ESL
SCIENCE
BUSINESS
BILINGUAL
PRESCHOOL
MATHEMATICS
LIBRARY MEDIA
SOCIAL STUDIES
WORLD LANGUAGES
GIFTED & TALENTED
TECHNOLOGY EDUCATION
ENGLISH LANGUAGE ARTS
FINE & PERFORMING ARTS
FAMILY & CONSUMER SCIENCE
HEALTH & PHYSICAL EDUCATION

RAHWAY PUBLIC SCHOOLS

CURRICULUM & INSTRUCTION

Content Area: Science

Course: Chemistry

Grade Level: 10-12

This curriculum is part of the Educational Program of Studies of the Rahway Public Schools.

ACKNOWLEDGMENTS

Jeffery Kurczeski,

Program Supervisor of 7-12 Math & Science and 9-12 Business & Technology Education

The Board acknowledges the following who contributed to the preparation of this curriculum.

Julie Koft, Science Teacher

Dr. Tiffany A. Beer, Director of Curriculum and Instruction

Subject/Course Title:
Chemistry
Grades 10-12

Date of Board Adoption:
August 26, 2025

RAHWAY PUBLIC SCHOOLS CURRICULUM

Chemistry: Grades 10-12

PACING GUIDE

Unit	Title	Pacing
1	Introduction to Chemistry, Matter, and Measurement	11 weeks
2	Energy, Electrostatics, and Atoms	7 weeks
3	Compounds, Solutions, and Solids	11 weeks
4	Chemical Reactions	11 weeks

ACCOMMODATIONS

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504 Accommodations:

- Provide scaffolded vocabulary and vocabulary lists.
- Provide extra visual and verbal cues and prompts.
- Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials.
- Provide links to audio files and utilize video clips.
- Provide graphic organizers and/or checklists.
- Provide modified rubrics.
- Provide a copy of teaching notes, especially any key terms, in advance.
- Allow additional time to complete assignments and/or assessments.
- Provide shorter writing assignments.
- Provide sentence starters.
- Utilize small group instruction.
- Utilize Think-Pair-Share structure.
- Check for understanding frequently.
- Have student restate information.
- Support auditory presentations with visuals.
- Weekly home-school communication tools (notebook, daily log, phone calls or email messages).
- Provide study sheets and teacher outlines prior to assessments.
- Quiet corner or room to calm down and relax when anxious.
- Reduction of distractions.
- Permit answers to be dictated.
- Hands-on activities.
- Use of manipulatives.
- Assign preferential seating.
- No penalty for spelling errors or sloppy handwriting.
- Follow a routine/schedule.
- Provide student with rest breaks.
- Use verbal and visual cues regarding directions and staying on task.
- Assist in maintaining agenda book.

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IEP Accommodations:

- Provide scaffolded vocabulary and vocabulary lists.
- Differentiate reading levels of texts (e.g., Newsela).
- Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials.
- Provide extra visual and verbal cues and prompts.
- Provide links to audio files and utilize video clips.
- Provide graphic organizers and/or checklists.
- Provide modified rubrics.
- Provide a copy of teaching notes, especially any key terms, in advance.
- Provide students with additional information to supplement notes.
- Modify questioning techniques and provide a reduced number of questions or items on tests.
- Allow additional time to complete assignments and/or assessments.
- Provide shorter writing assignments.
- Provide sentence starters.
- Utilize small group instruction.
- Utilize Think-Pair-Share structure.
- Check for understanding frequently.
- Have student restate information.
- Support auditory presentations with visuals.
- Provide study sheets and teacher outlines prior to assessments.
- Use of manipulatives.
- Have students work with partners or in groups for reading, presentations, assignments, and analyses.
- Assign appropriate roles in collaborative work.
- Assign preferential seating.
- Follow a routine/schedule.

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Gifted and Talented Accommodations:

- Differentiate reading levels of texts (e.g., Newsela).
- Offer students additional texts with higher lexile levels.
- Provide more challenging and/or more supplemental readings and/or activities to deepen understanding.
- Allow for independent reading, research, and projects.
- Accelerate or compact the curriculum.
- Offer higher-level thinking questions for deeper analysis.
- Offer more rigorous materials/tasks/prompts.
- Increase number and complexity of sources.
- Assign group research and presentations to teach the class.
- Assign/allow for leadership roles during collaborative work and in other learning activities.

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ELL Accommodations:

- Provide extended time.
- Assign preferential seating.
- Assign peer buddy who the student can work with.
- Check for understanding frequently.
- Provide language feedback often (such as grammar errors, tenses, subject-verb agreements, etc…).
- Have student repeat directions.
- Make vocabulary words available during classwork and exams.
- Use study guides/checklists to organize information.
- Repeat directions.
- Increase one-on-one conferencing.
- Allow student to listen to an audio version of the text.
- Give directions in small, distinct steps.
- Allow copying from paper/book.
- Give student a copy of the class notes.

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	• Provide written and oral instructions. • Differentiate reading levels of texts (e.g., Newsela). • Shorten assignments. • Read directions aloud to student. • Give oral clues or prompts. • Record or type assignments. • Adapt worksheets/packets. • Create alternate assignments. • Have student enter written assignments in criterion, where they can use the planning maps to help get them started and receive feedback after it is submitted. • Allow student to resubmit assignments. • Use small group instruction. • Simplify language. • Provide scaffolded vocabulary and vocabulary lists. • Demonstrate concepts possibly through the use of visuals. • Use manipulatives. • Emphasize critical information by highlighting it for the student. • Use graphic organizers. • Pre-teach or pre-view vocabulary. • Provide student with a list of prompts or sentence starters that they can use when completing a written assignment. • Provide audio versions of the textbooks. • Highlight textbooks/study guides. • Use supplementary materials. • Give assistance in note taking • Use adapted/modified textbooks. • Allow use of computer/word processor. • Allow student to answer orally, give extended time (time-and-a-half). • Allow tests to be given in a separate location (with the ESL teacher). • Allow additional time to complete assignments and/or assessments. • Read question to student to clarify. • Provide a definition or synonym for words on a test that do not impact the validity of the exam. • Modify the format of assessments. • Shorten test length or require only selected test items. • Create alternative assessments. • On an exam other than a spelling test, don’t take points off for spelling errors.

UNIT 1 OVERVIEW

Content Area: Science

Unit Title: Introduction to Chemistry, Matter, and Measurement

Target Course/Grade Level: Chemistry/Grades 10-12

Unit Summary: In this unit, students will be introduced to chemistry through inquiry, measurement, and scientific practices. Students will develop an understanding of mass as a conserved quantity through systems models, investigate various measurements and how to communicate them, and finally develop a particle model of matter consistent with their investigations.

