Burlington County Institute of Technology

Medford Campus

Westampton Campus

Chemistry

Department: Science
Credits: 5
Revised: August 2023
Board Approval Date: August, 2023

Course Description

Chemistry is a lab-intensive, college preparatory course focused on understanding chemical principles and their applications. Topics covered include atomic and molecular theory, concepts in bonding, periodic law, states of matter and solutions, mathematical calculations in chemistry, writing balanced chemical reactions and equilibrium, and nuclear reactions. Safety and laboratory skills will be developed during the course and safe laboratory behavior will be practiced at all times.

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Pacing Guide

Unit	Standards	Days
Unit 1 – Structures & Properties of Matter	HS-PS1-1, 3	Weeks 1-6
Unit 2 – Conservation of Matter	HS-PS1-2, 7	Weeks 7-10
Unit 3 – Reaction Rates & Chemical Equilibrium	HS-PS1- 4, 5, 6	Weeks 11-12
Unit 4 – Nuclear Chemistry	HS-PS1-8 HS-ESS1-1, 3	Weeks 13-14
Unit 5 – Applications of Chemistry	HS-PS2-6 HS-PS4-4, 5	Weeks 15-18

Curriculum Maps

Unit 1: Structure and Properties of Matter

Desired Outcomes

NJSLS

Physical Science (PS)

- HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. (RST.9-10.7, RST.9-10.4)
- HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. (RST.9-10.3, RST.9-10.7, RST.11-12.9, WHST.9-10.2 E-F, WHST.9-10.6, WHST.9-10.7, WHST.9-10.9)

Established Goals

- Provide evidence that the number of protons determine an element.
- Demonstrate how the gain or loss of electrons results in the formation of an ion.
- Illustrate that ions are elements that have different properties than the parent element.
- Explain how a change in the number of neutrons in an element forms an isotope. (Beanium Lab/Activity)
- Demonstrate that isotopes have similar properties to parent element, but different masses. (Beanium Lab/Activity)
- Explain the patterns of outermost (valence) electrons. (Periodic Trends Lab)
- Describe patterns in the organization of the periodic table. (Periodic Trends Lab)
- Explain how patterns influence the number and types of bonds formed by an element and between elements.
- Demonstrate that energy is required to overcome bonds of attraction in solids and liquids
- Demonstrate that condensation and freezing release energy as bonds of attraction are formed
- Investigate the strength of electrical forces between particles.
- Describe strong interactions as ionic bonds.
- Describe weaker interactions as covalent bonds.
- Use properties such as melting point, boiling point, vapor pressure, and surface tension to develop trends in

the periodic table (Periodic Trends Lab)

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. ● Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. ● Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for	**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) ● The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3	**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-PS1-3)

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)		

Enduring Understandings:

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.
- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.

Essential Questions:

- How does the structure of an atom determine the properties of an element?
- How does the composition of an element determine its placement on the periodic table?
- How can the periodic table be used to predict the properties/behavior of different atoms?
- How is the formation of an ionic bond different from the formation of a covalent bond?
- What types of intermolecular forces exist in molecules and how do they affect the physical properties of molecules?

Students will know:

- Subatomic Particles – Protons, Neutrons, Electrons
  - ⇒ Valence Electrons
  - ⇒ Ionic Bond, Covalent Bond, Metallic Bond

Students will be able to:

- Use a model to predict the relationships between systems or between components of a system.
- Explain that different patterns may be observed at

○ Periodic Table Organization ⇒ Ionization Energy, Electronegativity, Atomic Radius ⇒ # of Valence Electrons vs. Bond Formation ○ Particle Arrangement/Behavior ⇒ Solid, Liquid, Gas ⇒ Phase Transitions	each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. ● 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.

Assessment Evidence

Suggested Performance Tasks:

- Alien Periodic Table (Goal #7)
  - ⇒ Utilize physical and chemical properties of elements to identify trends on the periodic table and patterns of organization
- Adopt-an-Element Project
  - ⇒ Research physical and chemical properties of an element and examine its use in real world
- Path to the Periodic Table (Goal #7)
  - ⇒ Identify trends in the properties of elements, arrange the elements based on trends and defend/analyze the arrangement on the periodic table
- Build an Atom: Phet Simulation (Goal #1,

Required District/State Assessments:

- District marking period assessments
- SGO assessments

Suggested Formative/Summative Assessments:

- Practice Worksheets
  - ⇒ Calculating Subatomic Particles
  - ⇒ Isotopes & Atomic Masses
  - ⇒ Determining Valence Electrons
  - ⇒ Drawing Lewis Dot Diagrams
  - ⇒ Formation of Ionic Bonds
  - ⇒ Formation of Covalent Bonds
- Section Quizzes
  - ⇒ Isotopes & Subatomic Particles
  - ⇒ Periodic Table
  - ⇒ Ionic Bonding

2)
    - ⇒ Use the number of protons, neutrons and electrons to draw a model of the atom, identify the element, and determine the mass and charge
    - ⇒ Predict how addition or subtraction of a proton, neutron or electron will change the element. ‘
    - ⇒ Use the element name, mass and charge to determine the number of protons, neutrons and electrons
    - ⇒ Isotopes and Atomic Mass: Phet Simulations (Goal #3, 4, 5)
    - ⇒ Predict how mass and name of an atom will change given a change in the protons, electrons and neutrons
- POGIL-Classifying Types of Chemical Reactions (Goal #8)
    - ⇒ Identify and differentiate between the 4 types of chemical reactions
- Beanium Lab/Activity: (Goal #4, 5)
    - ⇒ Determine the atomic mass for BEANIUM based on the isotopic abundances and the isotopic masses.
- Graphing the Periodic Table (Goal #7)
    - ⇒ Utilize data, including melting point, molar mass, atomic radius, etc., to identify trends on the periodic table
    - ⇒ Covalent Bonding
- Chapter Tests
- Short/extended constructed response items from ELA NJGPA/NJSLA and Science NJSLA
- Projects
- Journals
- Observation
- Graphic organizers/concept mapping
- Presentations
- Warmups / exit ticketsSkill Assessment Worksheets:
- Content Quizzes:

Laboratory Investigation:

- Identification of an Unknown Based on Physical Properties(can also apply to new unit one)
  - ⇒ Argument Driven Application Lab
  - ⇒ Identify unknowns based on physical properties
- Comparing Properties of Substances (Student Design)
  - ⇒ Laboratory Report & Reflection
- Periodic Trends (Argument Driven Investigation) (Goal # 6, 14)
  - ⇒ Develop procedures, make a claim, defend with evidence
  - ⇒ Determine which properties follow a period trend

Learning Plan

Learning Activities:

- Videos
- Class Discussion
- In-Class Skill Practice
- Student Research for Planning Lab Investigation
- Textbook Chapters: Pearson Chemistry, Chapters 4, 5, 6, and 7

Related Standards

Interdisciplinary connections

Mathematics (NJSLS-N-Q.A.1, NJSLS-N-Q.A.2, NJSLS-N-Q.A.3)

- Examples:
  - ⇒ Considering the outermost energy level of atoms, define appropriate quantities for descriptive modeling of periodic trends for main group elements based on patterns of electrons in outermost energy levels.
  - ⇒ Use units as a way to understand the outcome of a simple chemical reaction involving main group elements based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. Choose and interpret units consistently in chemical reactions.
  - ⇒ Use units as a simple way to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. Choose and interpret units comparing the structure of substances at the bulk scale to infer the strength of electrical forces between particles. Choose and interpret the scale and origin in graphs and data displays comparing the structure of substances and the bulk scale and electrical forces between particles.

