Wall Township Public Schools	Board Approval Date: 8/20/2024

Course Title: Honors Lab Chemistry

Course Description:
This course differs from the non-honors course in the scope, pace and level of difficulty. Chemistry investigates matter and energy and ways in which these two quantities interact. Over a course of study in chemistry, students should be able to recognize how both matter and energy are both quantified (measured) and qualified (observed) in a variety of contexts. This course also makes connections between matter and the energy transformations in living systems and includes the connection to nuclear chemistry. Students will make connections between geoscience and human activity. This course exposes students to problem-solving situations that are developed through class discussions, demonstrations, and lab activities. Students will demonstrate understanding through performance expectations. Lab experiences complement the core concepts.

New Jersey Student Learning Standards - Science (Click here to skip below to a description about the Standards)

Course Sequence & Pacing

Unit Title	Estimated Number of Instructional Periods
Unraveling the Atom: Exploring Atomic Models and Properties in Chemistry	42
Reactive Minds: Exploring Chemical Kinetics and Mole Marvels	36
States of Matter Showdown: Unleashing the Power of Solids, Liquids, Gases, Solutions & Exploring the Chemistry of Acids, Bases, and their Real Life Applications	50

Unit 1

Stage 1 Desired Results

Unit 1: Unraveling the Atom: Exploring Atomic Models and Properties in Chemistry

Unit Summary:

In this unit students build on the model of the atom as a foundation for explaining chemical formulas. A study of atomic models is essential to investigate atomic isotopes and radioactivity. The concept of the energy and stability in an atom is dependent on the electron organization. Students will use the periodic table as a tool to explain and predict patterns for electron configurations and use this knowledge to predict the properties of elements. The properties of substances are determined by the interactions between atoms which can be predicted using knowledge of atomic structure. A study of the different kinds of bonds that atoms can make with one another allows students to construct models and explanations about their macroscopic properties. Students learn how to write chemical formulas and to name compounds building on their prior knowledge of atomic structure and bonding. Students are expected to demonstrate proficiency in developing and using models; constructing explanations and designing solutions; using mathematical and computational thinking; and obtaining, evaluating, and communicating information; and they are expected to use these practices to demonstrate understanding of the core ideas. The crosscutting concepts of patterns; energy and matter; scale, proportion, and quantity; and stability and change are called out as organizing concepts for this unit.

Unit 1 Learning Standards / Targets

NJSLS Science (PE):

HS-PS1-8: Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy release during the processes of fission, fusion, and radioactive decay.

HS-PS4-1: Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

HS-PS4-3: Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

HS-PS4-4: Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

HS-PS1-1: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-2: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
HS-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-ESS1-2: Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
HS-ESS1-3: Communicate scientific ideas about the way stars, over their life cycle, produce elements

Unit Enduring Understandings:

- Everything in the universe is either energy or matter. All matter is made up of atoms ‑ positive nuclei surrounded by negative particles.
- Different models of the atom have been developed over time to include explanations of unexpected nuclear occurrences.
- The periodic table is a system of organized groups of related elements. Understanding of regularities and patterns in the periodic table allows for predictions of interactions among the elements.
- Structure and function and properties are often related ‑ an atom's electron configuration determines how it interacts with other atoms to form bonds.
- Models of molecules are structures that correspond to real objects and explain what we observe on the macroscopic scale.
- The naming of chemicals and formulas depends on the regularities and patterns inherent in the periodic table.

Unit Essential Questions:

- What are the substructures of an atom and how do they influence the properties, formation and abundance of the elements?
- How can the Periodic Table be used to explain and predict the properties of elements?
- How does matter and energy change during radioactive decay?
- Are atoms more stable alone or bonded?
- How does molecular structure and intermolecular forces of attraction of a chemical species determine properties?
- How much flexibility is there in writing chemical formulas?

Vocabulary: energy, matter, atoms, positive nuclei, negative particles, periodic table, element, electron configuration, bond, model, macroscopic, pattern

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLK)*

9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving.
9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Computer Science & Design Thinking *(CS & DT)*:
8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. , including climate change.