Approximate Length of Unit: 11 weeks

LEARNING TARGETS

NJ Student Learning Standards:
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-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
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).

Science & Engineering Practices:
Using Mathematics and Computational Thinking
- Use mathematical representations of phenomena to support claims.

Developing and Using Models
- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
- Use a model to predict the relationships between systems or between components of a system.

Disciplinary Core Ideas:
HS-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.
- 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.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-PS3.A: Definitions of Energy
- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's

total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

Cross-Cutting Concepts:
Energy and Matter
- The total amount of energy and matter in closed systems is conserved.
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

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.

Career Readiness, Life Literacies, and Key Skills:
9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.
9.3.ST.3 Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces.
9.3 ST.4 Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.
9.3.ST‐ET.1 Use STEM concepts and processes to solve problems involving design and/or production.
9.3.ST‐ET.5 Apply the knowledge learned in STEM to solve problems.
9.3.ST-SM.3 Analyze the impact that science and mathematics has on society.
9.3.ST-SM.4 Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret and summarize research and statistical data.
9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
9.4.12.CI.3 Investigate new challenges and opportunities for personal growth, advancement, and transition.
9.4.12.CT.1 Identify problem-solving strategies used in the development of an innovative product or practice.
9.4.12.CT.2 Explain the potential benefits of collaborating to enhance critical thinking and problem solving.
9.4.12.CT.4 Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.
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.1 Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.
9.4.12.TL.2 Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.4 Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Interdisciplinary Connections and Standards:
ELA
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.
RI.MF.11–12.6 Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information (e.g., express a personal point of view, new interpretation of the concept).
W.AW.11–12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
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.
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.
Mathematics
N.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.
N.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
N.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
A.SSE.A.1 Interpret expressions that represent a quantity in terms of its context.
A.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
A.CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
F.IF.C.7 Graph functions are expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
F.BF.A.1 Write a function that describes a relationship between two quantities.
S.ID.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).

Unit Understandings:
Students will understand that…
- Conserved quantities remain constant within an isolated system, changing only when transferred to or from the surroundings. Scientists model systems and surroundings to explain changes in conserved quantities.
- Measurements always involve some degree of estimation and uncertainty. Scientists must communicate the precision of measurements to support reliable data interpretation.
- A conversion factor is a ratio of equivalent quantities and is equal to one. Multiplying a measurement by a conversion factor changes it into an equivalent value in another unit.
- Matter is made of randomly moving particles too small to see. Their arrangement and motion explain many macroscopic observations.
- The mole is a counting unit for a fixed number of particles in a sample large enough to measure.
- The periodic table organizes elements based on their properties and can be used to determine information about any known element.
- Chemical formulas communicate the mole ratio of elements in a compound, while chemical equations communicate the mole ratio of reactants used up and products formed.

Unit Essential Questions:

- How can we measure the amount of matter scientifically?
- How are the observations we make related to the arrangement and motion of particles?
- How can categorizing matter into a system and its surroundings help us understand changes?
- How can we classify substances and changes?
- How does the periodic table help us predict and understand substance properties?
- What information is communicated in a chemical equation?

Knowledge and Skills:

Students will know…

Topic 1.1 Matter and Measurement

- Content Vocabulary: Matter, mass, gram, substance, conserved quantity, isolated system, system, surroundings, precision, significant figures, volume, liter, conversion factor, metric prefixes, water displacement, density, particle, phase, gas, liquid, solid, compressible, rigid, diffusion.
- Mass is a conserved quantity; volume and density are not.
- Water displacement can measure the volume of solids due to equivalent volume units mL and cm^3.
- Instruments record with one estimated digit; more digits mean more precise tools with more reproducible measurements.
- Significant figures communicate the lack of specificity/precision in a measurement. Calculated values cannot be more precise than the measurements used.
- Density is the same for all samples of a pure solid/liquid, independent of amount. It is also a conversion factor.
- Any space between particles of matter is empty space, as the particles are matter.
- Gas particles are 1000 times less dense than those of liquids and solids, and liquids are usually less dense than solids. This causes many of the property differences between phases.

Topic 1.2 Gas Properties and Behavior

- Content Vocabulary: Temperature, average kinetic energy, Celsius, thermal expansion, gas pressure, atmosphere, Pascal, proportional relationship, linear relationship, Kelvin, mole, Avogadro's number, scientific notation, molar mass, inverse relationship, change factor, ideal gas law, gas constant, STP, molar volume.
- When particles are heated, they move and spread out more, causing a volume increase.
- Scientific notation is a way of writing very small or very large numbers without excessive zeros.
- Molar mass is a conversion factor allowing us to measure a specific number of particles in a lab.
- P and V are inversely related; P and T(K), P and n, and V and T(K) are proportional.
- With gas relationships, the ratio of initial and final values of one variable can be used as a change factor to determine the initial/final value of another.
- The ideal gas law is an equation derived from the gas relationships to calculate the current state of any variable when the others are known.
- Every mole of gas has the same volume at STP (22.4 L).

Topic 1.3 Describing Substances and Changes

- Content Vocabulary: periodic table, group, element, metal, nonmetal, metalloid, conductive, malleable, brittle, compound, pure substance, mixture, atom, formula unit, chemical formulas, subscripts, chemical equations, conservation of mass, reaction coefficients, aqueous, diatomic elements, physical change, chemical change.
- The periodic table is organized in order of increasing mass, with elements of similar properties in the same column/group.
- Most elements are considered metals and are generally solids at room temperature, conductive, malleable, and shiny. Nonmetal elements are generally nonconductive, brittle, and dull.
- Elements and compounds are pure substances, composed of a definite ratio of elements and with a definite set of characteristic properties not related to its components.

- Mixtures do not have a definite ratio, and their properties are a mix of the component properties.
- A formula unit is the smallest combination of atoms in the compound's fixed ratio of atoms.
- Chemical equations represent the reaction in an isolated system and show the number of each atom staying constant during the reaction.
- To reflect the conservation of mass and the chemical formulas/identities involved, coefficients are added in a process called balancing.

Students will be able to…

Topic 1.1 Matter and Measurement

- Construct/interpret bar charts to illustrate mass conserved during a change.
- Use evidence and chemical reasoning to support the idea that mass is a conserved quantity.
- Use a system/surroundings model to explain a change in mass.
- Use graphs to analyze the relationships between mass and volume.
- Explain the difference between mass and volume.
- Design and conduct experiments to identify an unknown.
- Report values with correct significant digits and units.
- Use ratios as conversion factors between units of mass, volume, and density.
- Create/analyze particle diagrams to illustrate differences in mass, volume, density, and phase.
- Develop a particle-level explanation for differences in mass, volume, density, and phase.
- Use evidence and chemical reasoning to support the particle model of matter.