NJ SEL Competencies

- Self-Awareness: Recognize the importance of self-confidence in handling daily tasks and challenges.
- Self-Management: Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals.

Climate Change

- The Chemistry of the Greenhouse Effect: Students will learn about the chemistry of the greenhouse effect, including the relationship between temperature and energy in the Earth's atmosphere, properties of gases, absorption and emission of radiation, atmospheric molecular interactions, lapse rate, Earth's radiative energy balance, and the difference between greenhouse gases.

Culturally Relevant Connections

- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as Zoom/Google Meet, 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).
- Structure the learning around explaining or solving a social or community-based issue.

Accommodations

Special Education/ 504/ At Risk Students Accommodations & Modifications:

- Provide students with multiple choices for how they can represent their understanding (e.g. multisensory techniques, auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena.

ELL:

- Provide students with multiple literacy strategies
- Collaborate with after-school programs or clubs to extend learning opportunities.

Enrichment

Project Storyline: As scientists for an Environmental company you want solve environmental problems by creating models that are both cost effective and environmentally friendly. You and your colleagues must discuss and develop a successful plan of action to present to the board of trustees. What is the main focus of the project? What things do you need to take into consideration?

- Essential Question: I want to do the right thing, what is the greener choice for grocery bags (paper or plastic/reusable vs. disposable); cold drink containers (plastic, glass, or aluminum); or hot drink containers (paper, Styrofoam, or ceramic)?
- Project Concepts:
  - ⇒ The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.

- ⇒ Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
- ⇒ When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, aesthetics, and to consider social, cultural, and environmental impacts.
- ⇒ 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.
- ⇒ Models (e.g., physical, mathematical, computer models) can be used to simulate why the molecular-level structure is important in the functioning of designed materials.

Unit 2: Conservation of Matter

Desired Outcomes

NJSLS

Physical Science (PS)

- HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. (RST.11-12.4)
- HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Determine the mass of reactants required to produce the desired mass of product for a given reaction. (RST.11-12.8)

Established Goals

- Write a balanced chemical equation that symbolically represents the description of a chemical reaction (RST.9-10.4.)
- Classify reactions as synthesis, decomposition, single replacement, or double replacement.
- Recognize reaction types and predict when they will occur
- Express the law of conservation of mass qualitatively using symbolic representations and drawings.
- Demonstrate that atoms, and therefore mass, are conserved during a chemical reaction.
- Determine the mass of reactants required to produce the desired mass of product for a given reaction.
- Use the mole as a conversion from atomic scale to macroscopic scale
- Utilize mathematical thinking to solve conversion problems
- Connect the number of particles, moles, mass, and volume of substances to one another, both qualitatively and quantitatively.
- Describe and give analogies of dynamic equilibrium where changes are always occurring, but

overall numbers remain constant.
- Demonstrate that equilibrium results from an equality between the rates of forward and reverse reactions, where Q = K

Science and Engineering Practices	***Disciplinary Core Ideas***	***Crosscutting Concepts***
Using Mathematics and Computational Thinking Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to support claims. (HS-PS1-7) Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and	PS1.A: Structure and Properties of Matter • The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-2) PS1.B: Chemical Reactions • The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)	**Patterns** • **Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-2)** **Energy and Matter** • **The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)** **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)**

progresses to explanations and designs that are supported by multiple and independent student generated sources of evidence consistent with scientific ideas, principles, and theories. • 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)		

Enduring Understandings:

- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.
- The 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.
- Science assumes the universe is a vast single

Essential Questions:

- How is a chemical change different from a physical change?
- What are the indicators that a reaction has taken place (a new substance has been formed)?
- How can chemical reactions be classified?
- Using the activity series, how do we predict the products of a single displacement reaction?
- How does a balanced chemical equation show relationships between the reactants and products of a chemical reaction?
- Why is the mole an important measurement in

system in which basic laws are consistent.	chemistry? ○ How do chemical reactions obey the law of conservation of mass? ○ How are balanced chemical equations used in stoichiometric calculations? ○ How can you calculate amounts of reactants and products in a chemical reaction? ○
Students will know: Types of Reactions ○ Reactivity Patterns - Valence Electrons, Electronegativity ○ Examples – Synthesis, Decomposition, Single Displacement, Double Displacement, Combustion Law of Conservation of Mass ○ Balancing Chemical Equations ○ Reactants vs. Products Stoichiometry ○ Mole, Mass, Volume, Avogadro's Number Rates of Reaction ○ Chemical Equilibrium ⇒ Reaction Quotient ⇒ Equilibrium Constant	**Students will be able to:** ○ Use mathematical representations of phenomena to support claims. ○ Explain that the total amount of energy and matter in closed systems is conserved. ○ Explain that 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. ○ Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, and 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.
Assessment Evidence	
Suggested Performance Tasks:	**Required District/State Assessments:**

- Demonstration of the Law of Conservation of Matter

Laboratory Investigation:

- Formation of a Salt Lab (Traditional)
  - ⇒ Reflection & Revision of Procedure
- Double Displacement Lab - Precipitates (Student Design)
  - ⇒ Laboratory Report & Reflection
- Development of a Reaction Matrix (Argument Driven Investigation
  - ⇒ Students develop procedures to create a matrix from known chemical compounds, and then analyze unknown compounds to determine their identity, and defend their claim of identities with evidence from the lab. (Goals #1, 2, 3, 5)
- Molar Relationships (Argument Driven Investigation)
  - ⇒ Students use knowledge of the mole and molar mass relationship to develop procedures to identify unknown substances based upon the mass and number of moles given for each substance. (Goals #8, 9)
- Identification of Reaction Products (ADI)
  - ⇒ Students develop procedures to determine the products of chemical reactions, and then make a claim as to the identity of

- District marking period assessments
- SGO assessments

Suggested Formative/Summative Assessments:

- Practice Worksheets
  - Writing Skeleton Equations
  - Classifying Chemical Reactions
  - Predicting Products of a Chemical Reaction
  - Balancing Chemical Equations
  - Mole Conversions
  - Stoichiometry - Basic Conversions
  - Limiting Reactant & Percent Yield
- Section Quizzes
  - Chemical Equations
  - Types of Reactions
  - The Mole
  - Stoichiometry
- Chapter Tests
- Short/extended constructed response items from ELA NJGPA/NJSLA and Science NJSLA
- Projects
- Journals
- Observation
- Graphic organizers/concept mapping
- Presentations
- Warmups / exit tickets

the precipitates that may form by defending their claim with evidence from the lab. (Goals #1, 2, 3, 5) ○ Measuring the Size of a Molecule ⇒ Students will determine the number of molecules of oleic acid in a single drop from the approximate mass of each molecule based upon the measured width and length of the molecule. (Goal #7, 8)	

Learning Plan

Learning Activities:

- Videos
- Class Discussion
- In-Class Skill Practice
- Student Research for Planning Lab Investigation
- Textbook Chapters: Pearson Chemistry, Chapters 10, 11, and 12

Related Standards

Interdisciplinary connections

Mathematics (HSN.Q.A.1, HSN.Q.A.2)

- Examples:
  - ⇒ Use symbols to represent energy distribution in a system when two components of different temperature are combined, and manipulate the representing symbols. Make sense of quantities and relationships in the energy distribution in a system when two components of different temperature are combined.

⇒ Use a mathematical model to describe energy distribution in a system when two components of different temperatures are combined. Identify important quantities in energy distribution in a system when two components of different temperature are combined and map their relationships using tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.

English Language Arts/Literacy (WHST.9-12.7)

- Examples:
  - ⇒ Ask and refine questions to support uniform energy distribution among the components in a system when two components of different temperature are combined, using specific textual evidence.
  - ⇒ Conduct short as well as more sustained research projects to determine energy distribution in a system when two components of different temperature are combined.

21st Century Skills (NJSLS Career Readiness, Life Literacies, and Key Skills - Technology Literacy)

- 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.).
  - ⇒ Example: Lab: Density of Family IV Elements. Digital graphing, interpolation and extrapolation are needed in order to predict the densities of two unknown elements in family IV on the periodic table.

NJ SEL Competencies

- Social Awareness: Demonstrate an awareness of the expectations for social interactions in a variety of settings
- Responsible Decision-Making: Evaluate personal, ethical, safety and civic impact of decisions

Culturally Relevant Connections

- Provide opportunities for students to connect with people of similar backgrounds. Incorporate relatable aspects of students' lives
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures.
- Bring in guest speakers.

- Use learning stations that utilize a range of materials.
- Use Media that positively depicts a range of cultures.
- Instructional Delivery: Establish an interactive dialogue to engage all students. Continuously interact with students and provide frequent feedback.
- Use frequent questioning as a means to keep students involved.
- Intentionally address visual, tactile, and auditory learners.

Accommodations

Special Education/ 504/ At Risk Students Accommodations & Modifications:

- Provide students with multiple choices for how they can represent their understanding (e.g. multisensory techniques, auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling.
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena. Use an alternative instructional method to address individual learning style
- Provide study guide for assessments
- Provide additional time to complete assignments
- Break instruction into smaller manageable units
- Break task down and provide guidance through steps needed for task
- Provide small group instruction
- Provide written cues during lecture/discussion
- Encourage student to highlight notes

ELL:

- Provide students with multiple literacy strategies, verbal and textual.
- Provide sensory and graphic support, e.g. real life objects, video, newspaper/magazine and Music
- Integrate meaningful and purposeful tasks/activities that are relevant to student's lives and cultural experiences.
- Provide interactive support : Collaborate with after school programs or clubs to extend learning opportunities.

○ Read test to student ○ Assist student with organization ○ Encourage participation and provide positive feedback ○ Prompt student to stay on task ○ Provide one-one instruction ○ Modify seating arrangement ○ Provide test with modifications ○ Provide written directions to reinforce oral directions ○ Clarify vocabulary or directions on a test ○ Allow use of mnemonic techniques during testing ○ Provide student with an alternate setting for test administration ○ Utilize an alternative assessment ○ Modify assignment ○ Modify length of assignment ○ Provide advance notice of upcoming test ○ Provide a copy of class notes ○ Provide extra time for test	

Enrichment

- 3-Dimensional Periodic Table displaying a particular periodic Trend
- Endangered Elements and Green Chemistry
- Bonding: Polar covalent, ionic bonds: water vs. fat soluble vitamins.
- Identify and demonstrate examples of the 5 main types of chemical reactions in everyday life.
- Historical Impact of Chemical Discoveries:
  - ⇒ Your history teacher tells you that chemistry has nothing to do with his/her subject and he/she has no idea why you are taking it. Your job is to create a short video, presentation or brochure about why students need chemical knowledge. Focus on the fact that many chemicals/reactions throughout history have served to completely change our world. Examples range from TNT to caffeine to the synthesis of many important pharmaceuticals. Choose one important reaction or chemical and

research the changes this particular chemical or chemical process has had on human history. Be sure to include all relevant chemical reactions and label and explain each.

Unit 3: Reaction Rates & Chemical Equilibrium

Desired Outcomes

NJSLS

Physical Science (PS)

- HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. (WHST.9-10.2)
- HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. (WHST.9-10.7)
- HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. (RST.11-12.3)

Established Goals

- Explain that the amount of energy per bond depends on the strength of the bond
- Relate how the energy released or absorbed affects the internal motion of atoms and molecules in a system.
- 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.
- Connect the rate law to the frequency and success of molecular collisions, considering the sufficient energy needed to overcome the activation energy barrier.
- 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.
- Predict the number and energy of collisions between molecules.
- Summarize how changes in mass, moles, volume, temperature, pressure, and addition of a catalyst affect equilibrium

- Evaluate ways to disturb equilibrium and the corrective shifts that occur.
- Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
- Apply Le Chatelier's Principle as it relates to chemical reaction systems.
- Devise ways to increase product formation by adding reactants or removing products

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-PS1-4) **Constructing Explanations and Designing Solutions** ● Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to	**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. (HSPS1-4),(HS-PS1-5)	**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. (HSPS1-5) **Energy and Matter** ● Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4) **Stability and Change** ● Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

explanations and designs that are supported by multiple and independent student generated sources of evidence consistent with scientific ideas, principles, and theories. Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5) • 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)	• 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)	

Enduring Understandings:	**Essential Questions:**
○ A stable molecule has less energy than the	○ To what extent do factors such as temperature,

same set of atoms separated; one must provide at least this energy in order to take the molecule apart. ○ Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. ○ In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. ○ 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 (tradeoffs) may be needed. ○ Much of science deals with constructing explanations of how things change and how they remain stable.	mixing, concentration, particle size, and surface area affect the rates of chemical reactions and how can this be modeled? ○ How do chemical reactions attain a state of equilibrium and what factors affect the maintenance of equilibrium? ○ How do the amounts of reactants and products change at equilibrium, and what three stresses can cause a change in the equilibrium position? ○ Why is there a change in temperature during a chemical reaction? ○ What happens to energy and matter during a chemical reaction? ○ How can we apply Le-Chatelier's principle to increase the yield of a product?
<u>Students will know:</u> ○ Bond Energy ⇒ Formation & Dissociation ○ Reaction Rates ⇒ Rate Laws ⇒ Activation Energy	**<u>Students will be able to:</u>** ○ Explain that 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. ○ Develop a model based on evidence to illustrate the relationships between systems or between

⇒ Molecular Collisions ⇒ Factors Affecting Reaction Rates ⇒ Le Chatelier's Principle	components of a system. ○ Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. ○ Explain that 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. ○ Refine a solution to a complex real world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.

