO # 1, 2, 5
EXPLAIN	**Examples of Explaining Activities:**	
Film clips Problem sets	Film clip on - Writing and naming ionic formulas - Writing and naming covalent formulas - Writing and naming acids and bases Graphics	Asking Questions and Defining Problems Analyzing and Interpreting Data SLO # 1, 2, 5
ELABORATE	**Examples of Elaborating Activities:**	
Experiments	- Names and formulas for ionic compounds - Making ionic compounds - Making models of ionic compounds using paper	Asking Questions and Defining Problems Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information SLO # 1, 2, 5
EVALUATE	**Examples of Evaluating Activities:**	
Assessments	Tests	Obtaining, Evaluating, and Communicating Information SLO # 1, 2, 5
	Lab reports	Obtaining, Evaluating, and Communicating Information Constructing Explanations and Designing Solutions

		SLO # 1, 2, 5
	Projects see next page for suggestions.	Obtaining, Evaluating, and Communicating Information SLO # 1, 2, 5

Project suggestions
Students should not copy and paste from their sources.

1. Research how chemists determine bond lengths in a compound. In particular, find out how they might determine that the two bonds in an ozone molecule (O3) have the same length. Prepare a brief descriptive report of what you learned.
2. Determine why magnetic fields are intense in the vicinity of stars. Write a short explanation of your findings. Include a bibliography that lists your sources.
3. RasMol is a freeware program for viewing the structure of molecules. Connect to the internet and use a search engine to find RasMol website. Download a copy the RasMol program, documentation, and several models of large protein molecule. Prepare a presentation of the software capabilities for your class.
4. Create a bulletin board that tells about alloys. Research how steel, the most important industrial alloy in the modern world, is made. You already know that various metals may be added to the basic iron and carbon mixture. How do manufacturers of steel decide which metals to add and what the proportions should be? Research other useful metal alloys. What are some potential uses of alloys in electronics? In aerospace? In constructions and civil engineering? In automotive engineering? In medicine? What are other uses for alloys?
5. Most elements are found in nature combined with other elements. Ores are rocks that contain enough of desired elements to make separating the elements. Ores are rocks that contain enough of a desired element to make separating the element

from the ore worth the effort. Research some industrial processes that are used to separate elements from their ores. Present your findings in a written report.

6. X – Ray diffraction crystallography is used to study the structure of crystals. Find out more about this process. How are the samples prepared? How are the x–rays generated and detected? If possible, visit a laboratory where x – ray diffraction studies are performed as part of research in chemistry. Prepare an oral report to share with your classmates.
7. Check the labels of different foods and other products that you have at home. Look on the labels for acids. What acids do you find, and what kinds of products contain acids?
8. Some people must have a diet low in sodium. Many foods contain sodium. It is also in table salt. People on low sodium diets often use salt substitutes. Research salt substitutes. Find out what they are and whether there are any health risks associated with their use. Write a brief report summarizing your findings.
9. Many different ions are important to the proper functioning of your body. Choose one ion and find out what foods are the best sources of that ion. Write a newspaper article that reports your findings.

Unit #: 4	Unit Name: Mass Relationships (Stoichiometry)	Unit Length: 30 days

ESSENTIAL QUESTIONS:

1. How does a chemist count?
2. Is it practical to count each grain of sand?
3. Avogadro's number which is equal to 1 mole of a substance is very large, why?
4. How can we quantify things that we cannot see?
5. How are conversions made among particles, mass, volume, and moles of any substance?
6. Why is the mole an important measurement of chemistry?
7. Is there a difference between empirical and molecular formulas?
8. In stoichiometry why is a balanced chemical equation necessary?
9. Is there a difference between actual yield and theoretical yield?
10. Why is percent composition important?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**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 reactions.]*	HS-PS1-7

2	**Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.**	**HS-ETS1-2**
3	**Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.** *[Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [*Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.*]*	**HS-PS1-2**

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • 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** • 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**	**ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)	**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) **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)

