CURRICULUM

FOR

HONORS CHEMISTRY

GRADES 10-12

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

ACKNOWLEDGMENTS

Dr. Susan Dube, Program Supervisor of Math, Science, and Technology Education

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

Julie Koft

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

Subject/Course Title:
Honors Chemistry
Grades 10-12

Date of Board Adoption:
September 19, 2023

RAHWAY PUBLIC SCHOOLS CURRICULUM

Honors Chemistry - Grades 10 - 12

PACING GUIDE

Unit	Title	Pacing
1	Introduction to Chemistry, Matter, & Periodic Table	4 weeks
2	Atoms and Electrons	5 weeks
3	Chemical Compounds	5 weeks
4	Chemical Equations & Stoichiometry	5 weeks
5	Gas Laws, Behaviors, & Properties	3 weeks
6	Thermochemistry	3 weeks
7	Kinetics & Equilibrium	3 weeks
8	Aqueous Solutions	2 Weeks
9	Acids & Bases	3 Weeks
10	Electrochemistry	4 Weeks
11	Nuclear Chemistry	3 Weeks

ACCOMMODATIONS

504 Accommodations:	**IEP 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.	• 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.
Gifted and Talented Accommodations:	**ML Accommodations:** • Provide extended time.

• 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.	• 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. • 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 OVERVIEW

Content Area: Honors Chemistry

Unit Title: Introduction to Chemistry, Matter and the Periodic Table

Target Course/Grade Level: Grades 10, 11, and 12

Unit Summary:

In this unit the science of chemistry is introduced with the fundamental concepts of matter. Topics include a broad overview of the field of chemistry, the branches of chemistry, properties of matter, introduction to the periodic table and its trends, the science and engineering practices, and scientific measurements and calculations.

Approximate Length of Unit: 4 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

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 levels of atoms.

Science & Engineering Practices:

Developing and Using Models
Developing and Using Models Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)

Disciplinary Core Ideas:

PS1.A: Structure and Properties of Matter
Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)

The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1), (HS-PS1-2)

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. (secondary to HS-PS1-1),(secondary to HS-PS1-3)
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 (HS-PS1-1), (HS-PS1-2), (HS-PS1-3), (HSPS1-5)

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.STSM.3. Analyze the impact that science and mathematics has on society.
9.3.STSM.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 (e.g., 1.1.12prof.CR3a).
9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
9.4.12.CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources).
9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)
9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.
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 (e.g., 7.1.AL.IPERS.6).

Interdisciplinary Connections and Standards:

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

RST.11-12.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
RST.11-12.2. Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks;analyze the specific results based on explanations in the text.
RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
RST.11-12.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
RST.11-12.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. WHST.11-12.1. Write arguments focused on discipline-specific content.
WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.
WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Educational Technology
8.1.12.F.1 Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs

Mathematics:
MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)

Unit Understandings:
Students will understand that…

- Matter can be differentiated based on composition and physical properties
- Physical and chemical properties of matter can be used to compare and contrast samples of matter
- The periodic table provides information about the physical and chemical properties of elements
- SI units and scientific notation are used to describe measurements clearly and accurately
- Significant figures in data reporting are ways to communicate the precision of a measurement

Unit Essential Questions:

- How is chemistry central to the universe?
- How is scientific information gathered and assessed?

Knowledge and Skills:
Students will know…

Key definitions: Chemical, chemistry, atom, change of state, chemical change, chemical property, chemical reaction, compound, element, extensive property, gas, intensive property, liquid, mass, matter, mixture, physical change, physical property, product, pure substance, reactant, solid, periodic table, periodic trends, family, group, period, metal, metalloid, nonmetal, system, theory, conversion factor, density, derived unit, quantity, SI, volume, weight, accuracy, directly proportional, indirectly proportional, percent error, precision, scientific notation and significant figures.

Students will be able to...

- Differentiate between physical properties and chemical properties of matter.
- Classify changes of matter as physical or chemical.
- Explain the molecular level particles of a gas, liquid, and solid.
- Distinguish between a mixture and a pure substance.
- Use a periodic table to name elements, given their symbol and vice versa.
- List the characteristics that distinguish metals, nonmetals, and metalloids.
- Describe the purpose the science and engineering practices.
- Explain the SI units for length, mass, time, volume, and density.
- Interpret data to determine the density of matter.
- Transform a statement of equality to a conversion factor.
- Apply the rules of significant figures to determine the number of significant figures in measurements.
- Perform mathematical operations and determine the significant figures.
- Convert measurements into scientific notation.

EVIDENCE OF LEARNING

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

- Department Approved Common Assessment Questions
- Students will be given conceptual problems and chemistry math-based problems for independent practice, in class and homework.
- Written and oral responses to prompts.
- Lab report based on observations and data collected in the Determining the Density of an Unknown Substance lab.
- Student self-assessment through POGIL and group activities.
- Laboratory and demonstration analysis.

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

- Introduce chemistry concepts within historical and cultural contexts. For example, discuss how chemical innovations and discoveries have impacted different communities, including the contributions of scientists from diverse backgrounds.
- Significant Zeroes POGIL (Process-Oriented Guided Inquiry Learning) activities.
- Physical vs. Chemical Changes, Measure for Measure and Significant Figures group activities.
- On line and live demonstrations of types of matter, separation of matter, laboratory equipment and measurement units.
- Scientific Measurement, Determining the Density of an Unknown Substance and Observation of Chemical Reaction labs.

RESOURCES

Teacher Resources:

- NJCTL standards based presentations and activities
- Text: Buthelezi, T., Dingrando, L., Hainen, N., Wistrom, C., & Zike, D. (2022). *Inspire chemistry*. McGraw-Hill Education.

Equipment Needed:

- Laptop and projector for use with PowerPoint presentations.
- Calculators.
- Laboratory equipment and chemicals for demonstrations and labs.