Topic 1.2 Gas Behavior and Properties

- Create/analyze particle diagrams to illustrate differences in volume, temperature and pressure.
- Use graphs to analyze the relationships between temperature and pressure.
- Develop a particle-level explanation for changes in pressure, temperature, and volume.
- Explain the differences between the Celsius and Kelvin scales.
- Create/analyze particle diagrams to illustrate differences in mass and moles.
- Explain the purpose of the mole counting unit.
- Report values with correct significant digits, units, and scientific notation.
- Use ratios as conversion factors between units of particles, moles, and mass.
- Use graphs to analyze the relationships between volume, temperature, pressure, and moles.
- Design and conduct experiments to determine the relationships between P, V, n, and T.
- Use a ratio to determine the change in P, V, n, or T.
- Calculate a variable with $PV = nRT$.
- Use ratios as conversion factors between units of particles, moles, and mass.

Topic 1.3 Describing Substances and Changes

- Create/analyze particle diagrams to illustrate differences between elements, compounds, mixtures.
- Translate between symbolic equations, particle-level models, and macroscopic observations.
- Use position on the periodic table to predict an element's type and properties.
- Use evidence and chemical reasoning to evaluate a claim about the properties of a compound.
- Design and conduct experiments to separate mixture components.
- Use ratios as conversion factors between units of mass and moles.
- Construct/interpret bar charts to illustrate mass conserved during a change.
- Translate between symbolic equations, particle-level models, and macroscopic observations.
- Develop a particle-level explanation for differences between physical and chemical changes.
- Explain how to balance a chemical equation.
- Use a ratio to determine the change in a reactant/product.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- End of Unit Common Assessment - See folder for assessment links.
- A mix of conceptual, representation-based, math-based, and data analysis questions will be used to gather formative data through:
  - Do now questions, exit tickets, and independent classwork/homework.
  - Group whiteboarding problems, card sort activities, and exploratory analysis activities.
- Summative data will be collected through:
  - Quizzes
  - Analysis and CER conclusions of labs such as:
    - Density of an Unknown
    - Imploding Cans

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Inquiry investigations and labs including:
  - Topic 1.1:
    - Investigating Changes with Mass Activity
    - Density of an Unknown Lab
    - Properties of Phases Lab
  - Topic 1.2:
    - Investigating Temperature Scales
    - Moles on the Pavement Activity
    - Imploding Cans Lab
  - Topic 1.3:
    - Investigating Water Electrolysis
    - Differentiating Substances Card Sort
    - Investigating Physical and Chemical Changes Lab
- Instruction on vocabulary, concepts, and problem solving techniques following gradual release framework.
- Collaborative and independent practice of skills such as:
  - Mass bar charts
  - Significant figures/digits
  - Density calculations and conversions
  - Particle diagrams
  - Mole Conversions (avogadro's number, molar mass, molar volume, mole ratios)
  - Gas laws proportional reasoning and calculating
  - Understanding chemical formulas and chemical reactions
  - Balancing chemical equations

RESOURCES

Teacher Resources:

- Shared Department Drive Folder (Request Access)
- Simulations:
    - PhET Density
    - PhET States of Matter
    - PhET Gases
    - PhET Balancing
- Modeling Chemistry Curriculum
- ISLE (Investigative Science Learning Environment) Chemistry Activities
- POGIL (Process Oriented Guided Inquiry Learning) Activities
- NJCTL (NJ Center for Teaching and Learning) Resources
    - Gases
    - Mole Calculations
    - Periodic Table
    - Chemical Reactions
    - Stoichiometry

Equipment Needed:

- Projection and computer equipment
- Group whiteboards and dry erase materials
- Poster and individual periodic tables
- Calculators
- Laboratory equipment and chemicals for labs, activities, and demonstrations

UNIT 2 OVERVIEW

Content Area: Science

Unit Title: Energy, Electrostatics, and Atoms

Target Course/Grade Level: Chemistry/Grades 10-12

Unit Summary: In this unit, students will examine the central concepts of energy and attractive forces, and begin using them to describe and explain changes that occur. Students will develop an understanding of atomic structure through the application of energy and attractive forces, and then use those same concepts to evaluate models and predict elemental properties.

Approximate Length of Unit: 7 weeks

LEARNING TARGETS

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

Science & Engineering Practices:
Developing and Using Models
- Use a model to predict the relationships between systems or between components of a system.
- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

Planning and Carrying Out Investigations
- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Using Mathematics and Computational Thinking
- Create a computational model or simulation of a phenomenon, designed device, process, or system.

- Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Obtaining, Evaluating, and Communicating Information

- Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible.

Disciplinary Core Ideas:

HS-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.
- 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-PS2.B: Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

HS-PS3.A Definitions of Energy

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

HS-PS3.B Conservation of Energy and Energy Transfer

- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.
- The availability of energy limits what can occur in any system.
- Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down).

HS-PS3.D Energy in Chemical Processes

- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment.

HS-PS4.A Wave Properties

- The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.

HS-PS4.B Electromagnetic Radiation

- When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.

Cross-Cutting Concepts:
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.

Systems and System Models
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Energy and Matter
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

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.

Cause and Effect
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Career Readiness, Life Literacies, and Key Skills:

9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.

9.3.ST.3 Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces.

9.3 ST.4 Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.

9.3.ST‐ET.1 Use STEM concepts and processes to solve problems involving design and/or production.

9.3.ST‐ET.5 Apply the knowledge learned in STEM to solve problems.

9.3.ST-SM.3 Analyze the impact that science and mathematics has on society.

9.3.ST-SM.4 Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret and summarize research and statistical data.

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

9.4.12.CI.3 Investigate new challenges and opportunities for personal growth, advancement, and transition.

9.4.12.CT.1 Identify problem-solving strategies used in the development of an innovative product or practice.

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

9.4.12.CT.4 Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.

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.1 Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

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

9.4.12.TL.4 Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Interdisciplinary Connections and Standards:
ELA

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.

RI.MF.11–12.6 Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information (e.g., express a personal point of view, new interpretation of the concept).

W.AW.11–12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

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.

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.

Mathematics

N.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.

N.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

N.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

A.SSE.A.1 Interpret expressions that represent a quantity in terms of its context.