• Use mathematical representations of phenomena to support claims. (HS-PS1-7) **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. (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) **Asking Questions and Defining Problems**		

● Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) **Using Mathematics and Computational Thinking** ● Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4) **Constructing Explanations and Designing Solutions** ● Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)		

New Jersey Student Learning Standards Connections:

ENGLISH LANGUAGE ARTS:

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 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-PS1-5)

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1), (HS-ETS1-3)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1), (HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),(HS-ETS1-3)

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

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-6)

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4)

MATHEMATICS:

MP.2 Reason abstractly and quantitatively. (HS-PS1-5), (HS-PS1-7), (HS-ETS1-1), (HS-ETS1-3),(HS-ETS1-4)

MP.4 Model with mathematics. (HS-PS1-4), (HS-ETS1-1), (HS-ETS1-2), (HS-ETS1-3), (HS-ETS1-4)

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-PS1-4), (HS-PS1-5), (HS-PS1-7), (HS-PS1-8) 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-PS1-4), (HS-PS1-5), (HS-PS1-7)
Technology & Career Standards: **8.1 Educational Technology:** All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Mole, Avogadro’s number, representative particle, molar mass, Avogadro’s hypothesis, STP, molar volume, percent composition, empirical formula, molecular formula, stoichiometry, mole ratio, limiting reagent,	Temperature, pressure, percent, solid, liquid, gas	Text: Lab manual General lab equipment Apron and goggles Balances

excess reagent, theoretical yield, actual yield, percent yield, balanced chemical equation, reactant, product, aqueous		

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
Demos	Inquiry Activity – Counting by measuring mass (paper clips)	Asking Questions and Defining Problems SLO # 1
	Inquiry Activity – How many can you make?	Asking Questions and Defining Problems SLO # 1
EXPLORE	**Examples of Exploring Activities:**	
Experiments Problem sets	Experiments - Counting by measuring mass (water) - Empirical formula of magnesium oxide - Percent composition - Analysis of baking soda	Asking Questions and Defining Problems Developing and Using Models

	- Limiting reagents - Balanced chemical equations	Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information SLO # 1
	Problem sets - Measuring matter - Representative particles to mole and reverse - Molar mass of an element - Molar mass of a compound - Mole – mass and mole – volume relationships - Percent composition - Chemical formulas – (empirical and molecular) - Balanced chemical equations	Asking Questions and Defining Problems Developing and Using Models Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information SLO # 1
EXPLAIN	**Examples of Explaining Activities:**	
Film clips Problem sets	- Film clips - Graphics - Worksheets	Asking Questions and Defining Problems Developing and Using Models Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information

		SLO # 1
ELABORATE	**Examples of Elaborating Activities:**	
Projects	Projects – see next page for suggestions	Planning and Carrying Out Investigations Developing and Using Models Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information SLO # 1
EVALUATE	**Examples of Evaluating Activities:**	
Assessments	Write your own test and answer key	Asking Questions and Defining Problems Developing and Using Models Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information

		SLO # 1, 2, 3
	Lab reports	Asking Questions and Defining Problems Developing and Using Models Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information SLO # 1, 2, 3

Projects

1. Design an experiment to measure the percent by mass of water in a soil sample. Show your design to your teacher and if approved, collect some soil samples and find the percent by mass of water in the soil.
2. Aluminum is one of the most common materials to recycle. Using the concept of the mole, design an experiment to determine the number of aluminum atoms recycle for a typical aluminum soda can. Determine also if different brands of

aluminum cans contain the same number of atoms. Have your teacher review and approve your experimental design. Perform the experiment and report the results to your teacher or class.

3. Find the percent of fat in different brands of margarine. Present your findings using a poster as a visual aid.
4. Commercial fertilizers are rated using numbers that show the percent by mass of nitrogen, phosphorus, and potassium – elements essential for plant growth. The N – P – K rating on my bag of fertilizers is `4 – 28 – 15. Visit your local nursery or garden center to find examples of fertilizers that are designed for certain types of plants. Write a description of the special requirements of these plants.
5. Write two sample problems describing how to solve both mole-mole and mass-mass problems.