UNIT OVERVIEW

Content Area: Honors Chemistry

Unit Title: The Atom and Electrons

Target Course/Grade Level: Grades 10, 11, and 12

Unit Summary:

The historical scientific research leading to the structure of the atom, the structure of the atom and its subatomic particles, electron configurations and a more in depth look at periodic trends are covered in this unit.

Approximate Length of Unit: 5 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

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 levels of atoms.
HS-PS4-3: Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations, one model is more useful than the other.
HS-PS4-4: Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

Science & Engineering Practices:
Developing and Using Models
Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)
Engaging in Argument from Evidence
Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-PS4-3)
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. (HS-PS4-4)

Disciplinary Core Ideas:
PS1.A: Structure and Properties of Matter
Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1), (HS-PS1-2)

PS4.A: Wave Properties
Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3)

PS4.B: Electromagnetic Radiation
Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3)
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. (HS-PS4-4)

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. (secondary to HS-PS1-1),(secondary to HS-PS1-3)

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. (HS-PS1-1), (HS-PS1-2), (HS-PS1-3), (HSPS1-5)

Systems and System Models:
Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows—within and between systems at different scales. (HS-PS4-3)

Cause and Effect:
Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS4-4)

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.STSM.3. Analyze the impact that science and mathematics has on society.
9.3.STSM.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 (e.g., 1.1.12prof.CR3a).
9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).

9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
9.4.12.CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources).
9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)
9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.
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 (e.g., 7.1.AL.IPERS.6).

Interdisciplinary Connections and Standards:
NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

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RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
RST.11-12.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
RST.11-12.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
WHST.11-12.1. Write arguments focused on discipline-specific content.
WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.
WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Educational Technology
8.1.12.F.1 Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs

Mathematics:
MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)
HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS4-1),(HS-PS4-3)
HSASSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-1),(HS-PS4- 3)
HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1),(HS-PS4-3)

Unit Understandings:
Students will understand that…

- Various subatomic particles make up an atom and determine its properties
- The mole is a unit that can be used to count particles of matter
- Properties of atoms are periodic based on their position in the periodic table
- Electron configurations are particularly important in determining an atoms chemical properties

Unit Essential Questions:

- What is an atom?
- How does an atom's electron configuration affect its chemical properties?

Knowledge and Skills:
Students will know...

Key definitions: Law of Conservation of Mass, atom, atomic mass unit, atomic radius, electronegativity, atomic number, average atomic mass, isotopes, mass number, electromagnetic radiation, electromagnetic spectrum, excited state, frequency, wavelength, photoelectric effect, photon, angular momentum quantum number, magnetic quantum number, principal quantum number, spin quantum number, quantum theory, Heisenberg Uncertainty Principle, orbital, Aufbau Principle, electron configuration, Hund's Rule, highest occupied level, inner-shell electrons, noble gas, noble gas configuration and Pauli-Exclusion Principle.

Students will be able to...

- Explain the historical scientific research experiments that led to developments of the model of the atom to present day.
- Use case studies to explore chemical applications and their historical impact. Discuss how chemistry was used during the Holocaust and genocides, such as the use of chemicals for disinfection and harmful purposes, emphasizing ethical considerations.

- Explore how chemistry has been used in the context of environmental justice issues that affect marginalized communities, including Asian Pacific Islanders, LGBTQ individuals, and African Americans.
- Explain the structure of the atom and interpret the subatomic particles for different atoms of elements in the periodic table.
- Explain an isotope and the composition of an element on the periodic table based on the abundance and mass of its isotopes.
- Explain the electron configuration of the atoms of elements in the Periodic Table and be able to analyze an element or ion to determine the electron configuration.
- Explain and interpret data on the atomic radius and electronegativity in the periodic table based on electron structure of the substance.

EVIDENCE OF LEARNING

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

- **End of Unit Assessment**:
  - Students will explain the structure of an atom and its subatomic particles.
  - Department Approved Common Assessment Questions
- Students will be given conceptual problems and chemistry math-based problems for independent practice, in class and homework.
- Written and oral responses to prompts.
- Lab report based on observations and data collected in the Flame Test lab.
- I^2 activities to analyze graphs and the periodic trends.
- Student self-assessment through POGIL and group activities.
- Laboratory and demonstration analysis.
- Students will complete a timeline project to reveal the history and the discovery of the atom and its subatomic particles. End of Unit Assessment: • • Students will determine an element's electron configuration by analyzing an element or ion.

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

- History of the Atom Timeline Project.
- Analyzing the Atom and Average Atomic Mass POGIL (Process-Oriented Guided Inquiry Learning) activities.
- Feather Isotopes and Electron Configuration Scavenger Hunt group peer activities.

- Online and live demonstrations of isotopes and moles.
- Electron Configurations, Candium Isotope Average Atomic Mass, Periodic Trends and Flame Tests labs.

RESOURCES

Teacher Resources:

- NJCTL standards based presentations and activities
- Text: Buthelezi, T., Dingrando, L., Hainen, N., Wistrom, C., & Zike, D. (2022). *Inspire chemistry*. McGraw-Hill Education.

Equipment Needed:

- Laptop and projector for use with PowerPoint presentations.
- Calculators.
- Laboratory equipment and chemicals for demonstrations and labs.

UNIT OVERVIEW

Content Area: Honors Chemistry

Unit Title: Chemical Compounds

Target Course/Grade Level: Grades 10, 11, and 12

Unit Summary:

In this unit, the topic of study includes the formation and properties of chemical compounds, specifically ionic, metallic and molecular compounds. The language of chemical compounds and formulas is introduced as well.

Approximate Length of Unit: 5 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

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 levels 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.