A.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

A.CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

F.IF.C.7 Graph functions are expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

F.BF.A.1 Write a function that describes a relationship between two quantities.

S.ID.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).

Unit Understandings:

Students will understand that…

- Conserved quantities remain constant within an isolated system, changing only when transferred to or from the surroundings. Scientists model systems and surroundings to explain changes in conserved quantities.
- As we are part of the surroundings for most systems under study, a change in temperature we feel/measure is not directly indicative of the change in energy for the system under study.
- Neutral atoms have an equal number of protons and electrons. Ions form when an atom gains/loses electrons to achieve a more favorable state, typically a full valence s/p orbital (usually 8 valence electrons).
- The number of valence electrons an atom has impacts the properties of the element. As groups have the same number of valence electrons, the elements in a group have similar properties.
- Periodic trends such as atomic radius, ionization energy, and electronegativity can be explained by comparing the attraction between an atom's nucleus and its valence electrons (nuclear effective charge).

Unit Essential Questions:

- What measurements allow us to describe the energy of a system?
- How can categorizing matter into a system and its surroundings help us understand changes?
- How do attractions between particles impact the properties and changes we observe?
- What observations allow us to infer the subatomic structure of substances?

Knowledge and Skills:

Students will know…

Topic 2.1 Matter and Intro to Energy and Electrostatics

- Content Vocabulary: Energy, specific heat capacity, electrostatic charges, potential energy, thermal energy, average kinetic energy, heating, endothermic, exothermic, heating curve, energy transfer.
- The mass of a sample and the magnitude of the temperature change are proportional to how much energy is needed to change the temperature.
- Our body does not feel temperature, but rather how quickly energy is transferred.
- Matter and atoms can be charged (+ or -) or neutral.
- Oppositely charged particles attract, same charges repel.
- Energy is a conserved quantity; temperature is not.
- Heating is the transfer of thermal energy through particle collisions between matter at different temperatures; some particles will increase kinetic energy, and others will decrease.
- Heating/thermal energy transfer continues until all objects are the same temperature and have the same average kinetic energy of particles.

Topic 2.2 Atoms, Electrons, and Light

- Content Vocabulary: protons, neutrons, nucleus, electrons, ions, net charge, atomic mass, light, wavelength, frequency, EM spectrum, visible light, colors, emission spectra, electron configurations, orbital diagrams, orbitals, excited, ground state, valence electrons, inner electrons, nuclear effective charge, periodic trend, electronegativity, atomic radius, ionization energy.
- Protons are positive, stationary in the nucleus, and determine an atom's identity. Neutrons are neutral, stationary in the nucleus, and contribute to an atom's mass. Electrons are negative and mobile around the outside of the nucleus.
- Metals form positive ions by losing electrons; their low attraction to electrons makes them good conductors. Nonmetals are the opposite.
- Light is a form of energy released when a charged particle changes its motion/energy. Different wavelengths of light are associated with different energies, and the colors of visible light are a small part of that spectrum.
- Each chemically distinct substance has a unique arrangement of electrons that changes their motion/energy in unique ways. This causes them to emit only specific wavelengths of light rather than a range.
- Electron configurations and orbital diagrams describe the different motions/energies of electrons in an atom/ion.
- Excited electrons have absorbed energy and changed to a higher energy/motion. Eventually, the excess energy is released as light, and the electron changes back to its ground state.
- The nuclear effective charge is the attraction to the nucleus experienced by a valence electron; it's affected by the number of protons, the number of inner electrons, and the distance to the nucleus.

Students will be able to…

Topic 2.1 Intro to Energy and Electrostatics

- Create particle diagrams to illustrate differences in temperature and phase.
- Construct/interpret bar charts to illustrate energy conserved during a change.
- Use a system/surroundings model to explain a change in energy.
- Use graphs to analyze chemical systems over time spent heating.

- Use attractive forces between particles to explain static electricity and phase changes.
- Describe an observed change in terms of the types of energy involved.
- Explain how energy distribution becomes more uniform over time.
- Construct/interpret bar charts to illustrate energy conserved during a change.
- Design and conduct experiments to identify an unknown.
- Report values with correct significant digits and units.
- Calculate a variable with $q = mc\Delta T$.

Topic 2.2 Atoms, Electrons, and Light

- Explain the impact each subatomic particle has on an atom.
- Use position on the periodic table to predict an element's properties.
- Use evidence and chemical reasoning to support hypotheses about atomic structure.
- Use orbital diagrams to model a substance.
- Use evidence and chemical reasoning to evaluate a claim about EM waves.
- Design and conduct experiments to identify an unknown.
- Use Bohr diagrams to model a substance.
- Use attractive forces between particles to explain periodic trends.
- Develop a particle-level explanation for conductivity.
- Explain how well various models/diagrams represent electrons.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- End of Unit Common Assessment - See folder for assessment links.
- A mix of conceptual, representation-based, math-based, and data analysis questions will be used to gather formative data through:
  - Do now questions, exit tickets, and independent classwork/homework.
  - Group whiteboarding problems, card sort activities, and exploratory analysis activities.
- Summative data will be collected through:
  - Quizzes
  - Analysis and CER conclusions of labs such as:
    - Specific Heat of a Metal
    - Flame Test

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Inquiry investigations and labs including:
  - Topic 2.1:
    - Investigating Heating Activity
    - Specific Heat of a Metal Lab
  - Topic 2.2:
    - Building an Atom Simulation Activity
    - Flame Test Lab
    - Periodic Trend Puzzle Activity
- Instruction on vocabulary, concepts, and problem solving techniques following gradual release framework.

- Collaborative and independent practice of skills such as:
    - Particle Diagrams
    - Heating Curves
    - Energy Bar Charts
    - Specific heat capacity calculations
    - Subatomic particles
    - EM spectra
    - Valence electrons
    - Periodic Trends

RESOURCES

Teacher Resources:

- Shared Department Drive Folder (Request Access)
- Simulations:
    - PhET Hydrogen Atom
    - PhET Rutherford Scattering
    - PhET Balloons and Static Electricity
    - PhET Build an Atom
    - De Broglie Model
- Modeling Chemistry Curriculum
- ISLE (Investigative Science Learning Environment) Chemistry Activities
- POGIL (Process Oriented Guided Inquiry Learning) Activities
- NJCTL (NJ Center for Teaching and Learning) Resources
    - Periodic Table
    - Atomic Structure

Equipment Needed:

- Projection and computer equipment
- Group whiteboards and dry erase materials
- Poster and individual periodic tables
- Calculators
- Laboratory equipment and chemicals for labs, activities, and demonstrations

UNIT 3 OVERVIEW

Content Area: Science

Unit Title: Compounds, Solutions, and Solids

Target Course/Grade Level: Chemistry/Grades 10-12

Unit Summary: In this unit, students will investigate the role of structure and attractive forces in the properties and changes of matter. Students will develop an understanding that changes can often be explained with the idea that particles rearrange based on the strength of attraction between them. Students will then explore how these attractions impact the particle-level structure of a substance and the macroscopic properties. Finally, by exploring molecules, students will develop an understanding of how molecular structure can impact the strength of attractions within a substance.