Unit #: 5	Unit Name: Reactions in Aqueous Solutions	Unit Length: 15 days

ESSENTIAL QUESTIONS:

1. Does chemical bonding mimic any macroscopic processes?
2. Does one size fit all?
3. Why must the mass of the reactants be equal to the mass of the products in a chemical reaction?
4. What characteristics are used to classify chemical reactions?
5. Why is water an effective solvent for ionic compounds?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**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 reactions.]*	**HS-PS1-7**
2	**Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.** *[Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]*	**HS-PS1-4**

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models ● 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** ● 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**	**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. (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) **PS2.B: Types of Interactions** Attraction and repulsion between electric charges at the atomic scale explain 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-PS1-2),(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)

● Use mathematical representations of phenomena to support claims. (HS-PS1-7) **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. (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) **Asking Questions and Defining Problems**	structure, properties, and transformations of matter, as well as the contact forces between material objects.*(secondary to HS-PS1-1),(secondary to HS-PS1-3)* ● **ETS1.C: Optimizing the Design Solution** ● Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6) **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. (HS-ETS1-1) ● Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have	- ***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)

• Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) **Using Mathematics and Computational Thinking** • Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4) **Constructing Explanations and Designing Solutions** • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)	manifestations in local communities. (HS-ETS1-1) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) • Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)	

New Jersey Student Learning Standards Connections:

ENGLISH LANGUAGE ARTS:

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 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-PS1-5)

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1), (HS-ETS1-3)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1), (HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),(HS-ETS1-3)

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

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-6)

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4)

MATHEMATICS:

MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7),(HS-ETS1-1),(HS-ETS1-3), (HS-ETS1-4)

MP.4 Model with mathematics. (HS-PS1-4), (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3), (HS-ETS1-4)

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-PS1-4), (HS-PS1-5),(HS-PS1-7),(HS-PS1-8) 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-PS1-4), (HS-PS1-5),(HS-PS1-7)
Technology & Career Standards: **8.1 Educational Technology:** All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Chemical equation, skeleton equation, catalyst, coefficients, balanced equation, Precipitation reaction, acid-base reaction, oxidation reduction reaction, concentration, molarity, molality, titration	Analysis, components, data, deduction, demonstrate, derived, elements, equation, interpretation, principle, procedure, process, required, significant, structure, transfer, variables	Text: Lab manual General lab equipment Apron and goggles

(combination reaction, decomposition reaction, single – replacement reaction, double – replacement reaction, combustion reaction), activity series, solubility rules, complete ionic equation, spectator ion, net ionic equation, catalyst, aqueous (aq), solid (s), liquid (l), gas (g), exothermic, endothermic, solvent, solute, reversible reaction, reaction rate, activation energy, Collision theory, chemical equilibrium, LeChatelier's principle, titration		

THE 5 “E”s	Examples of Learning Activities for the specified “E”	SLO’s and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
Demos	Inquiry Activity - Modeling chemical reactions - Temperature and reaction rates	Asking Questions and Defining Problems Planning and Carrying Out Investigations SLO # 2
EXPLORE	**Examples of Exploring Activities:**	
Experiments Problem sets	Describe each type of reactions - Precipitation reaction - Acid – Base reaction - Redox reaction - Reversible reaction	Planning and Carrying Out Investigations Analyzing and Interpreting Data Constructing Explanations and Designing Solutions SLO # 2
	Problem sets - Writing and balancing chemical reactions (words and formulas) - Identifying types of chemical reactions - Predicting the products of chemical reactions - Net ionic equations - Predicting the formation of a precipitate - Collision theory - Factors affecting reaction rates - Reversible reactions - Equilibrium - LeChatelier Principle	Analyzing and Interpreting Data Using Mathematics and Computational Thinking SLO # 1, 2