Assessment Evidence

Suggested Performance Tasks:

- Calorimeter Design Project (HASPI)

Laboratory Investigation:

- Factors Affecting Reaction Rates
  - ⇒ Laboratory Report & Reflection
- Alka Seltzer Rates of Reaction (HASPI) OR Rates Inquiry Lab (HASPI)
  - ⇒ Laboratory Report & Reflection
- Reaction Rates (ADI)
  - ⇒ Develop procedures, make a claim, defend with evidence

Required District/State Assessments:

- District marking period assessments
- SGO assessments

Suggested Formative/Summative Assessments:

- Practice Worksheets
  - ⇒ Exothermic vs. Endothermic
  - ⇒ Calculating Bond Energies - Formation vs. Dissociation
  - ⇒ Graphing Reaction Rates
  - ⇒ Calculations Using Rate Laws
- Section Quizzes
- Chapter Tests

	○ Short/extended constructed response items from ELA NJGPA/NJSLA and Science NJSLA ○ Projects ○ Journals ○ Observation ○ Graphic organizers/concept mapping ○ Presentations ○ Warmups / exit tickets

Learning Plan

Learning Activities:

- Videos
- Class Discussion
- In-Class Skill Practice
- Student Research for Planning Lab Investigation
- Textbook Chapters: Pearson Chemistry, Chapters 18

Related Standards

Interdisciplinary connections

Mathematics [HSN-Q.A.1, 2, 3]

- Examples:
  - ⇒ Choose a level of accuracy appropriate to limitations on measurement when reporting quantities representing proportional relationships between masses of atoms in the reactants and products and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale.
  - ⇒ Use a mathematical model to explain how the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy, and map their relationships using

tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.

- ⇒ Represent an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs symbolically and manipulate the representing symbols. Make sense of quantities and relationships about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs symbolically and manipulate the representing symbols.
- ⇒ Use units as a way to understand an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. Choose and interpret units consistently in formulas representing the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. Choose and interpret the scale and the origin in graphs and data displays representing the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
- ⇒ Choose a level of accuracy appropriate to limitations on measurement when reporting quantities representing the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
- ⇒ Use a mathematical model to explain how to increase amounts of products at equilibrium in a chemical system. Identify important quantities in the cycling of matter and flow of energy among organisms in an ecosystem, and map their relationships using tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.

21st Century Skills (NJSLS Career Readiness, Life Literacies, and Key Skills - Technology Literacy)

- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
  - ⇒ Example: Lab: Heating /Cooling of Lauric Acid. Students will collect Data for the melting / freezing point of Lauric Acid, display data within a spreadsheet and create a graph in order to convey the identical temperature for freezing and melting point. Students will present their experimental results in either PowerPoint or Google Slides

NJ SEL Competencies

- Self-Awareness: Recognize one's feelings and thoughts

- Social Awareness: Demonstrate an awareness of the differences among individuals, groups, and others' cultural backgrounds

Culturally Relevant Connections

- Relationships: Learn about your students' individual cultures. Adapt your teaching to the way your students learn Develop a connection with challenging students
- Communicate and work with parents/guardians on a regular basis)
- Use learning stations that utilize a range of materials.
- Use Media that positively depicts a range of cultures.
- Instructional Delivery: Establish an interactive dialogue to engage all students
- Continuously interact with students and provide frequent feedback. Use frequent questioning as a means to keep students involved.
- Intentionally address visual, tactile, and auditory learners.

Accommodations

Special Education/ 504/ At Risk Students Accommodations & Modifications:

- Provide students with multiple choices for how they can represent their understanding (e.g. multisensory techniques, auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling.
- 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. Use an alternative instructional method to address

ELL:

- Provide students with multiple literacy strategies, verbal and textual.
- Provide sensory and graphic support, e.g. real life objects, video, newspaper/magazine and Music
- Integrate meaningful and purposeful tasks/activities that are relevant to student's lives and cultural experiences.
- Provide interactive support: Collaborate with after school programs or clubs to extend learning opportunities.
-

individual learning style ○ Provide study guide for assessments ○ Provide additional time to complete assignments ○ Break instruction into smaller manageable units ○ Break task down and provide guidance through steps needed for task ○ Provide small group instruction ○ Provide written cues during lecture/discussion ○ Encourage student to highlight notes ○ Read test to student ○ Assist student with organization ○ Encourage participation and provide positive feedback ○ Prompt student to stay on task ○ Provide one-one instruction ○ Modify seating arrangement ○ Provide test with modifications ○ Provide written directions to reinforce oral directions ○ Clarify vocabulary or directions on a test ○ Allow use of mnemonic techniques during testing ○ Provide student with an alternate setting for test administration ○ Utilize an alternative assessment ○ Modify assignment ○ Modify length of assignment ○ Provide advance notice of upcoming test ○ Provide a copy of class notes ○ Provide extra time for test	

Enrichment

- Teach Engineering: Calorimetry, Counting Calories

- Reaction Rates in Developing Products
  - ⇒ Many products take advantage of chemistry in order to change the rate of certain common reactions to suit their needs. Hand warmers are one such example. Create a brochure that will be included in the product packaging to inform the consumer about how it works. Research the chemical reaction involved and list at least 3 factors manipulated by the company in order to change the rate of this ordinary reaction and what effect this factor has on this reaction.

Unit 4: Nuclear Chemistry

Desired Outcomes

NJSLS

Physical Science (PS)

- HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. (RST.11-12.8)

Engineering, Technology, and Applications of Science (ETS)

- HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation. (RST.9-10.2)
- HS-ESS1-3. Communicate scientific ideas about the ways stars, over their life cycle, produce elements. (RST.11-12.7)

Established Goals

- Explain, using evidence, the very strong force holding the protons and neutrons of an atomic nucleus together.
- Compare and contrast chemical and nuclear reactions.
- Conclude that chemical reactions involve the rearrangement of atoms and their valence electrons
- Justify that nuclear reactions involve changes in the nucleus
- Construct a graphic organizer to compare and contrast fission and fusion reactions with respect to reactants, products, and energy. (WHST.9-10.9)
- 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.
- Construct representations, at the particle level and graphically, of the changes that occur in a given radioactive sample (e.g., 64 particles decaying over four half-lives).