Science & Engineering Practices:
Developing and Using Models
Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)

Constructing Explanations and Designing Solutions
Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-PS1-2)

Disciplinary Core Ideas:
PS1.A: Structure and Properties of Matter
Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)

The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1), (HS-PS1-2)

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. (secondary to HS-PS1-1),(secondary to HS-PS1-3)

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. (HS-PS1-1), (HS-PS1-2), (HS-PS1-3), (HSPS1-5)

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.STSM.3. Analyze the impact that science and mathematics has on society.
9.3.STSM.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 (e.g., 1.1.12prof.CR3a).
9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
9.4.12.CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources).
9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)
9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.

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 (e.g., 7.1.AL.IPERS.6).

Interdisciplinary Connections and Standards:

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects

RST.11-12.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
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RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
RST.11-12.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
RST.11-12.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
WHST.11-12.1. Write arguments focused on discipline-specific content.
WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.
WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Educational Technology

8.1.12.F.1 Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs

Mathematics:

MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)
HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS4-1),(HS-PS4-3)
HSASSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-1),(HS-PS4- 3)
HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1),(HS-PS4-3)

Unit Understandings:
Students will understand that…

- Electron composition impacts the formation of ions and compounds
- Different compounds form due to different atoms combining.
- Chemical names and formulas are essential tools of the chemist.
- Intermolecular forces and geometry of a molecule influence the properties of polarity and compounds.

Unit Essential Questions:

- How are compounds formed?
- Why is naming chemicals properly so vital?
- How does polarity affect the type of compound formed?

Knowledge and Skills:
Students will know...

Key definitions: Chemical bonding, covalent bonding, ionic bonding, polar, non-polar covalent, chemical formula, electron-dot notation, Lewis structure, lone pair, molecular compound, molecular formula, molecule, single bond, double bond, triple bond, diatomic molecular, VSEPR Theory, linear, bent, trigonal planar, trigonal pyramidal, tetrahedral, ionic compound, polyatomic ion, ductile, malleable, metallic bonding, binary compounds, ternary compounds and salt.

Students will be able to...

- Explain and interpret data on the ionic radius, electron affinity and ionization energy in the periodic table based on electron structure of the substance.
- Analyze electron composition of atoms to form structures of ionic compounds and molecular compounds.
- Interpret the configuration of molecular compounds to determine the molecular geometry and polarity.
- Compare and contrast the different intermolecular forces present in compounds.
- Illustrate Lewis structures of molecular compounds.
- Analyze Lewis structures to determine the VSEPR Theory geometry of compounds.
- Explain the rules for writing chemical formulas for ionic compounds and molecular compounds.
- Interpret chemical formulas and write the names or interpret chemical names and write the formula.

EVIDENCE OF LEARNING

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

- **End of Unit Assessment**:
  - Department Approved Common Assessment Questions 1
  - Department Approved Common Assessment Questions 2
- Students will be given conceptual problems and chemistry math-based problems for independent practice, in class and homework.
- Written and oral responses to prompts.
- Lab report based on observations and data collected in the Making Ionic Compounds lab.
- I^2 activities to analyze graphs and the periodic trends.
- Student self-assessment through POGIL and group activities. Laboratory and demonstration analysis.
- Students will complete a project to discover that chemical compounds are in the real world all around them, including foods and cleaning supplies

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

- Consumer Chemical Compounds Project.
- Polyatomic Ions and Naming Molecular Compounds POGIL (Process-Oriented Guided Inquiry Learning) activities.
- Speed Dating for Ions and Chemical Compounds Scavenger Hunt group peer activities.
- Online and live demonstrations of Ionic Compound Formation and VSEPR Theory.
- Making Ionic Compounds, Properties of Compounds, Drops on a Penny, Mixing Oil and Water and Covalent Bonding labs

RESOURCES

Teacher Resources:

- NJCTL standards based presentations and activities
- Text: Buthelezi, T., Dingrando, L., Hainen, N., Wistrom, C., & Zike, D. (2022). *Inspire chemistry*. McGraw-Hill Education.

Equipment Needed:

- Laptop and projector for use with PowerPoint presentations.
- Calculators.
- Laboratory equipment and chemicals for demonstrations and labs.

UNIT OVERVIEW

Content Area: Honors Chemistry

Unit Title: Chemical Equations and Stoichiometry

Target Course/Grade Level: Grades 10, 11, and 12

Unit Summary:

In this unit, the topic of study includes the types of chemical reactions and what occurs to atoms and compounds as they react in terms of amounts, properties and appearance

Approximate Length of Unit: 5 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

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

Science & Engineering Practices:
Using Mathematics and Computational Thinking
Use mathematical representations of phenomena to support claims. (HS-PS1-7)

Disciplinary Core Ideas:
PS1.A: Structure and Properties of Matter
A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)
PS2.B: Types of Interactions
Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HSPS1-4),(HS-PS1-5)
The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)

Cross Cutting Concepts:
Energy and Matter:
The total amount of energy and matter in closed systems is conserved. (HS-PS1-7) , Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4)

Career Readiness, Life Literacies, and Key Skills:

9.3.ST.2.Use technology to acquire, manipulate, analyze and report data.
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9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.
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 (e.g., 7.1.AL.IPERS.6).

Interdisciplinary Connections and Standards:

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RST.11-12.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
RST.11-12.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept,resolving conflicting information when possible.
WHST.11-12.1. Write arguments focused on discipline-specific content.
WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.
WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Educational Technology
8.1.12.F.1 Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs

Mathematics:
MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)

Unit Understandings:
Students will understand that…

- Chemical equations describe what happens to the arrangement of atoms in the chemical reactions.
- Using the mole concept can allow us to predict amounts of product or reactant from the chemical equation

Unit Essential Questions:

- How do you describe and classify chemical reactions?
- How do you determine chemical equivalents in chemical reactions?
- How do you analyze and measure the substances in a chemical reaction?

Knowledge and Skills:
Students will know...

Key definitions: Avogadro's number, mole, molar mass, activity series, empirical formula, percent composition, stoichiometry, mole ratio, actual yield, theoretical yield, limiting reactant, excess reactant, percent yield, formula mass, chemical equations, coefficients, balanced chemical equations, combustion reaction, single displacement reaction, double displacement reaction, synthesis reaction, double displacement reaction, bond strength, bond length.