	- Activation energy -	
EXPLAIN	**Examples of Explaining Activities:**	
Film clips Problem sets	- Film clips - Graphics using the macroscopic scale to explain the microscopic scale - Problem sets	Analyzing and Interpreting Data Using Mathematics and Computational Thinking SLO # 1, 2
ELABORATE	**Examples of Elaborating Activities:**	
Experiments	Removing silver tarnish (useful in housekeeping) Types of chemical reactions Precipitation reactions: Formation of solids Does Steel Burn Iodine clock	Obtaining, Evaluating, and Communicating Information Analyzing and Interpreting Data Constructing Explanations and Designing Solutions SLO # 1, 2
EVALUATE	**Examples of Evaluating Activities:**	
Assessments	Tests	Analyzing and Interpreting Data Using Mathematics and Computational Thinking

		Constructing Explanations and Designing Solutions SLO # 1, 2
	Lab reports	Obtaining, Evaluating, and Communicating Information SLO # 1, 2
	Performance Assessments: See suggestions on the next page	Analyzing and Interpreting Data Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions SLO # 1, 2

Performance Assessments

1. Develop two creative examples to represent what is happening in each of these types of reactions: combination, decomposition, single – replacement, double – replacement, combustion
    a. Example: combination reaction
    b. Graphite + wood = pencil
2. Provide an explanation for each statement:
    a. The five types of chemical reactions can be similar and different at the same time.
    b. Household ammonia and liquid bleach are both useful products if treated with care. Labels on both products warn users not to mix ammonia with bleach. Hint: The active ingredients in liquid bleach is usually sodium hypochlorite.
    c. Flour, sugar, and baking soda packaged together in a cake mix do not react with one another until they are mixed with a liquid and heated.
    d. Burning logs in a fireplace involves a chemical reaction whereas making wood chips out of the logs does not.
    e. Vinegar added to baking soda is a home remedy for clearing a clogged drain.
3. Keeping a log of all the chemical reactions you observe or experience in one week. Classify each reaction by type. Describe evidence of the reactions as well as what you think the products were.
4. Many products are marketed as being environmentally friendly because they are biodegradable. Research with biodegradable means. Select a product that is marketed as being biodegradable, and identify the products into which it degrades. Present your findings on a piece of construction paper or poster board.

Unit #: 6	Unit Name: Gases	Unit Length: 15 days

ESSENTIAL QUESTIONS:

1. Should we continue to manufacture aerosol cans?
2. What are the characteristics of a gas?
3. What are intermolecular forces?
4. Are ideal gases real?
5. How is the Kinetic Molecular Theory used to explain the behavior of matter?
6. Do gases respond to changes in temperature, pressure and volume?
7. How is the average kinetic energy of a system related to the gas laws?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**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-PS3-4**
2	**Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.** *[Clarification Statement: See Three-Dimensional Teaching and Learning Section for examples].*	**HS-ETS1-3**

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (HS-PS3-4) **Engaging in Argument from Evidence** ● Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2) **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:	**PS3.B: Conservation of Energy and Energy Transfer** ● Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-4) ● Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4) **PS3.D: Energy in Chemical Processes** Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-4) .	**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)

decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5)		

New Jersey Student Learning Standards Connections:

ENGLISH LANGUAGE ARTS:

RST.11-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-PS3-4),(HS-ESS3-2)

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-3)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS3-2),(HS-PS3-4),(HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-3)

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-PS3-4), (HS-ESS2-5)

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.