- Explain the energy transformations and transfers occurring in a nuclear power plant.
- Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation.
- Illustrate how different elements are formed throughout the life cycle of stars.

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) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims,	**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. (HSPS1-8) **ESS1.A: The Universe and Its Stars** ● The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1) ● The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.	**Energy and Matter** ● In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) ● In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HSESS1-3) **Scale, Proportion, and Quantity** ● The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1)

methods, and designs. ● Communicate scientific ideas (e.g. about phenomena and/or 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-ESS1-3)	(HS-ESS1-3) ● Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-3)	

Enduring Understandings:

- 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.
- Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation.
- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.

Essential Questions:

- What changes occur in the nuclei of atoms involved in the reactions that fuel the sun?
- What changes occur in the nuclei of atoms involved in the reactions that fuel nuclear power plants?
- How do nuclear reactions (fission and fusion) convert very small amounts of matter into energy?
- How can nuclear reactions be both beneficial and dangerous?
- Compare & contrast nuclear fission & fusion reactions.
- What is radioactive decay and how will you calculate the half- life period?

○ Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. ○ The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. ○ Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.	
Students will know: ○ Nuclear Fusion vs. Fission ○ Radioactive Decay ⇒ Half-Life ○ Types of Radiation ⇒ alpha, beta, gamma	**Students will be able to:** ○ Develop a model based on evidence to illustrate the relationships between systems or between components of a system. ○ Demonstrate that the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. ○ Communicate scientific ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Assessment Evidence

Suggested Performance Tasks:

- Nuclear Energy Debate

Laboratory Investigation:

- PhET Online Simulations for: Alpha Decay, Beta Decay, Nuclear Fission, and Radioactive Dating Game
- Students will explore the various ways in which nuclear reactions occur. Students will first predict expected results, then carry out the simulation, and compare the collected results to the expected results. (Goals #4,5,6)

Required District/State Assessments:

- District marking period assessments
- SGO assessments

Suggested Formative/Summative Assessments:

- Practice Worksheets
  - Calculation of Half-Life
  - Radioactive Decay of Elements
  - Composition of stars
  - Life Cycle of stars
- Section Quizzes
  - Nuclear Reactions
  - Star Formation and Life
- Chapter Tests
- Short/extended constructed response items from ELA NJGPA/NJSLA and Science NJSLA
- Projects
  - Nuclear Decay Model Construction
- Journals
- Observation
- Graphic organizers/concept mapping
- Presentations
- Warmups / exit tickets

Learning Plan

Learning Activities:

- Videos
- Class Discussion
- In-Class Skill Practice
- Student Research for Debate
- Textbook Chapters: Pearson Chemistry, Chapter 25

Related Standards

Interdisciplinary connections

English Language Arts/Literacy

- ST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-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 claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (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)

- ⇒ Example: Students may use mathematical equations to represent the changes in the composition of the atom's nucleus and the energy involved in these processes.

21st Century Skills (NJSLS Career Readiness, Life Literacies, and Key Skills - Technology Literacy)

- 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.).
  - ⇒ Example: Graphical Analysis of Nuclear Decay - Students create graphs from provided data, and analyze in order to find patterns related to Half Life

NJ SEL Competencies

- Relationship Skills: Establish and maintain healthy relationships
- Responsible Decision-Making: Identify the consequences associated with one's actions in order to make con

Culturally Relevant Connections

- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tools such as Zoom, 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).
- Structure the learning around explaining or solving a social or community-based issue.
- Relationships: Learn about your students' individual cultures.
- Incorporate instructional materials that relate to a variety of cultural experiences
- Incorporate lessons that challenge dominant viewpoints Provide students with opportunity to engage with text that highlights authors, speakers, characters or content that reflect students lived experiences (mirror) or provide a window into the lived experience of people whose identities differ from students.
- Bring in guest speakers.
- Use learning stations that utilize a range of materials. Use media that positively depicts a range of cultures.
- Present relatable real world problems from various viewpoints.

Accommodations

Special Education/ 504/ At Risk Students Accommodations & Modifications:

- Provide students with multiple choices for how they can represent their understanding (e.g. multisensory techniques, auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling.
- 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. Use an alternative instructional method to address individual learning style
- Provide study guide for assessments
- Provide additional time to complete assignments
- Break instruction into smaller manageable units
- Break task down and provide guidance through steps needed for task
- Provide small group instruction
- Provide written cues during lecture/discussion
- Encourage student to highlight notes
- Read test to student
- Assist student with organization
- Encourage participation and provide positive feedback
- Prompt student to stay on task
- Provide one-one instruction

ELL:

- Provide students with multiple literacy strategies, verbal and textual.
- Provide sensory and graphic support, e.g. real life objects, video, newspaper/magazine and Music
- Integrate meaningful and purposeful tasks/activities that are relevant to student's lives and cultural experiences.
- Provide interactive support: Collaborate with after school programs or clubs to extend learning opportunities.
-

○ Modify seating arrangement ○ Provide test with modifications ○ Provide written directions to reinforce oral directions ○ Clarify vocabulary or directions on a test ○ Allow use of mnemonic techniques during testing ○ Provide student with an alternate setting for test administration ○ Utilize an alternative assessment ○ Modify assignment ○ Modify length of assignment ○ Provide advance notice of upcoming test ○ Provide a copy of class notes ○ Provide extra time for test	

Enrichment
○ Chemistry Olympiad ○ Exposure to Radon Case Study: Students will investigate neighborhood data on Radon detection & exposure

Unit 5: Applications of Chemistry

Desired Outcomes

NJSLS

Physical Science (PS)

- HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. (RST.11-12.1)
- HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. (RST.11-12.8)
- HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. (RST.11-12.4)

Established Goals

- Identify and communicate evidence for why molecular level structure is important in the functioning of designed materials.
  - ⇒ Describe the relationship between the material's function and its macroscopic properties (e.g. strength, conductivity, reactivity, state of matter, durability) and each of the following: molecular structure, intermolecular forces & polarity, the ability of electrons to move freely.
- Obtain at least two claims proposed in published material regarding the effect of electromagnetic radiation that is absorbed by matter (including living tissue).
  - ⇒ Use reasoning about data (photon energies, relative wavelengths, probability of ionization) to analyze the validity and reliability of claims made in published material.
  - ⇒ Describe the cause and effect reasoning in each claim including extrapolation to larger scales (eg. effects on a single cell to the effects on the entire organism).
- Use at least two different formats to communicate technical information and ideas, including fully describing at least two devices and the physical principles upon which the devices depend (must

include photoelectric effect).