Students will be able to...

- Describe types of chemical reactions and be able to analyze reactants and/or products to predict the types of chemical reactions for: synthesis, decomposition, single displacement, double displacement and combustion.
- Apply equations and analyze data to determine a compound's molar mass, percent composition.
- Analyze data and calculate the empirical and molecular formula of a compound.
- Balance a chemical equation using the mole.
- Explain the concept of a stoichiometric equivalent in a chemical reaction.
- Use stoichiometry to balance chemical reactions converting to/or from moles/mass of reactants to/or from moles/mass of products following the Law of Conservation of Mass.
- Explain a limiting reactant, excess reactant and percent yield.
- Use stoichiometry to calculate limiting reactants in chemical reactions and the resulting percent yield.

EVIDENCE OF LEARNING

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

- **End of Unit Assessment**:
  - Department Approved Common Assessment Questions
- Students will be given conceptual problems and chemistry math-based problems for independent practice, in class and homework.
- Written and oral responses to prompts.
- Lab report based on observations and data collected in the Maximizing Your Product lab.
- Student self-assessment through POGIL and group activities. Laboratory and demonstration analysis.

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

- Engage students in discussions about the ethical implications of chemical advancements. For example, explore the use of chemical agents during historical events and consider their impact on human lives and the environment.
- Bond Strengths and Lengths and Mole Ratio POGIL (Process-Oriented Guided Inquiry Learning) activities.
- Balancing Equations, Molar Mass Real World Problems, Stoichiometry Problems and S'mores Limiting Reactants group peer activities.
- Online and live demonstrations of percent composition, empirical formulas and the mole roadmap.

- Oreo Cookies, Single Displacement Reaction, Chemical Reactions, Precipitation Reactions Maximizing Your Product labs.

RESOURCES

Teacher Resources:

- NJCTL standards based presentations and activities
- Text: Buthelezi, T., Dingrando, L., Hainen, N., Wistrom, C., & Zike, D. (2022). *Inspire chemistry*. McGraw-Hill Education.

Equipment Needed:

- Laptop and projector for use with PowerPoint presentations.
- Calculators.
- Laboratory equipment and chemicals for demonstrations and labs.

UNIT OVERVIEW

Content Area: Honors Chemistry

Unit Title: Gas Laws, Behaviors, and Properties

Target Course/Grade Level: Grades 10, 11, and 12

Unit Summary:

An abstract phase of matter, gases, will be explored in this unit including the Kinetic Molecular Theory, physical and molecular characteristics of gases, effusion, diffusion, combustion reactions, and Gas Law's including Boyles', Charles, Gay-Lussacs, and the Ideal Gas Law.

Approximate Length of Unit: 3 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

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:
Using Mathematics and Computational Thinking
Use mathematical representations of phenomena to support claims. (HS-PS1-7)

Disciplinary Core Ideas:
PS1.A: Structure and Properties of Matter
The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (secondary to HS-PS2-6)
The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)

Cross Cutting Concepts:
Energy and Matter:
The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)

Structure and Function:
Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)

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.
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Educational Technology
8.1.12.F.1 Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs

***Mathematics*:**
MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)

Unit Understandings:
Students will understand that…

- The properties of gases differ from the properties of the other phases of matter
- Manipulating one of the factors associated with gases, volume, pressure, temperature or moles for gases, other factors will be affected.
- Volume, pressure, temperature or moles for gases in Gas Law problems can be calculated using the correct equation.
- The postulates of the Kinetic Molecular Theory explain the behaviors and real life phenomenon of gases.

Unit Essential Questions:

- As the temperature of a system is held constant what happens to the pressure of a gas as the volume is changed?
- As the volume of a system is held constant what happens to the pressure of a gas as the temperature is changed?
- As the pressure of a system is held constant what happens to the volume of a gas as the temperature is changed?
- What is the relationship between atmospheric pressure and altitude?

Knowledge and Skills:

Students will know...

Key definitions: Ideal gas, kinetic-molecular theory, real gas, diffusion, effusion, atmospheric pressure, barometer, millimeters of mercury, Pascal, pressure, standard temperature and pressure, Boyle's Law, Charles' Law, Gay-Lussac's Law, partial pressure, Ideal Gas Law, vapor pressure, directly proportional, inversely proportional, elastic collisions, non-elastic collisions, Kelvin Scale, kinetic energy.

Students will be able to...

- Explain the Kinetic Molecular Theory of Gases and corresponding properties of gases.
- Interpret units of pressure and force and apply a conceptual understanding to the behavior of gases in a closed container.
- Explain Boyle's, Charles', Gay-Lussac's, Combined and Ideal Gas Laws
- Apply the principles of Boyle's, Charles', Gay-Lussac's, Combined or the Ideal Gas Law to solve problems using equations based on these laws.
- Apply the principles of Boyle's, Charles', Gay-Lussac's, Combined or the Ideal Gas Law in order to explain real life phenomena.
- Explain the properties of effusion and diffusion and provide a real-life example.

EVIDENCE OF LEARNING

Assessment:

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

- **End of Unit Assessment**:
  - Department Approved Common Assessment Questions
- Students will be given conceptual problems and chemistry math-based problems for independent practice, in class and homework.
- Written and oral responses to prompts.
- Students will carry out laboratory experiments Process oriented guided inquiry based learning activity using an online PhET simulation explain properties and gas laws.

Learning Activities:

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

- Mini-group peer activities
- Online demonstrations of Gas Laws using the PhET online simulation
- Gas Laws, Behavior, and Properties hands on laboratory activities and demonstrations

RESOURCES

Teacher Resources:

- NJCTL standards based presentations and activities
- Text: Buthelezi, T., Dingrando, L., Hainen, N., Wistrom, C., & Zike, D. (2022). *Inspire chemistry*. McGraw-Hill Education.