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

MATHEMATICS:

MP.2 Reason abstractly and quantitatively. (HS-PS3-4),(HS-ESS3-2),(HS-ETS1-3)

MP.4 Model with mathematics. (HS-PS3-4), (HS-ETS1-3)

Technology & Career Standards:

8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Career Ready Practices: 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Kinetic energy, kinetic theory, gas pressure, vacuum, atmospheric pressure, barometer, pascal (Pa), standard atmosphere (atm), vaporization, evaporation, vapor pressure, compressibility, Boyle's law, Charles's law, Gay – Lussac's law, combined gas law, ideal gas law, ideal gas constant, partial pressure, Dalton's law of partial pressure, diffusion, effusion, Graham's law of effusion	Analysis, components, data, deduction, demonstrate, derived, elements, equation, interpretation, principle, procedure, process, required, significant, structure, transfer, variables	Text: Lab manual General lab equipment Apron and goggles

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
Demo	Observing gas pressure Sublimation of iodine Observing volume changes	Asking Questions and Defining Problems Analyzing and Interpreting Data SLO # 1
EXPLORE	**Examples of Exploring Activities:**	
Labs, Problem sets Websites	Labs - Pressure – Volume relationship for a gas - Diffusion of gases	Planning and Carrying Out Investigations Analyzing and Interpreting Data Using Mathematics and Computational Thinking

		Constructing Explanations and Designing Solutions SLO # 1
	Websites on the movement of gases	Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions SLO # 1, 2
EXPLAIN	**Examples of Explaining Activities:**	
Problem sets	Problem sets on each law showing the relationships involved (temperature, volume, pressure, moles, mass, molar mass, density)	Analyzing and Interpreting Data Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions SLO # 1, 2
ELABORATE	**Examples of Elaborating Activities:**	
Identify each gas law and how they work in the real world	Gases - Boyle's Law - Charles Law - Diffusion - Dalton's Law of Partial pressure	Analyzing and Interpreting Data Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions SLO # 1
EVALUATE	**Examples of Evaluating Activities:**	
Assessments	Test Lab reports Problem sets	Analyzing and Interpreting Data Using Mathematics and Computational Thinking

		Constructing Explanations and Designing Solutions SLO # 1

Today's World

1. An open empty soda can was heated over a Bunsen burner for about a minute. Describe what would happen if the can were quickly removed from the flame ad plunged upside down into an ice water bath. Use kinetic theory to explain your description.
2. Make a poster illustrating the gas laws you have learned. Your poster should describe each gas law, give its equation, and show one or more example of how the law applies in real life.
3. How does the vacuum use in Thermos bottles prevent heat transfer?
4. Aerosol cans are used in almost all areas of life, personal care products, food industry, and paint industry to name a few. In today's world of going green, should we continue to manufacture aerosol cans?

Unit #: 7	**Unit Name:** Thermochemistry	**Unit Length: 20 days**

ESSENTIAL QUESTIONS:

1. What is heat?
2. Does heat move?
3. What is (are) the difference(s) between endothermic and exothermic reactions?
4. Does adding heat to a system change its energy content?
5. What is the direction of energy flow in a chemical reaction?
6. How is energy transferred within a system?
7. What is the relationship between energy, work, and heat?
8. How can a balanced chemical equation be used to determine heats of reaction?
9. How useful are phase diagrams?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**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-PS3-4**
2	**Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.** *[Clarification Statement: See Three-Dimensional Teaching and Learning Section for examples].*	**HS-ETS1-3**

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (HS-PS3-4) **Engaging in Argument from Evidence** ● Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2) **Planning and Carrying Out Investigations** ● Plan and conduct an investigation individually and collaboratively to produce	**PS3.B: Conservation of Energy and Energy Transfer** ● Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-4) ● Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4) **PS3.D: Energy in Chemical Processes** ● Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-4) .	**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)

data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5)		

New Jersey Student Learning Standards Connections:

ENGLISH LANGUAGE ARTS:

RST.11-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-PS3-4),(HS-ESS3-2)

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-3)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS3-2),(HS-PS3-4),(HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-3)

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-PS3-4), (HS-ESS2-5)