- ⇒ Identify the wave behavior utilized by the device or the absorption of photons and production of electrons for devices that rely on the photoelectric effect, and qualitatively describe how the basic principles were utilized in the design through research and development to produce this functionality.
- ⇒ Discuss the real-world problem it solves or need it addresses and how civilization now depends on the device.
- ⇒ Identify and communicate the cause and effect relationships that are used to produce the functionality of the device.

Science and Engineering Practices	***Disciplinary Core Ideas***	***Crosscutting Concepts***
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable	**PS2.B: Types of Interactions** • Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) • Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing	**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-PS2-4) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-5) **Structure and Function** • Investigating or designing

measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS2-5) **Using Mathematics and Computational** Thinking Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. (HS-PS2-4) **Obtaining, Evaluating, and Communicating** Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to	magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5) • Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6)	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)

evaluating the validity and reliability of the claims, methods, and designs. ● Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)		

Enduring Understandings:

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
- When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.
- Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy.
- Photoelectric materials emit electrons when

Essential Questions:

- How does the molecular-level structure of a substance lead to its use in designed materials?
- What are the effects of electromagnetic radiation on matter (both biotic and abiotic)?
- How do technological devices utilize wave behavior to transmit/capture data and energy?

they absorb light of a high-enough frequency. ○ Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.	
Students will know: ○ Chemical Bonds ⇒ Ionic, Covalent, Metallic ○ Electromagnetic Radiation ⇒ Ultraviolet, X-Rays, Gamma Rays	**Students will be able to:** ○ Communicate technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). ○ Explain that 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. ○ Demonstrate that systems can be designed to cause a desired effect. ○ Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying data wherever

	possible. ○ Explain that cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about the smaller scale mechanisms within the system. ○ Illustrate that science and engineering complement each other in the cycle known as research and development (R&D). ○ Support the idea that modern civilization depends on major technological systems.

Assessment Evidence

Suggested Performance Tasks:

- Analysis of Clothing Design Materials

Laboratory Investigation:

- PhET Simulations
  - ⇒ Photoelectric Effect

Research Project:

- Aftermath of Nuclear Disasters
  - ⇒ Assessment of short & long-term effects.

Student-Led Demonstration/Presentations:

- How do devices transmit energy & data?

Required District/State Assessments:

- District marking period assessments
- SGO assessments

Suggested Formative/Summative Assessments:

- Practice Worksheets
- Section Quizzes
- Chapter Tests
- Short/extended constructed response items from ELA NJGPA/NJSLA and Science NJSLA
- Projects
- Journals
- Observation
- Graphic organizers/concept mapping

	○ Presentations ○ Warmups / exit tickets

Learning Plan

Learning Activities:

- Videos
- Simulations
- Class Discussions
- Student Research
- Textbook Chapters: Pearson Chemistry, Chapters 5 and 8

Related Standards

Interdisciplinary connections

English Language Arts/Literacy

- [SL.11-12.5] Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations describing how variations in the flow of energy into and out of Earth's systems result in changes in climate to enhance understanding of findings, reasoning, and evidence and to add interest.
- [RST.11-12.1] Cite specific textual evidence of the availability of natural resources, occurrence of natural hazards, and changes in climate and their influence on human activity.
    - Example: Use empirical evidence to write an explanation for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Mathematics

- [HSN-Q.A.1] Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- [HSN-Q.A.2] Define appropriate quantities for the purpose of descriptive modeling.
- [HSN-Q.A.3] Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- Examples:
    - ⇒ Represent symbolically an explanation for how variations in the flow of energy into and out of Earth's

systems result in changes in climate, and manipulate the representing symbols. Use symbols to make sense of quantities and relationships about how variations in the flow of energy into and out of Earth's systems result in changes in climate, symbolically and manipulate the representing symbols.

⇒ Use a mathematical model to explain how variations in the flow of energy into and out of Earth's systems result in changes in climate. Identify important quantities in variations in the flow of energy into and out of Earth's systems result in changes in climate and map their relationships using tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.

⇒ Use units as a way to understand problems and to guide the solution of multistep problems about how variations in the flow of energy into and out of Earth's systems result in changes in climate; choose and interpret units consistently in formulas representing how variations in the flow of energy into and out of Earth's systems result in changes in climate; choose and interpret the scale and the origin in graphs and data displays representing how variations in the flow of energy into and out of Earth's systems result in changes in climate.

⇒ Define appropriate quantities for the purpose of descriptive modeling of how variations in the flow of energy into and out of Earth's systems result in changes in climate.

⇒ Choose a level of accuracy appropriate to limitations on measurement when reporting quantities to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

⇒ Represent symbolically the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere, and manipulate the representing symbols. Make sense of quantities and relationships in the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

⇒ Use a mathematical model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. Identify important quantities in the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere and map their relationships using tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.

⇒ Use units as a way to understand the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere; choose and interpret units consistently in formulas representing the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere; choose and interpret the scale and the origin in graphs and data displays representing the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

⇒ Define appropriate quantities for the purpose of descriptive modeling of the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

- ⇒ Choose a level of accuracy appropriate to limitations on measurement when reporting quantities showing the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- ⇒ Represent symbolically how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity, and manipulate the representing symbols. Make sense of quantities and relationships among availability of natural resources, occurrence of natural hazards, and changes in climate and their influence on human activity.
- ⇒ Use units as a way to understand the relationships among availability of natural resources, occurrence of natural hazards, and changes in climate and their influence on human activity. Choose and interpret units consistently in formulas to determine relationships among availability of natural resources, occurrence of natural hazards, and changes in climate and their influence on human activity. Choose and interpret the scale and the origin in graphs and data displays representing relationships among availability of natural resources, occurrence of natural hazards, and changes in climate and their influence on human activity.
- ⇒ Define appropriate quantities for the purpose of descriptive modeling of relationships among availability of natural resources, occurrence of natural hazards, and changes in climate and their influence on human activity.
- ⇒ Choose a level of accuracy appropriate to limitations on measurement when reporting quantities showing relationships among availability of natural resources, occurrence of natural hazards, and changes in climate and their influence on human activity.

21st Century Skills (NJSLS Career Readiness, Life Literacies, and Key Skills - Technology Literacy)

- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
  - ⇒ Example: Using a spreadsheet, students will depict the inverse relationship that exists between frequency and wavelength when investigating the Electromagnetic Spectrum.