Equipment Needed:

- Laptop and projector for use with PowerPoint presentations.
- Calculators.
- Laboratory equipment and chemicals for demonstrations and labs.

UNIT OVERVIEW

Content Area: Honors Chemistry

Unit Title: Thermochemistry

Target Course/Grade Level: Grades 10, 11, and 12

Unit Summary:

In this unit students will explore the idea of heat transfer between a system and its surroundings. Thermal energy will be explained in order for students to determine if a system is endothermic or exothermic based upon the surrounding absorbing or releasing energy. Students will also be able to measure the amount of energy transferred using a calorimeter as well as explain the role of thermal energy in a chemical reaction and represent it in a thermochemical equation.

Approximate Length of Unit: 3 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

HS-PS3-1: Create a computational model to calculate the change in energy of one 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 motion 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).

Science & Engineering Practices:
Planning and Carrying Out Investigations
Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS3-4)

Using Mathematics and Computational Thinking
Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)

Disciplinary Core Ideas:
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. (HSPS3-1),(HS-PS3-2)

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. (HS-PS3-1)

Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4)

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. (HS-PS3-1)

The availability of energy limits what can occur in any system. (HS-PS3-1)

Uncontrolled systems always evolve toward more stable states— that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)

PS3.D: Energy in Chemical Processes
Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4)

PS1.A: Structure and Properties of Matter
A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)

PS2.B: Types of Interactions
Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HSPS1-4),(HS-PS1-5)

Cross Cutting Concepts:
Energy and Matter:
The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)

Systems and System Models:
When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4),

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. (HSPS3-1)

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.STSM.3. Analyze the impact that science and mathematics has on society.
9.3.STSM.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 (e.g., 1.1.12prof.CR3a).
9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
9.4.12.CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources).
9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)
9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.
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 (e.g., 7.1.AL.IPERS.6).

Interdisciplinary Connections and Standards:

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:
RST.11-12.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
RST.11-12.2. Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
RST.11-12.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text,

verifying the data when possible and corroborating or challenging conclusions with other sources of information.
RST.11-12.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
WHST.11-12.1. Write arguments focused on discipline-specific content.
WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.
WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Educational Technology
8.1.12.F.1 Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs

Mathematics:
MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)

Unit Understandings:
Students will understand that…

- The transfer of heat in an endothermic process is from the surroundings to the system and can provide an example involving a physical and chemical change
- The transfer of heat in an exothermic process is from the system to the surroundings and can provide an example involving a physical and chemical change
- The amount of measured heat transferred in a calorimeter based upon the specific heat of a metal
- A hot pack and cold pack is a chemical change involving endothermic and exothermic processes between the system and the surroundings
- The placement of heat in a thermochemical equation will classify the reaction as endothermic or exothermic

Unit Essential Questions:

- In a thermochemical equation in which type of process is thermal energy a product or a reactant?
- How does the specific heat of an object affect its ability to absorb and release thermal energy?
- In a chemical reaction where bonds are being formed will the system create a hot pack or a cold pack?
- Differentiate between when value for the heat of the system in an endothermic and exothermic reaction

Knowledge and Skills:

Students will know...

Key definitions: Endothermic, exothermic, system, surroundings, specific heat, calorimeter, thermochemical equation, thermal energy, heat, Joules, kilojoules, change in temperature, breaking bonds, bond formation, change of heat, standard heat of formation, enthalpy, and entropy.

Students will be able to...

- Differentiate between the transfer of heat in an endothermic process and an exothermic process
- Apply their knowledge of the transfer of heat in order to provide examples of physicals changes that represent each process
- Explain how a calorimeter works and determine the change of heat for both the system and surroundings.
- Explain the role of thermal energy in making or breaking bonds in both a hot pack and cold pack
- Classify a thermochemical equation as endothermic or exothermic

EVIDENCE OF LEARNING

Assessment:

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

- **End of Unit Assessment**:
  - Department Approved Common Assessment Questions
- Students will be given conceptual problems and chemistry math –based problems for independent practice, in class and homework.
- Students will carry out laboratory experiments.
- Students will perform a hands-on laboratory activity which involves them creating both a hot pack and cold pack and summarizing in which chemical reaction bonds are being broken/formed and whether heat is a reactant/product.
- Students will perform a hands-on laboratory activity in which they use a coffee cup calorimeter in order to determine the change of heat for both the system and surroundings based upon the specific heat of a metal.

Learning Activities:

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

- Mini-group peer activities
- Hot Pack vs. Cold Pack laboratory activity
- Specific heat of a metal calorimeter lab
- Thermodynamics laboratory activities and demonstrations.

RESOURCES

Teacher Resources:

- NJCTL standards based presentations and activities
- Text: Buthelezi, T., Dingrando, L., Hainen, N., Wistrom, C., & Zike, D. (2022). *Inspire chemistry*. McGraw-Hill Education.

Equipment Needed:

- Laptop and projector for use with PowerPoint presentations.
- Calculators.
- Laboratory equipment and chemicals for demonstrations and labs.

UNIT OVERVIEW

Content Area: Honors Chemistry

Unit Title: Kinetics and Equilibrium

Target Course/Grade Level: Grades 10, 11, and 12

Unit Summary:

In order for a chemical reaction to occur molecules must collide with one another with enough kinetic energy and the correct orientation. Therefore, only a small number of collisions result in a chemical reaction. In this unit students will explore the factors involved in increasing the rate of a reaction. The concept of Le Chatelier's principle will be applied to chemical reactions in equilibrium in order to determine equilibrium positions and shifts when a system is placed under stress.

Approximate Length of Unit: 3 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

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 product at equilibrium.