Approximate Length of Unit: 11 weeks

LEARNING TARGETS

NJ Student Learning Standards:

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

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

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

Science & Engineering Practices:

Developing and Using Models

- Use a model to predict the relationships between systems or between components of a system.

Planning and Carrying Out Investigations

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

Using Mathematics and Computational Thinking

- Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Constructing Explanations and Designing Solutions

- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
- 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.

Obtaining, Evaluating, and Communicating Information

- Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Disciplinary Core Ideas:

HS-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.
- 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.

HS-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.
- 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-PS2.B: Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

Cross-Cutting Concepts:

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.

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.

Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

Career Readiness, Life Literacies, and Key Skills:

9.3.ST.2 Use technology to acquire, manipulate, analyze and report data

9.3.ST.3 Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces.

9.3 ST.4 Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.

9.3.ST‐ET.1 Use STEM concepts and processes to solve problems involving design and/or production.

9.3.ST‐ET.5 Apply the knowledge learned in STEM to solve problems.

9.3.ST-SM.3 Analyze the impact that science and mathematics has on society.
9.3.ST-SM.4 Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret and summarize research and statistical data.
9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
9.4.12.CI.3 Investigate new challenges and opportunities for personal growth, advancement, and transition.
9.4.12.CT.1 Identify problem-solving strategies used in the development of an innovative product or practice.
9.4.12.CT.2 Explain the potential benefits of collaborating to enhance critical thinking and problem solving.
9.4.12.CT.4 Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.
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.1 Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.
9.4.12.TL.2 Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.4 Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

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F.IF.C.7 Graph functions are expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
F.BF.A.1 Write a function that describes a relationship between two quantities.
S.ID.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).

Unit Understandings:
Students will understand that…

- The particle-level structure of a substance is determined by the attractive forces at work within the substance through both intermolecular forces and chemical bonds. In turn, this structure impacts the macroscopic properties of the substance.
- The changes substances experience depend on the interactions between particles; impacting these interactions will impact the rate of the change.
- Attractive forces can explain the result of many changes/reactions. Often, the most likely result/product will bring particles with the strongest attraction closer together.
- Neutral atoms have an equal number of protons and electrons. Ions form when an atom gains/loses electrons to achieve a more favorable state, typically a full valence s/p orbital (usually 8 valence electrons).
- The number of valence electrons an atom has impacts the properties of the element. As groups have the same number of valence electrons, the elements in a group have similar properties.
- Periodic trends such as atomic radius, ionization energy, and electronegativity can be explained by comparing the attraction between an atom's nucleus and its valence electrons (nuclear effective charge).

Unit Essential Questions:

- How can we classify substances and changes?
- How do attractions between particles impact the properties and changes we observe?
- How does the periodic table help us predict and understand the properties of substances?
- How does the particle-level structure of a substance impact the attractions at work within the substance?

Knowledge and Skills:
Students will know…
Topic 3.1 Identifying and Naming Compounds

- Content Vocabulary: ionic compounds, conductivity, acids, molecular compounds, metal, nonmetal, hydrogen, crystal lattice, dissociated ions, molecule, polyatomic ions, transition metals.
- Compounds are named according to their component elements and rules based on the compound's general structure/function.
- Ionic compounds are made up of ions and conduct electricity while dissolved due to the moving charges. They are typically made of a metal and a nonmetal and also have extremely high melting points due to attraction between oppositely charged ions.
- Molecular compounds do not conduct electricity and have a structure that does not include charged particles. The lack of ion charges can explain their much lower melting/boiling points. They are typically made of 2 nonmetals.
- Ionic compounds form solids with a crystal lattice structure and dissociate into separate ions when they melt/dissolve.
- Molecular compounds form in a grouping structure, each group is called a molecule and remains as a distinct group in all states.
- Acidic compounds conduct electricity even though they are made up of 2 nonmetals (one of which being hydrogen). The hydrogen in these compounds ionizes and causes unique properties such as reactivity with metals.

Topic 3.2 Solutions and Dissolving

- Content Vocabulary: solute, solvent, solution, dissolving, mixture, aqueous, concentration, molarity, solubility curve, saturated, unsaturated, supersaturated, nucleation point, precipitate, boiling point elevation, freezing point depression, dissolving rate.
- Solutions are clear because solute particles are broken down into individual particles too small to see or impact light. Other types of mixtures may have visible components or be opaque because the mixed particles are still large enough to see or impact light.
- The solvent needs to surround the individual solute particles to prevent them from creating clumps, which causes a limit to the amount of solute that can dissolve in a certain amount of solvent.
- Attractions between solute and solvent allow for something to be dissolved. When particles of a substance are more attracted to each other than particles of the other substance, the two substances will not dissolve well.
- A solubility curve allows you to determine the point of saturation for a solute in a given substance at a given temperature.
- Increasing the temperature or the amount of solvent will increase the amount of solute that can be dissolved. Lowering either will cause the excess solute to come out of the solution as a precipitate.
- A solution is supersaturated if there is more solute dissolved than there should be at a given temperature. The excess solute will eventually come out of the solution as a precipitate.
- Boiling point elevation is caused by particles in a solution blocking and holding in the particles so they cannot leave the liquid until they move faster at higher temperatures.
- Freezing point depression is caused by the particles in a solution preventing the particles from packing together as closely until they move more slowly at colder temperatures.

Topic 3.3 Ionic and Metallic Solids

- Content Vocabulary: ions, polyatomic ions, charge, compound, transition metals, cation, anion, valence electrons, dot diagrams, bond.
- Some ions are attracted enough for the ions to not dissolve in water, or form a precipitate when mixed.
- Ionic solids are unaffected by charged objects because they are neutral overall. The ratio of ions in the compound ensures the positive and negative charges are balanced.
- Ionic solids do not conduct electricity because the ions are held in the lattice structure and don't allow free movement of charged particles, the same way dissolved ions do.
- Ionic compounds are brittle because a disruption to the pattern of ions causes repulsions between the same charges.
- Metal and ionic solids have organized lattice structures to minimize the distance between opposite charges; the attraction also leads to higher melting points for both.
- Metal solids form when metals let their electrons move freely between atoms. The cations can stay together because they are attracted to the 'sea of electrons'.
- Delocalization of electrons and movement of the negative charge allow metals to be malleable and conductive.