NJ SEL Competencies

- Self-Management: Understand and practice strategies for managing one's own emotions, thoughts, and behaviors
- Responsible Decision-Making: Identify the consequences associated with one's actions in order to make constructive choices

Culturally Relevant Connections

- Incorporate instructional materials that relate to a variety of cultural experience
- Incorporate lessons that challenge dominant viewpoints Provide student with opportunity to engage with text that highlights authors, speakers, characters or content that reflect students lived experiences (mirror) or provide a window into the lived experience of people whose
- Present relatable real world problems from various viewpoints.

Accommodations

Special Education/ 504/ At Risk Students Accommodations & Modifications:

- Provide students with multiple choices for how they can represent their understanding (e.g. multisensory techniques, auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling.
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena. Use an alternative instructional method to address individual learning style
- Provide study guide for assessments
- Provide additional time to complete assignments
- Break instruction into smaller manageable units
- Break task down and provide guidance through steps needed for task
- Provide small group instruction
- Provide written cues during lecture/discussion

ELL:

- Provide students with multiple literacy strategies, verbal and textual.
- Provide sensory and graphic support, e.g. real life objects, video, newspaper/magazine and Music
- Integrate meaningful and purposeful tasks/activities that are relevant to student's lives and cultural experiences.
- Provide interactive support: Collaborate with after school programs or clubs to extend learning opportunities.

○ Encourage student to highlight notes ○ Read test to student ○ Assist student with organization ○ Encourage participation and provide positive feedback ○ Prompt student to stay on task ○ Provide one-one instruction ○ Modify seating arrangement ○ Provide test with modifications ○ Provide written directions to reinforce oral directions ○ Clarify vocabulary or directions on a test ○ Allow use of mnemonic techniques during testing ○ Provide student with an alternate setting for test administration ○ Utilize an alternative assessment ○ Modify assignment ○ Modify length of assignment ○ Provide advance notice of upcoming test ○ Provide a copy of class notes ○ Provide extra time for test	

Enrichment

- Home chemical Inventory/ C&EN: chemistry behind everyday Products
- Teach Engineering: Skin and the effects of Ultraviolet Radiation, How effective is your sunscreen, nano particle protection from UV rays
- Teach Engineering : Everyday Polymers
- Chemistry Olympiad

Appendix A: Culturally Relevant Pedagogy Examples

BUILDING EQUITY IN YOUR TEACHING PRACTICE

How do the essential questions highlight the connection between the big ideas of the unit and equity in your teaching practice?

CONTENT INTEGRATION	KNOWLEDGE CONSTRUCTION	PREJUDICE REDUCTION	EQUITABLE PEDAGOGY	EMPOWERING SCHOOL CULTURE
Teachers use examples and content from a variety of cultures & groups.	Teachers help students understand how knowledge is created and influenced by cultural assumptions, perspectives & biases.	Teachers implement lessons and activities to assert positive images of ethnic groups & improve intergroup relations.	Teachers modify techniques and methods to facilitate the academic achievement of students from diverse backgrounds.	Using the other four dimensions to create a safe and healthy educational environment for all.
This unit / lesson is connected to other topics explored with students. There are multiple viewpoints reflected in the content of this unit / lesson. The materials and resources are reflective of the diverse identities and experiences of students. The content affirms students, as well as exposes them to experiences other than their own.	This unit / lesson provides context to the history of privilege and oppression. This unit / lesson addresses power relationships. This unit / lesson help students to develop research and critical thinking skills. This curriculum creates windows and mirrors* for students.	This unit / lesson help students question and unpack biases & stereotypes. This unit / lesson help students examine, research and question information and sources. The curriculum encourage discussion and understanding about the groups of people being represented. This unit / lesson challenges dominant perspectives.	The instruction has been modified to meet the needs of each student. Students feel respected and their cultural identities are valued. Additional supports have been provided for students to become successful and independent learners. Opportunities are provided for student to reflect on their learning and provide feedback.	There are opportunities for students to connect with the community. My classroom is welcoming and supportive for all students? I am aware of and sensitive to the needs of my students and their families. There are effective parent communication systems established. Parents can talk to me about issues as they arise in my classroom.

Developed by Karla E. Vigil. Adapted with permission from James A. Banks, CULTURAL DIVERSITY AND EDUCATION: FOUNDATIONS, CURRICULUM, AND TEACHING (6th edition), New York: Routledge, 2016, page 5 and Gordon School Institute on Multicultural Practice.

Appendix B: English Language Learners

WIDA Levels:

At the given level of English language proficiency, English language learners will process, understand, produce or use

6- Reaching	• Specialized or technical language reflective of the content areas at grade level • A variety of sentence lengths of varying linguistic complexity in extended oral or written discourse as required by the specified grade level • Oral or written communication in English comparable to proficient English peers
5- Bridging	• Specialized or technical language of the content areas • A variety of sentence lengths of varying linguistic complexity in extended oral or written discourse, including stories, essays or reports • Oral or written language approaching comparability to that of proficient English peers when presented with grade level material.
4- Expanding	• Specific and some technical language of the content areas • A variety of sentence lengths of varying linguistic complexity in oral discourse or multiple, related sentences or paragraphs • Oral or written language with minimal phonological, syntactic or semantic errors that may impede the communication, but retain much of its meaning, when presented with oral or written connected discourse, with sensory, graphic or interactive support
3- Developing	• General and some specific language of the content areas • Expanded sentences in oral interaction or written paragraphs • Oral or written language with phonological, syntactic or semantic errors that may impede the communication, but retain much of its meaning, when presented with oral or written, narrative or expository descriptions with sensory, graphic or interactive support
2- Beginning	• General language related to the content area • Phrases or short sentences • Oral or written language with phonological, syntactic, or semantic errors that often impede of the communication when presented with one to multiple-step commands, directions, or a series of statements with sensory, graphic or interactive support
1- Entering	• Pictorial or graphic representation of the language of the content areas • Words, phrases or chunks of language when presented with one-step commands directions, WH-, choice or yes/no questions, or statements with sensory, graphic or interactive support

Language Development Supports For English Language Learners To Increase Comprehension and Communication Skills

Environment

- Welcoming and stress-free
- Respectful of linguistic and cultural diversity
- Honors students' background knowledge
- Sets clear and high expectations
- Includes routines and norms
- Is thinking-focused vs. answer-seeking
- Offers multiple modalities to engage in content learning and to demonstrate understanding
- Includes explicit instruction of specific language targets
- Provides participation techniques to include all learners
- Integrates learning centers and games in a meaningful way
- Provides opportunities to practice and refine receptive and productive skills in English as a new language
- Integrates meaning and purposeful tasks/activities that:
  - Are accessible by all students through multiple entry points
  - Are relevant to students' lives and cultural experiences
  - Build on prior mathematical learning
  - Demonstrate high cognitive demand
  - Offer multiple strategies for solutions
  - Allow for a language learning experience in addition to content

