Pascack Valley Regional High School District

Pascack Hills High School, Montvale, New Jersey
Pascack Valley High School, Hillsdale, New Jersey

Course Name: Honors Chemistry

Born On: August, 2015
Revised On: August, 2020
Revised On: August, 2022
Current Revision: August 2023
Board Approval: 8/28/2023

New Jersey Curricular Mandates for Science Instruction

Disabled & LGBT:
18A:35-4.35 - History of disabled and LGBT persons included in middle and high school curriculum. A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards.

Diversity, Equity, and Inclusion (DEI):
C.18A:35-4.36a - Curriculum to include instruction on diversity and inclusion. 1. a. Beginning in the 2021-2022 school year, each school district shall incorporate instruction on diversity and inclusion in an appropriate place in the curriculum of students in grades kindergarten through 12 as part of the district's implementation of the New Jersey Student Learning Standards. b. The instruction shall: (1) highlight and promote diversity, including economic diversity, equity, inclusion, tolerance, and belonging in connection with gender and sexual orientation, race and ethnicity, disabilities, and religious tolerance; (2) examine the impact that unconscious bias and economic disparities have at both an individual level and on society as a whole; and (3) encourage safe, welcoming, and inclusive environments for all students regardless of race or ethnicity, sexual and gender identities, mental and physical disabilities, and religious beliefs. c. The Commissioner of Education shall provide school districts with sample learning activities and resources designed to promote diversity and inclusion.

Amistad Law:
N.J.S.A. 18A 52:16A-88 Every board of education shall incorporate the information regarding the contributions of African Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

Climate Change:
2020 NJSLS-Science: Earth's climate is now changing faster than at any point in the history of modern civilization, primarily as a result of human activities. Global climate change has already resulted in a wide range of impacts across New Jersey and in many sectors of its economy. The addition of academic standards that focus on climate change is important so that all students will have a basic understanding of the climate system, including the natural and human-caused factors that affect it. The underpinnings of climate change span across physical, life, as well as Earth and space sciences. The goal is for students to understand climate science as a way to inform decisions that improve quality of life for themselves, their community, and globally and to know how engineering solutions can allow us to mitigate impacts, adapt practices, and build resilient systems.

Dissection Law
N.J.S.A. 18A:35-4.25 and N.J.S.A. 18A:35-4.24 authorizes parents or guardians to assert the right of their children to refuse to dissect, vivisect, incubate, capture or otherwise harm or destroy animals or any parts thereof as part of a course of instruction.

Honors Chemistry

Unit 1: Electrons, Atomic Structure, and the Periodic Table

Time Allotted: Approximately 2-3 Weeks

New Jersey Student Learning Standards (NJSLS)

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

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

HS-ESS1-2: Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.

HS-ESS1-3: Communicate scientific ideas about the way stars, over their life cycle, produce elements.

Science & Engineering Practices

Developing and Using Models

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

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.

Obtaining, Evaluating, and Communicating Information

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

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Connections to Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community

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.
- 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.

PS1.B: Chemical Reactions

- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

ESS1.A: The Universe and Its Stars

- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
- The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.
- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.

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.

Energy and Matter

- Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems.
- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

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Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

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Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Scientific knowledge is based on the assumption that natural laws operate today

validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.	**PS4.B: Electromagnetic Radiation** • Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. *(secondary)*	as they did in the past and they will continue to do so in the future. • Science assumes the universe is a vast single system in which basic laws are consistent.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
• How can a model be used to represent matter at the atomic scale? • What are the merits and limitations of a model used to represent an atom? • What determines the "behavior" of electrons? • What can be predicted about similarities and differences in subatomic structure of elements? • How can the periodic table be used to help with making predictions about chemical and physical properties? • How can physical evidence be used to make predictions about elements and the subatomic structure?	- Evaluate merits and limitations of different models of the atom. - Construct explanations about elemental properties based on atomic properties such as atomic radius, ionization energy and electronegativity,. - Analyze atomic property data to organize elements in a model that allow for predictions of physical properties to be made. - Construct an explanation about atomic structure from data collected electromagnetic spectrum data from and known electron configurations. - Use a model of an atom based on evidence to illustrate how subatomic particles are involved with the exchange of energy. - Construct and revise and explanation about the atomic structure of unknown elements based on physical properties	- Use a computer model to evaluate the relationship between changes in subatomic structure and elemental identification. - Evaluate the merits and limitations of a computer model showing subatomic structure of an atom of a representative element. - Graph trends of atomic properties of elements. - Conduct a flame test on salt solution to identify metals. - Analyze hot gas spectra to identify elemental composition using emission spectra. - Organize periodic table of mystery elements - Use computer model to collect and analyze electromagnetic spectrum data to identify the components of a star *Scientist Spotlight*: • **Dr. Krystal Vasquez** – The struggles of inaccessibility for physically disabled scientists. - NPR Podcast w/ Dr. Vasquez - "Excluded from the Lab" by Dr. Vasquez • **John Dalton** – Colorblind scientist who worked in Atomic Theory.	• Assessment of lab skills (Experimental Design, Data Analysis, and/or Arguing a Scientific Claim) by submitting Lab Reports about associating atomic structure to physical properties of elements. • Debate/discussions about representations of atomic structure • Assessment of skills such as Problem Solving, Creating and Interpreting Graphs, and/or Creating Scientific Explanations by taking quizzes as well as the Unit Test • Assessment of written and verbal mastery of unit-specific vocabulary. • Assessment of modeling skills by drawing and labeling diagrams, making analogies, building a 3D structure, and/or making observational sketches. • Chemistry Benchmark #1

Resources/Materials	- Phet simulation ; Build an atom, Wave on a String and Isotopes and Atomic Mass - Explore Learning; Element builder, Periodic Trends& Electron Configurations - CK12 - PLIX - Bohr's Atomic Model - Classroom Lab: Spectral Analysis - Classroom Lab: Periodic Table Sequencing Activity - AACT ; Flame Test Classroom Demonstration/Lab - AACT: Periodic Trends Simulation - Glencoe: Mystery Element Virtual Lab		
ELA Companion Standards	**RST.11-12.1** - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. **RST.9-10.7** - Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. **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. **WHST.11-12.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. **WHST.11-12.9** - Draw evidence from informational texts to support analysis, reflection, and research. **WHST.9-12.2** - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.		
Interdisciplinary Connections	***ELA/Literacy*** **SL.9-10.1**. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.9-10.2**. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source. **SL.9-10.5**. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. ***Mathematics*** **HSN-Q.A.1** - Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. **HSN-Q.A.2** - Define appropriate quantities for the purpose of descriptive modeling. **HSN-Q.A.3** - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **MP.4** - Model with mathematics.		
Career Readiness, Life Literacies, and Key Skills	**9.4.12.CI.1**: Demonstrate the ability to reflect, analyze, and use creative skills and ideas **9.4.12.CT.1**: Identify problem-solving strategies used in the development of an innovative product or practice.		

	9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving. **9.4.12.IML.3**: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2**: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.2.12.ED.4**: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience. **8.2.12.ED.5**: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics). **8.2.12.ETW.4**: Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● Display labeled images of designs and parts. ● Use body movement and gestures to further explain concepts to students. ● Restate design steps aloud before project activity. ● Assign a native language partner.	● Provide adequate scaffolds for concept development and note-taking. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Use color to identify and differentiate important aspects of concepts and problem-solving. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm or cues to help	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide peer mentoring to improve techniques. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Share understanding through peer tutoring ● Evaluate concepts through scientific literature. ● Provide AP Chem options for problem-solving.

	with time management • Work with a partner		

Honors Chemistry
Unit 2: Nuclear Chemistry
Time Allotted: Approximately 2-3 Weeks
New Jersey Student Learning Standards (NJSLS)
HS-PS1-7: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. **HS-PS1-8**: Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. **HS-PS4-4**: Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. **HS-ESS1-1**: Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation. **HS-ESS1-3:** Communicate scientific ideas about the way stars, over their life cycle, produce elements

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Using Mathematics and Computational Thinking • Use mathematical representations of phenomena to support claims. **Developing and Using Models** • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. **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.	**PS1.B: Chemical Reactions** • The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. **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. **ESS1.A: The Universe and Its Stars** • The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. • The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar	**Energy and Matter** • The total amount of energy and matter in closed systems is conserved. • Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems. • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. **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. -

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

Connections to Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.

gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.

- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.