Topic 3.4 Molecules and Covalent Bonding

- Content Vocabulary: molecule, bond, bond angle, electron domain, lone pair, bonding pair, lewis structure, single bond, double bond, triple bond, electron domain geometry, linear, trigonal planar, tetrahedral, symmetry, polar, nonpolar, partial charges, intermolecular forces, dispersion forces, dipole forces, hydrogen bonding IMFs, emulsifiers, surfactants.
- Molecules are made up of atoms sharing electrons in covalent bonds; the atoms in a molecule do not have independent charges, the way ions do.
- Bonds are the attractions that hold together atoms/ions in a compound so strongly that the elements lose their individual identities.

- Ionic bonds are the attractions between oppositely charged ions, metallic bonds are attractions between positive ions and delocalized electrons. Molecular bonds are the attraction between shared electrons and the atomic nuclei.
- The more shared electrons in a covalent bond, the stronger the attraction/chemical bond.
- Intermolecular forces require less energy to break and don't change the identity of the substance when broken; these attractions are different and weaker than chemical bonds.
- Molecular geometry is determined by electron domains arranging around a central atom to maximize the distance between the same charges (other electron domains).
- The potential polarity of a bond depends on the relative electronegativities of the atoms in the bond. The symmetry of all the bonds in a molecule can impact the molecule's actual polarity if the dipoles cancel each other out.
- The size and shape of molecules will impact how well their intermolecular forces can attract each other.
- Emulsifiers/surfactants are macromolecules with a polar and nonpolar end and can attract two different substances that would not normally interact.

Students will be able to…

Topic 3.1 Identifying and Naming Compounds

- Use the position on the periodic table to predict the type of compound formed.
- Translate between symbolic formulas/equations, particle-level models, and macroscopic observations.
- Create particle diagrams to illustrate differences between ionic and molecular compounds.
- Explain the property difference between ionic, molecular, and acidic compounds.
- Correctly apply naming conventions for ionic, molecular, and acidic compounds.
- Design and conduct experiments to identify an unknown type of compound.
- Use ratios as conversion factors between units of mass, moles, and moles of a component in a compound.

Topic 3.2 Solutions and Dissolving

- Create particle diagrams to illustrate differences in concentration.
- Use graphs to analyze chemical systems' saturation as temperature changes.
- Translate between symbolic formulas/equations, particle-level models, and macroscopic observations.
- Construct and interpret bar charts to illustrate mass conserved during a change.
- Develop a particle-level explanation for changes in freezing/boiling points.
- Develop a particle-level explanation for changes in the dissolving rate.
- Correctly apply naming conventions for ionic, molecular, and acidic compounds.
- Design and conduct experiments to assess the strength of attraction between particles with solubility.
- Design and conduct experiments to determine the relationship between the dissolving rate and another variable.
- Use ratios as conversion factors between units of mass, moles, molarity, volume, and moles of a compound component.

Topic 3.3 Ionic and Metallic Solids

- Create particle diagrams to illustrate differences in chemical formulas.
- Create particle diagrams to illustrate differences between ionic and metallic solids.
- Use dot diagrams to model a substance.
- Translate between symbolic formulas/equations, particle-level models, and macroscopic observations.
- Use position on the periodic table to predict an element's properties.
- Use attractive forces between particles to explain the properties of ionic and metallic compounds.
- Use attractive forces between particles to explain changes during dissolving and precipitation.

- Correctly apply naming conventions to ionic compounds.
- Explain the relationship between an ionic compound formula and its ion charges.
- Design and conduct experiments to assess the strength of attraction between particles with precipitation.
- Use ratios as conversion factors between units of mass, moles, molarity, volume, and moles of a compound component.
- Use a ratio to determine the change in a reactant/product.

Topic 3.4 Molecules and Covalent Bonding

- Create particle diagrams to illustrate differences in chemical formulas.
- Create particle diagrams to illustrate differences between ionic and molecular compounds.
- Create particle diagrams to illustrate interactions through intermolecular forces.
- Use position on the periodic table to predict an element's properties.
- Use Lewis structure diagrams to model a substance.
- Translate between symbolic formulas/equations, particle-level models, and macroscopic observations.
- Use attractive forces between particles to explain differences in evaporation rate, melting point, and solubility.
- Use attractive forces between particles to explain differences in bond angles.
- Correctly apply naming conventions to molecular compounds.
- Explain how geometry and electronegativity within a molecule impact polarity.
- Design and conduct experiments to assess the strength of attraction between particles.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- End of Unit Common Assessment - See folder for assessment links.
- A mix of conceptual, representation-based, math-based, and data analysis questions will be used to gather formative data through:
  - Do now questions, exit tickets, and independent classwork/homework.
  - Group whiteboarding problems, card sort activities, and exploratory analysis activities.
- Summative data will be collected through:
  - Quizzes
  - Analysis and CER conclusions of labs such as:
    - Investigating Dissolving Rate
    - Ionic Bonding

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Inquiry investigations and labs including:
  - Topic 3.1:
    - Investigating Different Types of Compounds Activity
  - Topic 3.2:
    - Investigating Dissolving Rate Lab
  - Topic 3.3:
    - Ionic Bonding Lab

- Topic 3.4:
  - Investigating Evaporation Rates Activity
- Instruction on vocabulary, concepts, and problem solving techniques following gradual release framework.
- Collaborative and independent practice of skills such as:
  - Naming and Formulas
  - Particle Diagrams
  - Mole and Molarity Calculations
  - Solubility Curves
  - Identifying types of substances and properties
  - Lewis Structures
  - Electron domain geometry
  - Polarity
  - Intermolecular forces and properties

RESOURCES

Teacher Resources:

- Shared Department Drive Folder (Request Access)
- Simulations:
  - PhET Molecule Polarity
  - PhET Molecule Shapes
  - PhET Molarity
- Modeling Chemistry Curriculum
- ISLE (Investigative Science Learning Environment) Chemistry Activities
- POGIL (Process Oriented Guided Inquiry Learning) Activities
- NJCTL (NJ Center for Teaching and Learning) Resources
  - Ionic Bonding and Ionic Compounds
  - Covalent Bonding and Molecular Compounds
  - Intermolecular Forces

Equipment Needed:

- Projection and computer equipment
- Group whiteboards and dry erase materials
- Poster and individual periodic tables
- Calculators
- Laboratory equipment and chemicals for labs, activities, and demonstrations

UNIT 4 OVERVIEW

Content Area: Science

Unit Title: Exploring Reactions

Target Course/Grade Level: Chemistry/Grades 10-12

Unit Summary: In this unit, students will investigate various changes in matter through the lenses of moles, attractions, and energy that they've developed throughout the course. Students will design and optimize processes to produce a desired change or amount of product by applying their chemical knowledge. They'll also investigate how principles of equilibrium impact reactions and how nuclear changes are different from chemical and physical changes.