Sensory Supports*	Graphic Supports*	Interactive Supports*	Verbal and Textual Supports
• Real-life objects (realia) or concrete objects • Physical models • Manipulatives • Pictures & photographs • Visual representations or models such as diagrams or drawings • Videos & films • Newspapers or magazines • Gestures • Physical movements • Music & songs	• Graphs • Charts • Timelines • Number lines • Graphic organizers • Graphing paper	• In a whole group • In a small group • With a partner such as *Turn-and-Talk* • In pairs as a group (first, two pairs work independently, then they form a group of four) • In triads • Cooperative learning structures such as *Think-Pair-Share* • Interactive websites or software • With a mentor or coach	• Labeling • Students' native language • Modeling • Repetitions • Paraphrasing • Summarizing • Guiding questions • Clarifying questions • Probing questions • Leveled questions such as *What? When? Where? How? Why?* • Questioning prompts & cues • Word Banks • Sentence starters • Sentence frames • Discussion frames • Talk moves, including *Wait Time*

*from *Understanding the WIDA English Language Proficiency Standards. A Resource Guide*. 2007 Edition.. Board of Regents of the University of Wisconsin System, on behalf of the WIDA Consortium—www.wida.us.

Galina (Halla) Jmourko, ESOL Coach, PGCPS; 2015, Rvsd. 2016

Appendix C: WIDA ELD Standards Integration

ELD-SC 9-12 Explain Interpretive	Interpret scientific explanations by • Defining investigable questions or problems based on observations, information, and/or data about a phenomenon • Paraphrasing central ideas in complex evidence, concepts, processes, and information to help explain how or why a phenomenon occurs • Evaluating the extent to which reasoning, theory and/or models link evidence to claims and support conclusions
ELD-SC 9-12 Explain Expressive	Construct scientific explanations that • Describe reliable and valid evidence from multiple sources about a phenomenon • Establish neutral or objective stance in how results are communicated • Develop reasoning to illustrate and/ or predict the relationships between variables in a system or between components of a system • Summarize and refine solutions referencing scientific knowledge, evidence, criteria, and/or trade-offs
ELD-SC.9-12 Argue Interpretive	Interpret scientific arguments by • Identifying appropriate and sufficient evidence from data, models, and/ or information from investigations of a phenomenon or design solutions • Comparing reasoning and claims based on evidence from competing arguments or design solutions • Evaluating currently accepted explanations, new evidence, limitations (trade-offs), constraints, and ethical issues
ELD-SC.9-12 Argue Expressive	Construct scientific arguments that • Introduce and contextualize topic/ phenomenon in current scientific or historical episodes in science • Defend or refute a claim based on data and evidence • Establish and maintain an appropriate tone and stance (neutral/objective or biased/subjective) • Signal logical relationships among reasoning, evidence, data, and/or models when making and defending a claim, counterclaim, and/or rebuttal

Appendix D: Differentiated Instruction

Strategies to accommodate based on student individual needs::

1. Time/General
   a. Extra time for assigned tasks
   b. Adjust length of assignment
   c. Timeline with due dates for reports and projects
   d. Communication system between home and school
   e. Provide lecture notes/outline

2. Processing
   a. Extra Response time
   b. Have students verbalize steps
   c. Repeat, clarify or reword directions
   d. Mini-breaks between tasks
   e. Provide a warning for transitions
   f. Partnering

3. Comprehension
   a. Precise processes for balanced math instructional model
   b. Short manageable tasks
   c. Brief and concrete directions
   d. Provide immediate feedback
   e. Small group instruction
   f. Emphasize multi-sensory learning

4. Recall
   a. Teacher-made checklist
   b. Use visual graphic organizers
   c. Reference resources to
   d. promote independence
   e. Visual and verbal reminders
   f. Graphic organizers

5. Assistive Technology
   a. Computer/whiteboard
   b. Tape recorder
   c. Video Tape

6. Tests/Quizzes/Grading
   a. Extended time
   b. Study guides
   c. Shortened tests
   d. Read directions aloud

7. Behavior/Attention
   a. Consistent daily structured routine
   b. Simple and clear classroom rules
   c. Frequent feedback

8. Organization
   a. Individual daily planner
   b. Display a written agenda
   c. Note-taking assistance
   d. Color code materials

Appendix E: Enrichment

What is the purpose of enrichment?

The purpose of enrichment is to provide extended learning opportunities and challenges to students who have already mastered, or can quickly master, the basic curriculum. Enrichment gives the student more time to study concepts with greater depth, breadth, and complexity.

- Enrichment also provides opportunities for students to pursue learning in their own areas of interest and strengths.
- Enrichment keeps advanced students engaged and supports their accelerated academic needs.
- Enrichment provides the most appropriate answer to the question, “What do you do when the student already knows it?”

Enrichment is ...	**Enrichment is not...**
○ Planned and purposeful ○ Different, or differentiated, work – not just more work ○ Responsive to students’ needs and situations ○ A promotion of high-level thinking skills and making connections within content ○ The ability to apply different or multiple strategies to the content ○ The ability to synthesize concepts and make real world and cross curricular connections ○ Elevated contextual complexity ○ Sometimes independent activities, sometimes direct instruction ○ Inquiry based or open-ended assignments and projects ○ Using supplementary materials in addition to the normal range of resources ○ Choices for students ○ Tiered/Multi-level activities with flexible groups (may change daily or weekly)	○ Just for gifted students (some gifted students may need intervention in some areas just as some other students may need frequent enrichment) ○ Worksheets that are more of the same (busywork) ○ Random assignments, games, or puzzles not connected to the content areas or areas of student interest ○ Extra homework ○ A package that is the same for everyone ○ Thinking skills taught in isolation ○ Unstructured free time

Appendix F: Resources

Textbook:

- Wilbraham, Anthony, et. al., Pearson Chemistry, 2017 Edition. Upper Saddle River, NJ, Pearson, 2017. [ISBN: 978-1-32-320589-1]
- Wilbraham, Anthony, et. al., Pearson Chemistry TE,, 2017 Edition. Upper Saddle River, NJ, Pearson, 2017. [ISBN: 978-1-32-320591-4]

Appendix G: Climate Change Curriculum Statement

With the adoption of the 2020 New Jersey Student Learning Standards (NJSLS), New Jersey became the first state in the nation to include climate change across content areas. These standards are designed to prepare students to understand how and why climate change happens, the impact it has on our local and global communities and to act in informed and sustainable ways.

Districts are encouraged to utilize the NJSLS to develop interdisciplinary units focused on climate change that include authentic learning experiences, integrate a range of perspectives and are action oriented. While the 2016 NJSLS-English Language Arts (ELA) and Mathematics do not have specific climate change standards, districts may want to consider how they can design interdisciplinary climate change units that incorporate relevant ELA and mathematics standards.

Components of this are tagged throughout the curriculum as appropriate under the “Related Standards” section in each unit.