Science & Engineering Practices:
Constructing Explanations and Designing Solutions
Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5)

Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)

Disciplinary Core Ideas:
PS1.B: Chemical Reactions
Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HSPS1-4),(HS-PS1-5)
In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)

ETS1.C: Optimizing the Design Solution

Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS1-6)

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. (HS-PS1-1), (HS-PS1-2), (HS-PS1-3), (HSPS1-5)

Stability and Change:

Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

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.STSM.3. Analyze the impact that science and mathematics has on society.
9.3.STSM.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 (e.g., 1.1.12prof.CR3a).
9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
9.4.12.CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources).
9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)
9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.
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 (e.g., 7.1.AL.IPERS.6).

Interdisciplinary Connections and Standards:

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

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RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
RST.11-12.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
RST.11-12.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
WHST.11-12.1. Write arguments focused on discipline-specific content.
WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.
WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Educational Technology

8.1.12.F.1 Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs

***Mathematics*:**

MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HSPS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1- 7),(HS-PS1-8)

Unit Understandings:

Students will understand that…

- A molecule must have enough kinetic energy and the correct orientation for an effective collision.
- In order to increase the rate of a reaction one must manipulate both environmental and chemical factors.

- When a system is placed under stress it will shift in such a way in order to relieve that stress.
- When the rate of the forward and reverse reaction are equal a system is equilibrium.

Unit Essential Questions:

- In order for a chemical reaction to occur, molecules must collide with one another. However, only a small number of collisions result in a chemical reaction. Why? What theory describes this?
- What factors affect the rate of a chemical reaction?
- Why do chemical reactions not go to completion?
- What is Le Chatelier's principle and how is it applied when a reactant or a product is added/removed from a chemical system?
- What does it mean for s system to be at equilibrium?

Knowledge and Skills:

Students will know...

Key definitions: activation energy, reaction mechanism, rate determining step, intermediates, catalyst, rate law, reaction rate, chemical kinetics, chemical equilibrium, equilibrium shifts, stress, forward reaction, reverse reaction, concentration, molecular collisions, collision theory, Le Chatelier's Principle.

Students will be able to...

- Explain chemical kinetics and use data for reaction rates and reaction mechanisms to describe chemical reactions.
- Apply the components of the collision theory in order to explain how chemical reactions occur.
- Explain equilibrium using Le Chatelier's principle and analyze data for conditions that effect equilibrium
- Apply Le Chatelier's principle in order to explain equilibrium position and shifts when a system is placed under stress.

EVIDENCE OF LEARNING

Assessment:

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

- **End of Unit Assessment**:
  - Department Approved Common Assessment Questions
  - Students will use data from reaction rates and reaction mechanisms to describe chemical reactions.
- Students will be given conceptual problems and chemistry math –based problems for independent practice, in class and homework.
- Students will carry out laboratory experiments

- Students will complete the “All Screwed Up” Kinetics nut and bolts process oriented guided inquiry based learning activity in order to apply and explain the collision theory.

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

- Mini-group peer activities
- “All Screwed Up” kinetics activity
- Kinetics and Equilibrium Laboratory

RESOURCES

Teacher Resources:

- NJCTL standards based presentations and activities
- Text: Buthelezi, T., Dingrando, L., Hainen, N., Wistrom, C., & Zike, D. (2022). *Inspire chemistry*. McGraw-Hill Education.

Equipment Needed:

- Laptop and projector for use with PowerPoint presentations.
- Calculators.
- Laboratory equipment and chemicals for demonstrations and labs.

UNIT OVERVIEW

Content Area: Honors Chemistry

Unit Title: Aqueous Solutions

Target Course/Grade Level: Grades 10, 11, and 12

Unit Summary:

In this unit students will be introduced to the solution making process and all applicable vocabulary. Once students understand different types of solutions as well as their concentration calculations they will be asked to create their own concreated stock solution of a specific molarity. The stock solution will then be diluted in order to make a solution of a new volume and molarity.

Approximate Length of Unit: 2 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

HS-PS1-6: Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of product at equilibrium.
HS-PS1-7: Use mathematical representation to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Science & Engineering Practices:
Constructing Explanations and Designing Solutions
Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)

Using Mathematics and Computational Thinking
Use mathematical representations of phenomena to support claims. (HS-PS1-7)

Disciplinary Core Ideas:
PS1.B: Chemical Reactions
In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)
The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)

ETS1.C: Optimizing the Design Solution
Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS1-6)

Cross Cutting Concepts:

Stability and Change:

Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

Energy and Matter:

The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)

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.STSM.3. Analyze the impact that science and mathematics has on society.
9.3.STSM.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 (e.g., 1.1.12prof.CR3a).
9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
9.4.12.CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources).
9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)
9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.
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 (e.g., 7.1.AL.IPERS.6).

Interdisciplinary Connections and Standards:

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

RST.11-12.2. Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
RST.11-12.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
RST.11-12.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
WHST.11-12.1. Write arguments focused on discipline-specific content.
WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.
WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Educational Technology
8.1.12.F.1 Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs

Mathematics:
MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HSPS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1- 7),(HS-PS1-8)

Unit Understandings:
Students will understand that…

- A homogeneous aqueous solution is composed of a solute dissolved in a solvent through the process of solvation.
- A solubility curve allows you to determine the point of saturation of a solution at a given temperature.
- Ionic compounds, acids, and bases dissociate in order to create a solution containing electrolytes in order to conduct an electrical current.
- Substances of different polarities will be immiscible with one another.

- The amount of solute dissolved in a solvent determines the solutions molar concentration
- As a solution becomes more dilute the concentration of the solution decreases

Unit Essential Questions:

- How many grams of the solute do you need to dissolve in order to prepare 400mL of a 5.0 M stock solution of $CuCl_2$?
- Explain the piece of equipment you need to use and the procedure for preparing the stock solution.
- What volume of stock solution will you need to create a 250 mL dilution of 2.0 M from the stock solution?
- Explain the procedure for preparing the dilution.
- Compare and contrast solutions containing electrolytes and non-electrolytes and the type of compounds they are composed of?

Knowledge and Skills:

Students will know...