NJSLS Companion Standards - ELA
RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. (HS-PS1-1)
RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3),(HS-PS1-5)
WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-2),(HS-PS1-5)
WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-PS1-2)
WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-3),(HS-PS2-6)
WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3)
WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3)
SL.UM.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

Connections to NJSLS - Mathematics
MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
(HS-PS1-2),(HS-PS1-3),(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),(HS-PS1-8)
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)

Unit 1 Stage 2 Assessment Evidence

Formative Assessments:

- Calculate the amount of energy associated with various amounts of light.
- Build atoms, ions & isotopes.
- Analyze isotopic data to determine stability
- Compare and contrast models of the atom
- Identify patterns on the periodic table
- Predict macroscopic properties of a molecule by evaluating the molecular geometry
- Use the periodic table to predict the chemical formula and name of a substance
- Compare and contrast the properties of ionic, covalent, and metallic solids
- Argue a claim about the bonding character of substance based on evidence
- Create a subatomic scale model that explains a phenomena
- Construct an explanation that explains a phenomenon

Summative Assessments: (includes alternative assessments were applicable)b *** Common Benchmark Assessment**

- **HS-PS4-1, HS-PS4-3, HS-PS4-4, HS-ESS1-2,** Create a subatomic scale model and construct an explanation that explains a light related phenomenon.
- **HS-PS1-8, HS-ESS1-3** Develop a model based on evidence to illustrate the total number of neutrons plus protons does not change in any nuclear process and the total amount of energy and matter is conserved.
- **HS-PS1-1, HS- PS1-2** Given the properties of unknown elements, synthesize a periodic table which demonstrates the principles of patterns and periodicity.
- **HS-PS1-1, HS-PS1-3** Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims related to the attraction and repulsion between electric charges at the atomic scale to determine properties of different materials, structures of different components to reveal its function.
- **HS-PS1-1, HS-PS2-6** Develop and use molecular models to predict the molecular geometry and identity the patterns of VSEPR which guide the organization and classification of molecules.

- **HS-ESS3-2** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

Unit 1 Stage 3 Learning Plan

Teachers may choose any resources they feel address the above objectives. Not all may be used

Potential Topic Launches (Phenomenon)

- Nuclear phenomena: The Manhattan Project , The Nuclear Boy Scout, C-14 Dating, Geiger Counter, Smoke Detector

Potential Supporting Lessons

- Build an atom (phet simulation- online- HTML5)
- Isotopes and atomic mass (phet simulation- online- HTML5)
- Analyze isotopic data to determine stability
- Compare and contrast models of the atom
- Rutherford vs. Thomson Model? (phet simulation- online HTML5)
- Nuclear energy, stability, and radioactive decay
- Build a nucleus (phet simulation-online-HTML 5)
- Quizzes and tests

Potential Summative Assessments

- Students will construct an argument supporting or refuting the use of nuclear energy.

Potential Topic Launches (Phenomenon)

- Fireworks

Potential Supporting Lessons

- Wave calculations: energy, frequency, wavelength
- Electromagnetic spectrum
- Compare and contrast models of the electrons
- Flame test & Spectroscopy Activity
- Modeling electron configuration (Hog Hilton Activity)
- Quizzes and Test

Potential Summative Assessments

- Create a subatomic scale model that explains why stellar spectra or neon lights are different colors

Potential Topic Launches (Phenomenon)

- Conductivity of substances, Why do you have to get out of the ocean in a thunder and lightning storm?, Do fish get electrocuted when lightning strikes the ocean?

Potential Supporting Lessons

- Create a periodic table using property data and then identify patterns on the periodic table
- Predict macroscopic properties of a molecule by evaluating the molecular geometry
- Molecular Shapes (phet simulation-online- HTML 5)
- Polarity (phet simulation- online- HTML5)
- MoleculeShapes and Polarity: Basic (phet simulation-onlineHTML5)
- Molecular Shapes & Polarity activity
- Compare and contrast the properties of ionic, covalent, and metallic bonding
- Bonding- Solids Properties POGIL
- Bonding- Solids Properties- Lab Activity
- Investigate intermolecular forces of attraction
- Use the periodic table to predict the chemical formula and name of a substance
- Quizzes and tests

Potential Summative Assessments

- Write an explanation for the role ionic substances play in nerve function
- Argue a claim about the bonding character of substance based on evidence

Core Instructional & Supplemental Materials

Texts, Readings, Online Platforms & Other Resources:

- **Textbook: Modern Chemistry**
- **Google Classroom & Teacher Website**
- **Screencastify & Edpuzzle**
- **pHet simulations**

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:

Students receiving Special Education programming have specific goals and objectives, as well as accommodations and modifications outlined within their Individualized Education Plans (IEP) due to an identified disability and/or diagnosis. In addition to exposure to the general

education curriculum, the instruction is differentiated based upon the student's needs. The IEP acts as a supplemental curriculum guide inclusive of instructional strategies that support each learner.