Approximate Length of Unit: 11 weeks

LEARNING TARGETS

NJ Student Learning Standards:

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

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

HS-PS1-6 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-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.

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-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Science & Engineering Practices:

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Using Mathematics and Computational Thinking

- Create a computational model or simulation of a phenomenon, designed device, process, or system.
- Use mathematical representations of phenomena to support claims.

Constructing Explanations and Designing Solutions

- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
- 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.
- Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Disciplinary Core Ideas:

HS-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.
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.

HS-PS1.B: Chemical Reactions

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.
- 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.C: Nuclear Processes

- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process.

HS-PS3.A: Definitions of Energy

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.

HS-PS3.B: Conservation of Energy and Energy Transfer

- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.
- The availability of energy limits what can occur in any system.

Cross-Cutting Concepts:

Systems and System Models

- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

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.
- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
- The total amount of energy and matter in closed systems is conserved.
- 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.

Influence of Science, Engineering and Technology on Society and the Natural World

- Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

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.

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.

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

Career Readiness, Life Literacies, and Key Skills:

9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.

9.3.ST.3 Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces.

9.3 ST.4 Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.

9.3.ST‐ET.1 Use STEM concepts and processes to solve problems involving design and/or production.

9.3.ST‐ET.5 Apply the knowledge learned in STEM to solve problems.

9.3.ST-SM.3 Analyze the impact that science and mathematics has on society.

9.3.ST-SM.4 Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret and summarize research and statistical data.

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

9.4.12.CI.3 Investigate new challenges and opportunities for personal growth, advancement, and transition.

9.4.12.CT.1 Identify problem-solving strategies used in the development of an innovative product or practice.

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

9.4.12.CT.4 Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.

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.1 Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

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

9.4.12.TL.4 Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Interdisciplinary Connections and Standards:
ELA

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.

RI.MF.11–12.6 Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information (e.g., express a personal point of view, new interpretation of the concept).

W.AW.11–12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

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.

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.

Mathematics

N.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.

N.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

N.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

A.SSE.A.1 Interpret expressions that represent a quantity in terms of its context.

A.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

A.CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

F.IF.C.7 Graph functions are expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

F.BF.A.1 Write a function that describes a relationship between two quantities.

S.ID.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).

Unit Understandings:

Students will understand that…

- The changes substances experience depend on the interactions between particles; impacting these interactions will impact the rate of the change.
- Ratios can be used to determine the theoretical yield of a reaction if we assume the limiting reactant is completely reacted. This assumption is impacted by reaction rate, equilibrium, and various experimental errors.
- Attractive forces can explain the result of many changes/reactions. Often, the most likely result/product will bring particles with the strongest attraction closer together.
- Conserved quantities remain constant within an isolated system, changing only when transferred to or from the surroundings. Scientists model systems and surroundings to explain changes in conserved quantities.
- As we are part of the surroundings for most systems under study, a change in temperature we feel/measure is not directly indicative of the change in energy for the system under study.
- A chemical system that appears unchanging at the macroscopic level is actually at equilibrium, where two reverse processes are occurring at equal rates.

Unit Essential Questions:

- How can we classify substances and changes?
- How do attractions between particles impact the properties and changes we observe?
- How can we impact and optimize processes?
- What measurements allow us to describe the energy of a system?
- How can categorizing matter into a system and its surroundings help us understand changes?

Knowledge and Skills:

Students will know…

Topic 4.1 Chemical Reactions

- Content Vocabulary: reactant, product, reaction rate, synthesis, decomposition, single replacement, double replacement, combustion, theoretical yield, experimental yield, limiting reactant, excess reactant.
- During chemical reactions, reactant particles collide, breaking their bonds and reforming as product bonds.
- Reactant particles must collide with the right orientation and enough energy in order to react.
- Chemical reactions rarely occur with the exact ratio of reactants; there will always be a limiting reactant that runs out. Other reactants would be in excess.
- Any change that increases the likelihood or energy of particle collisions will increase the reaction rate.

Topic 4.2 Thermochemistry

- Content Vocabulary: bond energy, heating, activation energy, reaction coordinate diagrams, endothermic, exothermic, catalyst.
- Bonds are attractions; they can only be broken/separated by pulling apart oppositely charged objects, which requires an absorption of energy.
- The heat of a reaction is the net energy change of a reaction for each time the reaction completes in its coefficient ratio.
- The net energy change can be calculated with bond energies, taking the difference between the energy absorbed while breaking reactant bonds and the energy released while forming product bonds.
- Reactant bonds need to be broken for the reaction to start; the chemical system needs to absorb energy to do this (this energy the system needs to absorb is also called activation energy).
- The formation of new product bonds will lead to the release of energy.

Topic 4.3 Acids and Bases

- Content Vocabulary: acid, base, pH, logarithmic scale, conductivity, weak electrolyte, strong electrolyte, indicator, titration, equilibrium, Le Chatelier's principle.
- The lower the pH, the higher the concentration of H+ ions; a change in 1 pH unit relates to a change in concentration by a factor of 10.
- Acids must have a weak bond to H+ so that a negatively charged substance (base) can remove it
- Acids are able to donate an H+ ion and become a conjugate base, while bases are able to accept an H+ ion and become a conjugate acid.
- Indicators are weak acids/bases whose conjugate acid/base forms have different colors.
- Acid-base reactions are reversible; the reverse reaction has the conjugate acid react with a conjugate base.
- Reversible reactions reach equilibrium when the forward and reverse reactions are occurring at the same rate, so at the macroscopic level, concentrations of reactant and product are not changing.
- When a chemical system is at equilibrium, any change that impacts the rate of the forward/reverse reactions will disrupt equilibrium and impact the concentrations of product and reactant at the new equilibrium.