Key definitions: Solute, solvent, solvation, solution, homogeneous, aqueous, electrolyte, nonelectrolyte, dissociation, miscible, immiscible, polar, non-polar, solvation, solubility, solubility curve, molarity, unsaturated, saturated, supersaturated, soluble, concentration, agitation, precipitate.

Students will be able to...

- Explain the solution making process using all applicable vocabulary.
- Classify a solution as saturated, unsaturated, or supersaturated based upon the amount of solute dissolved at a given temperature by observing a solubility curve.
- Differentiate between electrolyte and nonelectrolytes in solution.
- Calculate the molarity of a stock solution and dilution using molar calculations and equations.
- Explain how to create a stock solution and dilution using applicable vocabulary.

EVIDENCE OF LEARNING

Assessment:

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

- **End of Unit Assessment**:
  - Department Approved Common Assessment Questions
- Students will be given conceptual problems and chemistry math –based problems for independent practice, in class and homework.
- Students will carry out laboratory experiments

- Students will complete the solutions lab in order to create a stock solution and dilutions of specific volumes and molarity.
- Students will complete a hands-on Kool-Aid lab in order to learn all applicable vocabulary within the solution making process.

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

- Mini-group peer activities
- Electrolytes vs. Nonelectrolytes lightbulb demonstration
- "Kool-Aid" solution activity
- Stock solutions and dilutions lab

RESOURCES

Teacher Resources:

- NJCTL standards based presentations and activities
- Text: Buthelezi, T., Dingrando, L., Hainen, N., Wistrom, C., & Zike, D. (2022). *Inspire chemistry*. McGraw-Hill Education.

Equipment Needed:

- Laptop and projector for use with PowerPoint presentations.
- Calculators.
- Laboratory equipment and chemicals for demonstrations and labs.

UNIT OVERVIEW

Content Area: Honors Chemistry

Unit Title: Acids and Bases

Target Course/Grade Level: Grades 10, 11, and 12

Unit Summary:

Acids and Bases differ in terms of their properties, pH, molecular composition, indicators, taste, chemical reactions, and everyday applications. In this unit students will explore these properties and then apply them in demonstrations, labs and pH calculations in order to classify solutions as acidic, basic, or neutral.

Approximate Length of Unit: 3 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

HS-PS1-6: Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of product at equilibrium.
HS-PS1-7: Use mathematical representation to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Science & Engineering Practices:
Constructing Explanations and Designing Solutions
Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)

Using Mathematics and Computational Thinking
Use mathematical representations of phenomena to support claims. (HS-PS1-7)

Disciplinary Core Ideas:
PS1.B: Chemical Reactions
In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)
The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)

ETS1.C: Optimizing the Design Solution
Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS1-6)

Cross Cutting Concepts:

Stability and Change:

Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

Energy and Matter:

The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)

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.
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9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
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Educational Technology
8.1.12.F.1 Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs

Mathematics:
MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HSPS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1- 7),(HS-PS1-8)

Unit Understandings:
Students will understand that…

- Acids and bases have differing properties in terms of pH, molecular composition, indicators, taste, and chemical reactions
- The rules within the naming process is different for binary acids, ternary acids, and bases
- Strong acids and bases completely dissociate into ions, whereas weak acids and bases do not
- Water is amphoteric, can act as both an acid and a base, because a proton donor is an acid and proton acceptor is a base

- Depending upon the pH of a solution and the indicator of choice the solution will change a specific color
- The pH of a solution can be determined from the concentration of hydrogen ions present
- Neutralization reactions between acids and bases result in the formation of water and salt

Unit Essential Questions:

- How can we differentiate between acids and bases?
- How are solution properties important for acids and bases?
- How is equilibrium important for acids and bases?
- How do acids and bases act in chemical reactions?

Knowledge and Skills:

Students will know...

Key definitions: Acids, bases, hydroxide, hydronium, pH, universal indicator, phenolphthalein, pH meter, litmus paper, conjugate acid, conjugate base, proton, Arrhenius, Bronsted-Lowry, selfionization, neutralization, binary, ternary, amphoteric, monoprotic, diprotic, triprotic, dissociation, neutral

Students will be able to...

- Differentiate between acids and bases in terms of pH, molecular composition, indicators, taste, and chemical reactions
- Name binary acids, ternary acids, and bases by following the correct rules for naming
- Identify strong acids and bases by observing the electrical current they emit into a lightbulb
- Label the components of an acid base reaction by applying the acid-base theories
- Identify the pH of a solution based upon the indicator used
- Calculate the pH or [H+] of a solution using mathematical equations
- Apply and explain neutralization reactions in terms of antacids and stomach acids

EVIDENCE OF LEARNING

Assessment:

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

- **End of Unit Assessment**:
  - Department Approved Common Assessment Questions
- Students will be given conceptual problems and chemistry math –based problems for independent practice, in class and homework.
- Students will carry out laboratory experiments
- Students will complete the "Everyday Acids and Bases" lab and learn how to test the pH of a solution using multiple methods.

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

- Mini-group peer activities
- Strong vs. Weak Acid/Base light bulb demonstration
- Acids and Bases Lab

RESOURCES

Teacher Resources:

- NJCTL standards based presentations and activities
- Text: Buthelezi, T., Dingrando, L., Hainen, N., Wistrom, C., & Zike, D. (2022). *Inspire chemistry*. McGraw-Hill Education.

Equipment Needed:

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- Calculators.
- Laboratory equipment and chemicals for demonstrations and labs.

UNIT OVERVIEW

Content Area: Honors Chemistry

Unit Title: Electrochemistry

Target Course/Grade Level: Grades 10, 11, and 12

Unit Summary:

In this unit, the topic of study includes the basics of electrochemistry, specifically the types of reactions that occur which allow a voltaic cell (battery) to work.