- Small group/One to one - Additional time - Review of directions - Student restates information - Space for movement or breaks - Extra visual and verbal cues and prompts - Preferential seating - Follow a routine/schedule - Rest breaks - Verbal and visual cues regarding directions and staying on task - Checklists - Immediate feedback- periodic trends graphic organizer, periodic table guided notes

Specific Strategies and Practices that Support English Language Learners

English language learner (ELL) is a national-origin-minority student who is limited-English-proficient. This term is often preferred over limited-English-proficient (LEP) as it highlights accomplishments rather than deficits.

- Pre-teaching of vocabulary and concepts - Personal Glossary - Extended Time - Simplified/Verbal Instructions - Frequent Breaks - Visual learning, including graphic organizers - Use of cognates to increase comprehension - Teacher modeling - Pairing students with beginning English language skills with students who have more advanced English language skills - Scaffolding - Word walls - Think-pair-share - Cooperative learning groups

Students at Risk of Failure

- Home/School Connection - Alternative Assessments - Learning Contracts - Homogenous Grouping - Supplemental Instruction - Think-Pair-Share by Readiness - Homework Options - Differentiated Online Practice - Leveled Rubrics - Tiered Level of Supports - Tiered Activities - Small Group Instruction - Work Alone Choice - Group Work Choice

Students with 504 Plans

Teachers are responsible for implementing designated services and strategies identified on a student’s 504 Plan.
504 plans are formal plans that schools develop to give kids the support they need and covers any condition that limits daily activities in a major way. Students' accommodations are outlined in their individual 504 plan.

Specific Strategies and Practices that Support Gifted & Talented Students

It is critical that all teachers are able to recognize a high-ability student who may need more depth and complexity in instruction.

-Homogenous Grouping - Small Group In-Depth Instruction - Differentiated Online Practice - Alternative Assessments - Pre-Assess to provide Differentiated Instruction to Accelerate Learning

Unit 2

Stage 1 Desired Results

Unit 2: Reactive Minds: Exploring Chemical Kinetics and Mole Marvels

Unit Summary:

Understanding the periodic table's regularities and patterns enables us to predict interactions among elements. Balancing chemical equations reinforces the Law of Conservation of Mass, emphasizing the prediction of products from specific reactants. At this level, students comprehend chemical reactions through molecule collisions and atom rearrangements. Exploring factors like temperature, surface area, concentration, and catalyst influence reveals their impact on reaction rates—chemical reactions, bound by the laws of conservation of mass and energy, are quantifiable. Mathematics aids in calculating reactant-product ratios, enabling quantitative predictions about reaction outcomes. The "mole" serves as a central unit for quantifying chemical reactions. In reversible reactions, manipulating product and reactant amounts involves adjusting factors like concentration, temperature, and pressure. Chemical reactions usually absorb or release energy. Energy can change form and flow, but it is always conserved. The enthalpy change for a reaction is the enthalpy of the product minus the enthalpy of the reactants. This unit emphasizes mathematical thinking in understanding chemical reactions, as students develop models, plan investigations, analyze data, and use evidence-based arguments to comprehend matter as a quantitative property of a system.

Unit 2 Learning Standards / Targets

NJSLS Science (PE):

HS.PS1.2 Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS.PS1.5 Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS.PS1.4 Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS.PS1.6 Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

HS.PS1.7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Unit Enduring Understandings:

- Understanding of regularities and patterns in the periodic table allow for prediction of interactions among the elements.
- Chemical reactions occur naturally (in the environment and biologically) or are engineered (industrial products).
- A chemical equation needs verification through experimentation and observation.
- The properties of elements determine how atoms and molecules interact.