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. WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS3-4) **MATHEMATICS:** MP.2 Reason abstractly and quantitatively. (HS-PS3-4),(HS-ESS3-2),(HS-ETS1-3) MP.4 Model with mathematics. (HS-PS3-4), (HS-ETS1-3)
Technology & Career Standards: **8.1 Educational Technology:** All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Thermochemistry, chemical potential energy, heat, system, surrounding, law of conservation of energy, endothermic process, exothermic process, heat	Analysis, components, data, deduction, demonstrate, derived, elements, equation, interpretation, principle, procedure,	Text: Lab manual General lab equipment Apron and goggles

capacity, specific heat, calorimetry, calorimeter, enthalpy, thermochemical equation, heat of reaction, heat of combustion, molar heat of fusion, molar heat of solution, Hess's law of heat summation, enthalpy, First law of thermodynamics, closed system, open system, energy,	process, required, significant, structure, transfer, variables	

THE 5 "E"s	**Examples of Learning Activities for the specified "E"**	**SLO's and Engineering Practices**
ENGAGE	**Examples of Engaging Activities:**	
Demo	Sublimation of iodine Observing volume changes Observing heat flow	Asking Questions and Defining Problems Analyzing and Interpreting Data SLO # 1
EXPLORE	**Examples of Exploring Activities:**	
Labs, Problem sets Websites	Labs - Heat of fusion of ice	Planning and Carrying Out Investigations Analyzing and Interpreting Data Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions SLO # 1, 2

	Websites on the movement of heat	Constructing Explanations and Designing Solutions SLO # 1
	Problem sets	Analyzing and Interpreting Data SLO # 1, 2
EXPLAIN	**Examples of Explaining Activities:**	
Problem sets	Worksheets on each topic	Analyzing and Interpreting Data SLO # 1, 2
ELABORATE	**Examples of Elaborating Activities:**	
	Thermochemistry - Heat of combustion of a candle - Calorimetry	Constructing Explanations and Designing Solutions Obtaining, Evaluating, and Communicating Information SLO # 1, 2
EVALUATE	**Examples of Evaluating Activities:**	
Assessments	Test	Constructing Explanations and Designing Solutions SLO # 1, 2
	Lab reports	Obtaining, Evaluating, and Communicating Information SLO # 1, 2
	Today's world	Constructing Explanations and Designing Solutions SLO # 1, 2

Today’s World

1. Some chefs like to cook with cast iron skillets, while other prefer to use lightweight stainless steel, and still others the newest copper coated skillets. Using what you have learned, list some of the advantages and disadvantages of each type of skillet. From your lists, write an advertisement for each type of skillet in which you highlight its features.
2. Explain why water condenses on the outside surface of a glass of ice water. Your response would be the form of pamphlet.
3. For one week, keep a list of chemical reactions that you encounter in your everyday life. Classify each reaction as either endothermic or exothermic.
4. An open empty soda can was heated over a Bunsen burner for about a minute. Describe what would happen if the can were quickly removed from the flame ad plunged upside down into an ice water bath. Use kinetic theory to explain your description.
5. Make a poster illustrating the gas laws you have learned. Your poster should describe each gas law, give its equation, and show one or more example of how the law applies in real life.
6. How does the vacuum use in Thermos bottles prevent heat transfer?
7. Aerosol cans are used in almost all areas of life, personal care products, food industry, and paint industry to name a few. In today’s world of going green, should we continue to manufacture aerosol cans?

Unit #: 8	Unit Name: Entropy, Free Energy, Kinetics (Rate Laws) & Equilibrium	Unit Length: 20 days

ESSENTIAL QUESTIONS:

1. Can energy be destroyed or transferred between systems?
2. What is entropy?
3. Is an increase in the entropy of the universe thermodynamically favored?
4. How is it possible for biological reactions with $\Delta G > 0$ to occur?
5. How is the reaction rate related to collisions?
6. What is the relationship between summed reactions and their individual equilibrium constant?
7. What is an equilibrium constant?
8. Some reactions spontaneous and others are not, why?
9. How can the rate of a reaction be increased?
10. Is it possible to increase the amount of product produced?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**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*	HS-PS3-4