Approximate Length of Unit: 4 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

HS-PS3-3: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Science & Engineering Practices:
Obtaining, Evaluating, and Communicating Information
Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS4-5)

Disciplinary Core Ideas:
PS3.D: Energy in Chemical Processes
Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4)
Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. (secondary to HS-PS4-5)

PS4.A: Wave Properties
Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2), (HSPS4-5)
PS4.B: Electromagnetic Radiation
Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5)
PS4.C: Information Technologies and Instrumentation
Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in

scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)

Cross Cutting Concepts:
Cause and Effect:
Systems can be designed to cause a desired effect. (HS-PS4-5)

Career Readiness, Life Literacies, and Key Skills:

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9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).
9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.
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Educational Technology
8.1.12.F.1 Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs

Mathematics:
MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)

Unit Understandings:
Students will understand that…

- Reduction and oxidation reactions affect the flow of energy.
- Voltaic cells (batteries) work by applying a redox reaction.

Unit Essential Questions:

- How are reductions and oxidation reactions linked?
- What causes a battery to work?

Knowledge and Skills:
Students will know...

Key definitions: Oxidation numbers, oxidation state, oxidation, reduction, anode, cathode, redox reaction, voltaic cell, battery, activity series, salt bridge, electrodes.

Students will be able to...

- Determine the oxidation numbers of elements based on the arrangement of their electrons.
- Compare and contrast oxidation and reduction reactions.
- Discover the order of reactivity of metals through the activity series.
- Discover how batteries operate using the knowledge of metal reactivity and redox reactions.
- Determine what an anode and cathode is in a voltaic cell.
- Analyze how a voltaic cell is able to create energy.
- Determine the type of energy produced in a voltaic cell.

EVIDENCE OF LEARNING

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

- **End of Unit Assessment**:
  - Department Approved Common Assessment Questions
  - Students will explain how voltaic cells create energy.
- Students will be given conceptual problems and chemistry math –based problems for independent practice, in class and homework.
- Students will carry out laboratory experiments
- Student self-assessment through POGIL and group activities.
- Laboratory and demonstration analysis.

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

- Oxidation and Reduction, The Activity Series and Voltaic Cells POGIL (Process-Oriented Guided Inquiry Learning) activities.
- Oxidation Numbers Race and Building a Voltaic Cell group peer activities.
- Building a Voltaic Cell lab.

RESOURCES

Teacher Resources:

- NJCTL standards based presentations and activities

- Text: Buthelezi, T., Dingrando, L., Hainen, N., Wistrom, C., & Zike, D. (2022). *Inspire chemistry*. McGraw-Hill Education.

Equipment Needed:

- Laptop and projector for use with PowerPoint presentations.
- Calculators.
- Laboratory equipment and chemicals for demonstrations and labs.

UNIT OVERVIEW

Content Area: Honors Chemistry

Unit Title: Nuclear Chemistry

Target Course/Grade Level: Grades 10, 11, and 12

Unit Summary:

Students will research a real life application of nuclear chemistry and develop models to illustrate the changes in the compositions of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

Approximate Length of Unit: 3 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

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

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. (HS-PS1-4), (HS-PS1-8)

Disciplinary Core Ideas:
PS1.C: Nuclear Processes
Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HSPS1-8)

Cross Cutting Concepts:
Energy and Matter:
In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8)

Career Readiness, Life Literacies, and Key Skills:

9.3.ST.2.Use technology to acquire, manipulate, analyze and report data.
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9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.
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 (e.g., 7.1.AL.IPERS.6).

Interdisciplinary Connections and Standards:

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

RST.11-12.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
RST.11-12.2. Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
RST.11-12.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
RST.11-12.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

WHST.11-12.1. Write arguments focused on discipline-specific content.
WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.
WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Educational Technology
8.1.12.F.1 Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs

Mathematics:
MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4 Model with mathematics. (HS-PS1-4),(HS-PS1-8)

Unit Understandings:
Students will understand that…

- Alpha, beta, or gamma radiation will be emitted in different nuclear chemical reactions.
- As the nuclear composition of an atom is altered it creates an isotope of that element.
- Although an isotope of an atom will have the same number of protons the atomic mass and number of neutrons will change.
- Certain real life applications of nuclear chemistry have safety concerns that may sway some parties to be for or against that technology.

Unit Essential Questions:

- How are nuclear changes different from chemical changes?
- Why are some elements and isotopes more radioactive than others?
- How are nuclear processes managed in their real world applications?
- How do radioactive isotopes impact living things and environments?

Knowledge and Skills:
Students will know...

Key definitions: nuclear composition, nucleus, protons, neutrons, electrons, atomic mass, isotope, nuclear radiation, alpha decay, beta decay, gamma radiation, nuclear fission, nuclear fusion, radioactive elements, nuclear stability, nuclear energy, radioactive decay.

Students will be able to...

- Research and gather information from multiple credible sources pertaining to a real life application of nuclear chemistry.
- Define and explain nuclear chemistry in terms of atomic nucleons.
- Differentiate between fission and fusion.
- Explain and identify the type of radiation emitted and classify it as alpha, beta, or gamma.

- Identify the isotope used in a nuclear reaction.

EVIDENCE OF LEARNING

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

- **End of Unit Assessment**:
  - Department Approved Common Assessment Questions
  - Students will explain nuclear chemistry in terms of an atom's nucleons.
- Students will be given conceptual problems and chemistry math –based problems for independent practice, in class and homework.
- Students will carry out laboratory investigations
- Students will complete a small group research presentation on a real life application of nuclear chemistry.

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

- Guided Investigation and Note Taking on Nuclear Chemistry
- Student lead nuclear chemistry research
- Research Presentation

RESOURCES

Teacher Resources:

- NJCTL standards based presentations and activities
- Text: Buthelezi, T., Dingrando, L., Hainen, N., Wistrom, C., & Zike, D. (2022). *Inspire chemistry*. McGraw-Hill Education.

Equipment Needed:

- Laptop and projector for use with PowerPoint presentations.
- Calculators.
- Laboratory equipment and chemicals for demonstrations and labs.