- Matter and energy is neither created nor destroyed.
- Quantities of all reactants are not always completely consumed
- The rate and outcome of a chemical reaction is influenced by controllable outside forces.
- The rate of a chemical reaction does not determine the quantity of the product.
- Energy can be either absorbed or released during a chemical reaction.
- The mole is an important unit of measurement that aids the quantification of matter.
- There are several ways in which elements and compounds react to form new substances and each reaction involves the flow of energy.

Unit Essential Questions:

- What information do chemical equations convey about matter and its changes?
- How can you balance reactions?
- To what extent is it advantageous to look at chemical composition in terms of moles instead of mass?
- How do you calculate the percent composition by mass of any given compound?
- Why do we need a proper balanced equation to solve a stoichiometry problem?
- How can you support the law of conservation of mass using a chemical equation?
- How can you determine the direction that a chemical reaction will occur?
- How can we maximize the amount of product being produced and minimize the amount of reactant waste?
- To what extent do temperature, surface area,concentration of reactant,and pressure affect reaction rates?
- How does the relative stability of the reactants and products determine whether energy will be released or absorbed?

Vocabulary: Chemical reactions, chemical equation, experimentation, observation, molecules, matter, energy, reactants, reaction rate, energy absorption, mole, percent composition, balanced equation, stoichiometry, Law of Conservation of Mass, temperature, surface area, concentration of reactant, pressure, stability

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLK)*

9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving.

9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions

9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately

9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
Computer Science & Design Thinking *(CS & DT)*: **8.1.12.DA.1**: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change. **8.1.12.DA.5**: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. , including climate change.
NJSLS Companion Standards - ELA **RI.MF.9–10.6** Analyze, integrate, and evaluate multiple interpretations of a text presented in different formats (e.g., visually, quantitatively, orally) as well as in words in order to address a question or solve a problem. **RI.CR.11–12.1** Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text. **W.IW.11–12.2** Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. **W.WR.11–12.4** 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. **W.WR.11–12.5** 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. **W.SE.11–12.6** 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. **RI.CR.11–12.1** Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text. **SL.UM.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.
Connections to NJSLS - Mathematics **MP.2** Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7) **MP.4** Model with mathematics. (HS-PS1-4),(HS-PS1-8) **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS12),(HS-PS1-3),(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),(HS-PS1-8)
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2),(HSPS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)

Unit 2 Stage 2 Assessment Evidence

Formative Assessments:

- Predict the effect of concentration, temperature, surface area and catalyst on the rate of a chemical reaction.
- Create molecular models to represent the factors affecting the rates of reaction.
- Create and explain potential energy diagrams, reaction energy profiles, and activation energy.
- Classify & calculate the thermodynamic nature of a reaction.
- Predict products of a chemical reaction based on patterns on the periodic table.
- Classifying and Balancing chemical reactions.
- Calculate molar mass and percent composition of compounds
- Calculate the mass of a chemical component that can be isolated from a compound by a chemical process.
- Calculate and determine the empirical and true molecular formulas of compounds
- Calculate theoretical yield of chemical processes including limiting reactant, excess, reactant, and determination of excess left over.
- Determination of efficiency of a chemical process by calculation of percent yield
- Investigation: Stoichiometry of a reaction.
- Investigation on concentration and equilibrium position
- Investigation: Effects of Reaction Stress on Equilibrium Position

Summative Assessments: ***Common Benchmark Assessment**

- **HS.PS1.2** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
- **HS.PS1.5** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
- **HS.PS1.4** Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
- **HS.PS1.6** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

- **HS.PS1.7** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
- **HS-PS3-1** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
- **HS-PS3-4** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
- **HS-ESS2-2** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
- **HS-ESS2-4** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate
- **HS-ESS2-7** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth
- **HS-ESS3-1** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity
- **HS-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity (i.e., climate change).