Topic 4.4 Nuclear Chemistry

- Content Vocabulary: isotope, atomic mass, percent abundance, nucleus, decay, half-life, nucleons, fission, fusion, nuclear notation, strong nuclear force, stability, stellar fusion, supernovae, nuclear reactors, moderators, control rods.
- The probability of an isotope decaying on its own is constant and can be used to track time. The half-life of an isotope is the time it takes for half of the atoms present to decay.
- The nucleus is held together by the extremely strong nuclear attractive force between protons and neutrons; this nuclear force is stronger than the electrostatic repulsion between protons.
- The strong force is attractive over a very small distance, so the larger the nucleus, the less attraction is holding the edges together, making a larger nucleus less stable.
- Lighter elements release energy when they are made during stellar fusion because they are more stable than the previous elements. These are made by gaseous stars as they age.
- Once a star has started fusion to create iron, it will either die and become a dense iron rock, or it will go supernova, and the extreme energy release allows for heavier elements to be created via fusion.
- Fission can be prompted by making atoms absorb neutrons and become a more unstable isotope.
- To increase fission more atoms need to absorb neutrons which is easier done when the neutrons move slower. Reactors use substances like graphite and water as moderators for neutron speed and increase fission rates.
- Control rods are used to slow down fission and are made of substances that absorb neutrons.

Students will be able to…

Topic 4.1 Chemical Reactions

- Use graphs to analyze the relationships between reaction rate and another variable.
- Create particle diagrams to illustrate differences in reaction type.
- Create particle diagrams to illustrate differences in substances as a reaction proceeds.
- Translate between symbolic formulas/equations, particle-level models, and macroscopic observations.
- Develop a particle-level explanation for changes in reaction rate.
- Explain collision theory.
- Develop a particle-level explanation for limiting reactants.
- Use a system/surroundings model to explain a change in mass.
- Correctly apply naming conventions to compounds.
- Design and conduct experiments to determine the relationship between reaction rate and another variable.
- Design and conduct experiments to produce a desired amount of product.
- Report values with correct significant digits and units.
- Use ratios as conversion factors between units of moles, mass, volume, concentration, and component moles.
- Use a ratio to determine the change in a reactant/product.

Topic 4.2 Thermochemistry

- Use graphs to analyze chemical systems as a reaction proceeds.
- Construct and interpret bar charts to illustrate energy conserved during a change.
- Translate between symbolic formulas/equations, particle-level models, and macroscopic observations.
- Use a system/surroundings model to explain a change in energy.
- Use attractive forces between particles to explain bond energy.
- Explain collision theory.
- Explain the role of catalysts.
- Describe an observed change in terms of the types of energy involved.
- Design and conduct experiments to determine the heat of reaction.

- Use ratios as conversion factors between units of energy, moles, temperature, and mass.
- Use a ratio to determine the change in a reactant/product.
- Calculate a variable with $\Delta H_{rxn} = \Delta H_{bonds\ broke}n - \Delta H_{bonds\ formed}$.
- Report values with correct significant digits and units.
- Calculate a variable with $q = mc\Delta T$.

Topic 4.3 Acids and Bases

- Create particle diagrams to illustrate differences in concentration.
- Translate between symbolic formulas/equations, particle-level models, and macroscopic observations.
- Use graphs to analyze the relationships between concentration and pH.
- Create particle diagrams to illustrate differences in substances as a reaction proceeds.
- Translate between symbolic formulas/equations, particle-level models, and macroscopic observations.
- Correctly apply naming conventions to ionic and acidic compounds.
- Explain the properties of acids/bases.
- Explain Le Chatelier's principle.
- Use evidence and chemical reasoning to support the idea that reaction systems achieve equilibrium between a forward and reverse reaction.
- Design and conduct experiments to determine the relationship between pH and concentration.
- Design and conduct experiments to increase the amount of a desired product.
- Report values with correct significant digits and units.
- Use ratios as conversion factors between units of concentration, moles, volume, and mass.
- Use a ratio to determine the change in a reactant/product.

Topic 4.4 Nuclear Chemistry

- Create particle diagrams to illustrate differences in nucleus composition.
- Use position on the periodic table to predict an element's properties.
- Construct and interpret bar charts to illustrate mass conserved during a change.
- Translate between symbolic formulas/equations, particle-level models, and macroscopic observations.
- Explain relative abundance.
- Use attractive forces between particles to explain the differences between nuclear changes and chemical changes.
- Use attractive forces between particles to explain the differences between fission and fusion.
- Explain the differences between alpha/beta decay and gamma radiation.
- Use evidence and chemical reasoning to support the idea that the strong nuclear force is different from an electrostatic force.
- Use evidence and chemical reasoning to evaluate a claim about nuclear applications.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- End of Unit Common Assessment - See folder for assessment links.
- A mix of conceptual, representation-based, math-based, and data analysis questions will be used to gather formative data through:
    - Do now questions, exit tickets, and independent classwork/homework.

    - Group whiteboarding problems, card sort activities, and exploratory analysis activities.
- Summative data will be collected through:
    - Quizzes
    - Analysis and CER conclusions of labs such as:
        - Applying Reaction Types
        - pH and Concentration

Learning Activities:
What differentiated learning experiences and instruction will enable all students to achieve the desired results?
- Inquiry investigations and labs including:
    - Topic 4.1:
        - Applying Reaction Types Lab
        - Production Lab
    - Topic 4.2:
        - Breaking and Reforming Bonds Investigation
        - Energy of Foods Lab
    - Topic 4.3:
        - pH and Concentration Lab
    - Topic 4.4:
        - Nuclear Notation and Bar Charts Activity
- Instruction on vocabulary, concepts, and problem solving techniques following gradual release framework.
- Collaborative and independent practice of skills such as:
    - Reaction Types
    - Particle Diagrams
    - Mole Conversions
    - Reaction Coordinate Diagrams
    - Bar Charts
    - Energy calculations
    - Nuclear notation
    - Percent Abundance

RESOURCES

Teacher Resources:
- Shared Department Drive Folder (Request Access)
- Simulations:
    - PhET Build a Nucleus
    - PhET Isotopes and Atomic Mass
    - PhET pH Scale
- Modeling Chemistry Curriculum
- ISLE (Investigative Science Learning Environment) Chemistry Activities
- POGIL (Process Oriented Guided Inquiry Learning) Activities
- NJCTL (NJ Center for Teaching and Learning) Resources
    - Atomic Origins
    - Chemical Reactions

    - Stoichiometry Unit
    - Thermochemistry
    - Kinetics and Equilibrium
    - Acids and Bases

Equipment Needed:
- Projection and computer equipment
- Group whiteboards and dry erase materials
- Poster and individual periodic tables
- Calculators
- Laboratory equipment and chemicals for labs, activities, and demonstrations