	Boundary: Assessment is limited to investigations based on materials and tools provided to students.]	
2	**Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.** *[Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]*	**HS-PS1-4**
3	**Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.** *[Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] [Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.]*	**HS-PS1-5**
4	**Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*** *[Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.]*	**HS-PS1-6**

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models ● 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** ● 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)	**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. (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. (HS-PS1-4),(HS-PS1-5) **ETS1.C: Optimizing the Design Solution** ● Criteria may need to be broken down into simpler ones that can be approached	**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**

Using Mathematics and Computational Thinking ● Use mathematical representations of phenomena to support claims. (HS-PS1-7) **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. (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)	systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6) **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. (HS-ETS1-1)	● 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)

New Jersey Student Learning Standards Connections:

ENGLISH LANGUAGE ARTS:

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 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-PS1-5)

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1), (HS-ETS1-3)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1), (HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1), (HS-ETS1-3)

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

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-6)

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4)

MATHEMATICS:

MP.2 Reason abstractly and quantitatively. (HS-PS1-5), (HS-PS1-7), (HS-ETS1-1), (HS-ETS1-3), (HS-ETS1-4)

MP.4 Model with mathematics. (HS-PS1-4), (HS-ETS1-1), (HS-ETS1-2), (HS-ETS1-3), (HS-ETS1-4)

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-PS1-4), (HS-PS1-5), (HS-PS1-7), (HS-PS1-8)

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-PS1-4), (HS-PS1-5), (HS-PS1-7)

Technology & Career Standards:

8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Career Ready Practices: 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Free energy, spontaneous reaction, nonspontaneous reaction, entropy, law of disorder, Gibbs free-energy change, rate law, rate constant, zero order reaction, first order reaction, second order reaction, activation energy, chemical kinetics, half-life, reaction order, chemical equilibrium, equilibrium constant, rate determining step	Analysis, components, data, deduction, demonstrate, derived, elements, equation, interpretation, principle, procedure, process, required, significant, structure, transfer, variables	Text: Lab manual General lab equipment Apron and goggles

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
Demos & Brainstorm	Spontaneous Reaction – lead (II) nitrate and sodium iodide	Asking Questions and Defining Problems Developing and Using Models SLO # 3
	Nonspontaneous reaction - the decomposition of carbon dioxide	Asking Questions and Defining Problems Developing and Using Models SLO # 3
	Entropy – Ice converted to steam	Asking Questions and Defining Problems Developing and Using Models SLO # 3
EXPLORE	**Examples of Exploring Activities:**	
Experiments	Lab - Enthalpy and Entropy - Heat of solution - Bromination of Acetone	Obtaining, Evaluating, and Communicating Information Analyzing and Interpreting Data SLO # 2, 3
EXPLAIN	**Examples of Explaining Activities:**	
Websites Problem sets	Problem sets on all topics	Constructing Explanations and Designing Solutions Analyzing and Interpreting Data SLO # 2, 3, 4

ELABORATE	**Examples of Elaborating Activities:**	
Experiments	Create their own experiment to show - Entropy - Enthalpy - Rate of reaction	Planning and Carrying Out Investigations Using Mathematics and Computational Thinking Developing and Using Models SLO # 1, 2, 3, 4
EVALUATE	**Examples of Evaluating Activities:**	
Assessment	Lab reports	Using Mathematics and Computational Thinking Developing and Using Models Constructing Explanations and Designing Solutions SLO # 1, 2, 3, 4
	Performance assessments – for suggestions see next page.	Developing and Using Models Constructing Explanations and Designing Solutions SLO # 1, 2, 3, 4