Unit 2 Stage 3 Learning Plan

Teachers may choose any resources they feel address the above objectives. Not all may be used

Potential Unit Launches

- Alkali metal reactions, Sugar and sulfuric acid, Genie in the bottle, Hindenburg Explosion
- Hot Hands vs. Instant Ice Pack
- Food spoilage (reaction rates)
- Stoichiometry engineering project

Potential Supporting Lessons

- Balancing Chemical equations: (phet simulation-html-5)
- Chembalancer: online game:Level 1, Level 1 review, Level 3
- Investigation: factors affecting reaction rates
- Modeling factors affecting reaction rates.
- Classify reaction types based on periodic patterns
- reaction energy bar charts and Potential energy diagrams
- Predict products of reactions using periodic patterns and activity series.

- Investigation formulas of a hydrate
- Investigation: determination of empirical formula
- Investigation: percent composition.
- Calculate molar mass and percent composition of compounds
- Calculate the mass of a chemical component that can be isolated from a compound by a chemical process.
- Calculate and determine the empirical and true molecular formulas of compounds
- Lego Stoichiometry
- Reactants, products & Left over (phet simulation- html-5)
- Calculate theoretical yields of chemical processes: including limiting reactant, excess reactant and determination of excess left over.
- Determination of the efficiency of a chemical process by calculation of percentage yield.
- Investigation: Stoichiometry of a reaction.
- Investigation on concentration and equilibrium position
- Investigation: Effects of Reaction Stress on Equilibrium Position
- Investigating equilibrium of Reactions: online simulation
- Use Le Chatelier's Principle to predict the outcome of a reaction when stresses are applied
- Quizzes and tests

Potential Summative Assessments

- Construct an explanation and draw a particulate level model relating to reaction Kinetics
- Use the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties to construct models to show the outcome of chemical reactions. Construct a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
- Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
- Design and carry out an investigation to predict the amount of reactant required to make a certain amount of product

Core Instructional & Supplemental Materials

Texts, Readings, Online Platforms & Other Resources:

- **Textbook: Modern Chemistry**
- **Google Classroom & Teacher Website**
- **Screencastify & Edpuzzle**

- **pHet simulations**

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

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English language learner (ELL) is a national-origin-minority student who is limited-English-proficient. This term is often preferred over limited-English-proficient (LEP) as it highlights accomplishments rather than deficits.

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- Home/School Connection - Alternative Assessments - Learning Contracts - Homogenous Grouping - Supplemental Instruction - Think-Pair-Share by Readiness - Homework Options - Differentiated Online Practice - Leveled Rubrics - Tiered Level of Supports - Tiered Activities - Small Group Instruction - Work Alone Choice - Group Work Choice

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Specific Strategies and Practices that Support Gifted & Talented Students
It is critical that all teachers are able to recognize a high-ability student who may need more depth and complexity in instruction.
-Homogenous Grouping - Small Group In-Depth Instruction - Differentiated Online Practice - Alternative Assessments - Pre-Assess to provide Differentiated Instruction to Accelerate Learning

Unit 3

Stage 1 Desired Results

Unit 3: States of Matter Showdown: Unleashing the Power of Solids, Liquids, Gases, Solutions & Exploring the Chemistry of Acids, Bases, and their Real Life Applications

Unit Summary:

This unit explores gasses, liquids, and solids and their properties and behavior according to the kinetic molecular theory based on molecular collisions and spatial arrangement of atoms. The unit will begin with properties of gasses, gas law calculations, and gas stoichiometry. It will continue on with intermolecular forces and how they determine a substance's state at a given temperature. Energy cannot be created or destroyed, but can be transferred to reach a thermal equilibrium which changes the properties of the substance. When energy is added, removed or when pressure changes occur, matter changes phases.Students apply knowledge of water's properties to build an understanding of aqueous solutions that includes factors that affect solution formation and solubility, concentration calculations, solution stoichiometry, and properties that depend on solution concentration. Factors such as temperature, pressure, and polarity (IMFA) affect the formation of solutions. Most everyday matter occurs as mixtures- combinations of two or more substances that can be separated by physical means. Colligative properties (freezing points, boiling points, & vapor pressure depend on the number of solute particles in a solution.) The unit will culminate with an exploration of acids and bases and their significance in the human body, soil pH, acid rain, foods, and household substances. Acid/base structure, properties, reactions, and strength will all be studied.

The crosscutting concepts of patterns, energy/matter, stability/change organize these ideas. Proficiency is expected in asking investigable questions, framing hypotheses from models/theories, developing/using models, planning/conducting investigations, applying math, and constructing explanations/solutions.

Unit 3 Learning Standards / Targets

NJSLS Science (PE):

HS.PS3.1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

HS.PS3.4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system second law of thermodynamics).

HS-PS1-1: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS.PS1.2 Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS.PS1.7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

HS-PS2-4 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

HS-PS1-3 Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles

HS-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes

HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate

HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems.

HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere

HS-ETS1-2: 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-ETS1-3 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.

Unit Enduring Understandings:

- Energy is neither created nor destroyed.
- Forces attract, hold together, or repel matter.
- The properties of elements determine how atoms and molecules interact.
- Chemical reactions occur naturally (in the environment and biologically) or are engineered (industrial products).
- Water is vital to life largely because of its unique properties.
- The gas laws can predict, analyze and explain many everyday occurrences involving gasses.
- Matter can exist in four states (solid, liquid, gas and plasma) depending on temperature.
- The kinetic molecular theory conceptually describes the physical behavior of gasses.
- Mathematical formulas can be used to predict the outcomes of an experiment.
- The physical properties of solutions can change based on the composition of solute and solvent.
- Solution concentrations can be described mathematically in a variety of terms.
- The terms “strong” and “weak” are not interchangeable with “concentrated” and “dilute” in terms of acids and bases.
- The pH scale is used to describe the acidity or basicity of a substance.
- Acids and bases are essential chemicals that support key functions in biological systems and drive invaluable industrial and household processes

Unit Essential Questions:

- How can you use the kinetic molecular theory to summarize the difference in the particle arrangement and average particle energy among particles in the solid, liquid, or gaseous form of a substance?
- How do you qualitatively interpret a heating curve in terms of kinetic and potential energy and phase changes?
- How can we quantitatively describe how systems reach thermal equilibrium?
- How do intermolecular forces between particles explain the bulk properties of substances and affect the rate of evaporation, boiling point and melting point of a liquid?
- Under what conditions will a real gas deviate from an ideal gas (or, the Ideal Gas Law)?
- In what way does the interrelationship of the variables of pressure,volume, temperature and moles predict the behavior of gasses?
- How can matter be modified to make it more useful?
- What role does polarity play in solubility?

- How does the amount of solute present affect the properties of a solution including boiling point, freezing point, and vapor pressure of a solvent?
- How is each type of concentration calculated?
- What factors affect the solubility of a solute in a solvent? (temperature, pressure, nature of solute)
- What are acids and bases and how do we describe their properties and explain their reactions?
- What is pH and how does it quantify the concentration of acids and bases?

Vocabulary: energy, forces, repel, matter, atoms, molecules, water, gas laws, solid, liquid, gas, plasma, kinetic molecular theory, solution, solute, solvent, strong, weak, concentrated, dilute, acid, base, pH, acidity, basicity, molecular theory, particle arrangement

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)***:**

9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving.

9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions

9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately

9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Computer Science & Design Thinking ***(****CS & DT****)*****:**

8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.

8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. , including climate change.

NJSLS Companion Standards - ELA

RI.CR.9–10.1. cite a range and thorough textual evidence and make clear and relevant connections, to strongly support an analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text.

RL.CR.11–12.1. Accurately cite strong and thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what a literary text says explicitly and inferentially, as well as interpretations of the text; this may include determining where the text leaves matters uncertain.

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

W.WR.11–12.5. 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.

W.SE.11–12.6. 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 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 (MLA or APA Style Manuals).

Connections to NJSLS - Mathematics

MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)

MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS12),(HS-PS1-3),(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),(HS-PS1-8)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2),(HSPS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)

Unit 3 Stage 2 Assessment Evidence

Formative Assessments:

- Analyze and interpret data to identify patterns in the relationship between gas variables.
- Calculate temperature, pressure, volume, and concentration using gas laws.
- Investigate how gas can be collected and use stoichiometric calculations to determine the amount, pressure and volume of each gas.
- Compare and contrast the behavior of ideal and real gas behaviors.
- Predict the identity of an unknown gas by the rate of diffusion.
- Utilize an understanding of intermolecular forces to predict the macroscopic properties of liquids.
- Describe and create particulate scale models for each part of a heating curve.
- Calculate the energy for each part of a heating curve.
- Collect and analyze data to determine the specific heat of known substances.
- Explaining phenomena using an understanding of the unique properties of water.
- Compare and contrast properties of crystalline and amorphous solids and their alloys.