Performance Assessment

1. Design an experiment to determine how temperature affects reaction rates. Choose a simple chemical reaction that has a visible precipitate or produces a nontoxic gas. Show your experimental design to your teacher. If your teacher approves your design, perform the experiment and make a graph illustrating the reaction rate versus temperature for the reaction you tested.
2. What are oscillating reactions? Prepare a report that defines them and includes several examples. Present your finding to the class.
3. Catalysts are important to many chemical reactions used in industry. Research catalysts and choose one that is used in an industrial reaction. Make a poster describing the chemical process and the role that the catalyst plays. Be sure to note the reactants and the products.
4. Write a short article describing the combustion of methane (CH_4) in terms of the reaction rate, the rate law, and the reaction mechanism.
5. Even though nitrogen gas (N_2) is very unreactive, it is an important component in the production of ammonia (NH_3). Ammonia is an important material used to make such diverse products as dyes, fertilizer, plastics, and explosives. The Haber process that combines atmospheric nitrogen with hydrogen gas to produce ammonia. Do some research to find out how the Haber process works. Make a bulletin – board display that illustrates the steps of this process.

Unit #: 9	**Unit Name:** Nuclear Chemistry	**Unit Length: 15 days**

ESSENTIAL QUESTIONS:

1. What is radioactivity?
2. What is radiocarbon dating?
3. Why is fusion considered the Holy Grail for the production of electricity?
4. Why aren't all forms of radiation harmful to living things?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	**Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.** *[Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] [Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.]*	**HS-PS1-8**

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

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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),(HS-ESS1-1)	**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)	**Energy and Matter** • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-ESS1-3), (HS-PS1-8), (HS-ESS1-1) ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-2),(HS-ESS1-4) - -- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems**

		• Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-ESS1-2) • Science assumes the universe is a vast single system in which basic laws are consistent. (HS-ESS1-2) **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-ESS1-2)

New Jersey Student Learning Standards Connections:

ENGLISH LANGUAGE ARTS:

RST.11-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.. (HS-ESS1-1)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-3), (HS-ESS1-2)

SL.11-12.4 Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.
(HS-ESS1-3)

MATHEMATICS:

MP.2 Reason abstractly and quantitatively. (HS-ESS1-1), (HS-ESS1-2),(HS-ESS1-3),(HS-PS1-8)

MP.4 Model with mathematics. (HS-ESS1-1)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS1-1), (HS-ESS1-2)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-1), (HS-ESS1-2)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-1), (HS-ESS1-2)

HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-ESS1-1)

HSA-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-ESS1-1), (HS-ESS1-2)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-ESS1-1), (HS-ESS1-2)

Technology & Career Standards:

8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Required Resources**
Radioactivity, alpha particle, beta particle, gamma ray, photon, positron, nucleon, K-capture, critical mass, nuclear fission, nuclear fusion, nuclear chain reaction, thermonuclear reaction,	Analysis, components, data, deduction, demonstrate, derived, elements, equation, interpretation, principle, procedure, process, required, significant, structure, transfer, variables	Text: Lab manual General lab equipment Apron and goggles

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
History of the discovery of radioactivity	History includes Antoine Henri Becquerel	Developing and Using Models SLO # 1, 2
	Simulation from the internet	Developing and Using Models SLO # 1
EXPLORE	**Examples of Exploring Activities:**	
Experiment	Lab – Simulating Radioactive Decay	Obtaining, Evaluating, and Communicating Information SLO # 1
EXPLAIN	**Examples of Explaining Activities:**	
Problem sets	Problem sets - Balancing nuclear equations - Nuclear stability - Nuclear radioactivity including radiocarbon dating - Nuclear fission - Nuclear fusion - Radioisotopes	Asking Questions and Defining Problems Using Mathematics and Computational Thinking Engaging in Argument from Evidence SLO # 1
ELABORATE	**Examples of Elaborating Activities:**	

Research	Uses of nuclear reactions - Power plants - Medicine - Dentistry	Asking Questions and Defining Problems Constructing Explanations and Designing Solutions Obtaining, Evaluating, and Communicating Information SLO # 1, 2
EVALUATE	**Examples of Evaluating Activities:**	
	Problem sets	Obtaining, Evaluating, and Communicating Information SLO # 1
	Research	Obtaining, Evaluating, and Communicating Information SLO # 1