- Calculate concentrations of solutions.
- Analyze and interpret data from solubility curves.
- Use solubility curves to make predictions.
- Use intermolecular forces of attraction to predict solubility.
- Create molecular scale models that explain the different conditions that affect the solubility of solids and gasses in liquids.
- Select the appropriate separation technique by evaluating the physical properties of a mixture.
- Model and calculate the effect of solute on vapor pressure, boiling point, freezing point, and osmosis in solutions.
- Compare and contrast the properties of acids and bases.
- Collect and analyze data on the effect of acids and bases on different indicators.
- Calculate pH
- Investigate the acidity and basicity of household products.
- Predict the outcome of acid/base reactions.
- Create a titration and curve and predict the equivalence point pH.
- Use equivalence points to predict the relative strength of an acid or base.
- Calculate the concentration of an unknown acid or base using titrations.

Summative Assessments: (includes alternative assessments were applicable)

- **HS.PS3.1** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
- **HS.PS3.2** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
- **HS.PS3.4** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system second law of thermodynamics).

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Common Benchmark Assessment

Unit 3 Stage 3 Learning Plan

Teachers may choose any resources they feel address the above objectives. Not all may be used

Potential Unit Launches

- Sublimation, Evaporation Rates, Why does rubbing alcohol feel cold?
- Why isn't boiled food as flavorful as grilled food? (heating curves/Maillard reactions)
- Ocean Acidification

- Rock salt on frozen sidewalks

Potential Supporting Lessons

- Mathematical applications of kinetic molecular theory and properties of gasses:
  - Boyle, Charles, Gay Lussacs, Avogadro, Ideal Gas Law, and Dalton's Law, stoichiometry of gaseous reactions.
  - Investigation collecting a gas by water displacement
- Perform graphical analysis and create molecular scale diagrams for how kinetic molecular theory determines properties of solids and liquids:
  - Vapor pressure diagrams, phase diagrams,
  - heating curves, and calculations,
  - thermal equilibrium calculations,
  - crystalline, amorphous, solids, and alloys,
  - special properties of water
  - Determining heat of fusion for an unknown substance
  - Drawing heating/cooling curves
  - Investigation to determine the heat loss of glass marbles
- Properties and calculations with solutions
  - Concentration calculations
  - Solubility curves
  - Particulate diagrams of factors that affect solubility
  - Separations of mixtures lab
  - Role that polarity plays in the miscibility of solutions
  - Dramatize Raoult's Law
  - Calculate Raolt’s Law
  - Particulate diagrams of boiling point and freezing point with solutes
  - Calculations for boiling point and freezing point
  - Osmosis
  - Freezing point depression lab
- Properties and calculations with acids and bases
  - pH virtual lab
  - neutralization reactions and calculations
  - titration lab

    - Percent ionization
- Quizzes and Test

Potential Summative Assessments

- Design and carry out a procedure to collect a predetermined amount of gas.
- Calculate the specific heat and predict the identity of an unknown substance.
- Design and carry out an investigation in order to predict how adding creamer to coffee will affect the temperature
- Design and carry out an investigation do determine how temperature will change when mixing liquids of different temperatures and adding a solid to a liquid
- Evaluate which salt would be best to de-ice roads or planes 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.
- Plan an experiment to collect data to determine the concentration of an unknown acid.

Core Instructional & Supplemental Materials

Texts, Readings, Online Platforms & Other Resources:

- **Textbook: Modern Chemistry**
- **Google Classroom & Teacher Website**
- **Screencastify & Edpuzzle**
- **pHet simulations**

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:

Students receiving Special Education programming have specific goals and objectives, as well as accommodations and modifications outlined within their Individualized Education Plans (IEP) due to an identified disability and/or diagnosis. In addition to exposure to the general education curriculum, the instruction is differentiated based upon the student's needs. The IEP acts as a supplemental curriculum guide inclusive of instructional strategies that support each learner.

- Small group/One to one - Additional time - Review of directions - Student restates information - Space for movement or breaks - Extra visual and verbal cues and prompts - Preferential seating - Follow a routine/schedule - Rest breaks - Verbal and visual cues regarding directions and staying on task - Checklists - Immediate feedback- Gas Laws Graphic Organizer - Calculations Checklist

Specific Strategies and Practices that Support English Language Learners

English language learner (ELL) is a national-origin-minority student who is limited-English-proficient. This term is often preferred over limited-English-proficient (LEP) as it highlights accomplishments rather than deficits.

- Pre-teaching of vocabulary and concepts - Personal Glossary - Extended Time - Simplified/Verbal Instructions - Frequent Breaks - Visual learning, including graphic organizers - Use of cognates to increase comprehension - Teacher modeling - Pairing students with beginning English language skills with students who have more advanced English language skills - Scaffolding - Word walls - Think-pair-share - Cooperative learning groups

Students at Risk of Failure

- Home/School Connection - Alternative Assessments - Learning Contracts - Homogenous Grouping - Supplemental Instruction - Think-Pair-Share by Readiness - Homework Options - Differentiated Online Practice - Leveled Rubrics - Tiered Level of Supports - Tiered Activities - Small Group Instruction - Work Alone Choice - Group Work Choice

Students with 504 Plans

Teachers are responsible for implementing designated services and strategies identified on a student's 504 Plan.

504 plans are formal plans that schools develop to give kids the support they need and covers any condition that limits daily activities in a major way. Students' accommodations are outlined in their individual 504 plan.

Specific Strategies and Practices that Support Gifted & Talented Students

It is critical that all teachers are able to recognize a high-ability student who may need more depth and complexity in instruction.

-Homogenous Grouping - Small Group In-Depth Instruction - Differentiated Online Practice - Alternative Assessments - Pre-Assess to provide Differentiated Instruction to Accelerate Learning

New Jersey Student Learning Standards - Science

Science

Scientific and technological advances have proliferated and now permeate most aspects of life in the 21st century. It is increasingly important that all members of our society develop an understanding of scientific and engineering concepts and processes. Learning how to construct scientific explanations and how to design evidence-based solutions provides students with tools to think critically about personal and societal issues and needs. Students can then contribute meaningfully to decision-making processes, such as discussions about climate change, new approaches to health care, and innovative solutions to local and global problems.

Three Dimensions of NJSLS Science

Performance Expectations (PE) are student learning standards devised with the three dimensions or components described below. For detailed information regarding the research and design behind the standards click here.

Disciplinary Core Ideas (DCI)

The fundamental ideas that are necessary for understanding a given science discipline. The core ideas all have broad importance within or across science or engineering disciplines, provide a key tool for understanding or investigating complex ideas and solving problems, relate to societal or personal concerns, and can be taught over multiple grade levels at progressive levels of depth and complexity.

Disciplinary Core Ideas in Physical Science (PS)
Disciplinary Core Ideas in Life Science (LS)
Disciplinary Core Ideas in Earth and Space Science (ESS)
Disciplinary Core Ideas in Engineering, Technology, and the Application of Science (ETS)

Science and Engineering Practices (SEP)

The practices are what students DO to make sense of phenomena. They are both a set of skills and a set of knowledge to be internalized. The SEPs reflect the major practices that scientists and engineers use to investigate the world and design and build systems.

Crosscutting Concepts (CCC)

These are concepts that hold true across the natural and engineered world. Students can use them to make connections across seemingly disparate disciplines or situations, connect new learning to prior experiences, and more deeply engage with material across the other dimensions. The NGSS requires that students explicitly use their understanding of the CCCs to make sense of phenomena or solve problems.

Science and Engineering Practices (SEP)	**Crosscutting Concepts (CCC)**
● Asking Questions and Defining Problems ● Planning and Carrying Out Investigations ● Analyzing and Interpreting Data ● Developing and Using Models ● Constructing Explanations and Designing Solutions	● Patterns ● Cause and Effect: Mechanism and Explanation ● Scale, Proportion, and Quantity ● Systems and System Models ● Energy and Matter

● Engaging in Argument from Evidence ● Using Mathematics and Computational Thinking ● Obtaining, Evaluating, and Communicating Information	● Structure and Function ● Stability and Change