PS4.B: Electromagnetic Radiation

- When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.
- Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. *(secondary)*

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.
- Science assumes the universe is a vast single system in which basic laws are consistent.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
• How do nuclear reactions affect life on earth? • Where does matter come from? • How did the elements form? • How can half-life be used to make predictions? • How can materials be used to protect from types of radiation? • What role should nuclear energy play to meet future energy demands? • When and how are inferences and experimental observations used in science?	- Apply scientific ideas, principles, and/or evidence to provide an explanation of nuclear decay - Use mathematical representations of half-life to describe and/or support claims and/or explanations. - Use mathematical representations of nuclear energy to effectively communicate the potential of this form of energy, while using historical and scientific data to effectively describe the negative aspects.	- Explore models and perform mathematical representation using half-life. - Manipulate different models to explore atomic changes that occur as a result of nuclear change.. - Discuss models that represent the differences between fission and fusion. - Debate the pros and cons of nuclear energy. - Carry out an investigation to explore the potential for various materials to be used to shield alpha, beta or gamma radiation. - Students will observe visible spectra of known elements and	• Assessment of lab skills (Experimental Design, Data Analysis, and/or Arguing a Scientific Claim) by submitting Lab Reports • Develop models based on evidence 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. • Student designs, conducts and communicates findings to answer a question about the effectiveness of a specific material to shield from

	- Develop a model based on evidence and scientific understanding to illustrate the atomic changes in a nuclear reaction. - 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. - Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation. - Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. - Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. - Communicate scientific ideas about the way stars, over their life cycles, produce elements. - Communicate scientific ideas related to observations and inferences to evaluate two theories about the origin of the universe.	identify an unknown element or combination of elements by visible spectra. - Distinguish between data collected from empirical observations and inference, which may or may not arise from data to compare and contrast the Steady State and Big Bang theories for the origin of our universe. *Scientist Spotlights:* • **Lloyd Albert Quarterman** – African American Chemist who worked on the Manhattan Project • **Lise Meinter** – Jewish, female scientist who discovered nuclear fission. • **Katherine Way** – American, female scientist who worked on the Manhattan Project & established the Nuclear Data Project. *Diversity, Equity, and Inclusion*: • Inequalities in the Nuclear Age: Impact of Race and Gender on Radiation Exposure at the Savannah River Site (1951-1999)	alpha, Beta or gamma radiation. • Communicate scientific ideas in both orally and graphically to describe the way stars, over their life cycles, produce elements. • Communicate scientific ideas orally using manipulatives related to observations and inferences to evaluate two theories about the origin of the universe. • Assessment of skills such as Problem Solving, Creating and Interpreting Graphs, and/or Creating Scientific Explanations by taking quizzes as well as the Unit Test • Assessment of written and verbal mastery of unit-specific vocabulary. • Assessment of modeling skills by drawing and labeling diagrams, making analogies, building a 3D structure, and/or making observational sketches.
Resources/Materials	- Vernier lab: Radiation shielding lab - Explore Learning: Half-life, Nuclear Decay & Star Spectra - CK12 Plix: Types of Radioactive Decay - Classroom Lab: Penny Half-life Lab - NASA: Supernova Chemistry & Evidence is Clear! (Origin of Everything - 1955)		

	- DOE: NUCLEAR 101: How Does a Nuclear Reactor Work? - NJDEP: WHAT IS THE RELATIONSHIP BETWEEN RADIOACTIVITY AND RADON? - Science News for Students (Current events & articles related to radiation exposure)
ELA Companion Standards	**RST.9-10.7** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research.
Interdisciplinary Connections	***ELA/Literacy*** **SL.9-10.1**. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.9-10.2**. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source. **SL.9-10.3**. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any false reasoning or distorted evidence. **SL.9-10.4**. Present information, findings, and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. **SL.9-10.5**. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. ***Mathematics*** **MP.2** Reason abstractly and quantitatively. **MP.4** Model with mathematics. **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
Career Readiness, Life Literacies, and Key Skills	**9.4.12.CI.1**: Demonstrate the ability to reflect, analyze, and use creative skills and ideas **9.4.12.CT.1**: Identify problem-solving strategies used in the development of an innovative product or practice. **9.4.12.CT.2**: Explain the potential benefits of collaborating to enhance critical thinking and problem solving. **9.4.12.IML.3**: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions

	9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data. **9.1.12.CFR.2**: Summarize causes important to you and compare organizations you seek to support to other organizations with similar missions. **9.1.12.CFR.3**: Research companies with corporate governance policies supporting the common good and human rights. **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.DA.5**: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. **8.2.12.ED.4**: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience. **8.2.12.ED.5**: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics). **8.2.12.ETW.4**: Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● Display labeled images of designs and parts. ● Use body movement and gestures to further explain concepts to students. ● Restate design steps aloud before project activity. ● Assign a native language partner.	● Provide adequate scaffolds for concept development and note-taking. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Use color to identify and differentiate important aspects of concepts and problem-solving. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide peer mentoring to improve techniques. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Share understanding through peer tutoring ● Evaluate concepts through scientific literature. ● Provide AP Chem options for problem-solving.

	few distractions • Sit where they learn best (for example, near the teacher) • Use an alarm or cues to help with time management • Work with a partner		

Honors Chemistry
Unit 3: Matter, Measurement & the Mole
Time Allotted: Approximately 2-3 Weeks
New Jersey Student Learning Standards (NJSLS)
HS-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
HS-PS1-7 Use mathematical representation to support the claim that atoms and therefore mass are conserved during a chemical reaction.
HS-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperatures are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ESS2-3 Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
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. • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**PS1.A: Structure and Properties of Matter** • Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. • The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. **PS1.B: Chemical Reactions** • The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. **PS1.B: Chemical Reactions** • The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.	**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. **Energy and Matter** • The total amount of energy and matter in closed systems is conserved. • Energy drives the cycling of matter within and between systems.

Using Mathematics and Computational Thinking

- Use mathematical representations of phenomena to support claims.

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.

Developing and Using Models

- Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
- Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based on empirical evidence.
- Science disciplines share common rules of evidence used to evaluate explanations about natural systems.
- Science includes the process of coordinating patterns of evidence with current theory.

PS3.B: Conservation of Energy and Energy Transfer

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

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.

ETS1.C: Optimizing the Design Solution

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

ESS2.A: Earth Materials and Systems

- Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior.

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection.

PS4.A: Wave Properties

- Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (*Secondary to HS-ESS2-3*)

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.

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes the universe is a vast single system in which basic laws are consistent.

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
• How should data collected about matter be quantified? • How can a particulate model assist in explaining scientific	- Plan and conduct an investigation to demonstrate the kinetic molecular theory. - Construct, use, and/or present an	- POGIL Activity, "What's in a Name?" - Classroom Visualizations of Kinetic Molecular Theory Activity - Evaluate multiple sources of	• Develop a table, using the three levels of representations of chemistry to relate the Kinetic Molecular Theory to what

phenomena? ● In what ways can units be used in problems-solving questions about scientific phenomena? ● How can the periodic table be used to help with making predictions about chemical and physical properties? ● What can we learn and/or predict about Earth systems from the composition of matter? ● How can we use technology to help quantify, and/or measure, atoms and subatomic particles?	oral and written argument or counter-arguments based on data and evidence that evaluates choices of measurement equipment used when conducting an experiment. - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence: 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. - Plan 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. - Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to explain the role of thermal convection in the movement of Earth's materials. - Create and/or revise a computational model or simulation to demonstrate how particle counting is accomplished by weighing. - Use math representations employing the mole concept to demonstrate the relationship between various units and quantities of atomic particles. - Construct an explanation that communicates how the outermost electrons states of atoms can be	information to develop reasoning for how thermal convection causes Earth's materials to move. - Experimentally prove a mole ratio exists for a given compound - Organize an "Alien" periodic table of mystery elements - Demonstration of various quantities of a mole. - Develop a computer model to evaluate relationships between mass and counting particles. - Send-a-problem (Cooperative Learning Strategy) for Mole Concept Problem-solving. - Experimentally determine empirical formulas for an ionic compound, a covalent compound and for a hydrate. *Scientist Spotlight*: ● Arthur Holmes: Harnessing the Mechanics of Mantle Convection to the Theory of Continental Drift	happens to water molecules during heating. ● Organize information about Earth's interior from multiple sources using a "jot chart". ● Develop a model of Earth's interior layers based on research of multiple sources. ● Employ math representations using the mole concept to successfully make predictions about matter on the atomic scale ● Employ math representations on collected data to quantify the atomic particles used in a chemical reaction. ● Demonstrate a model (math or computational) that allows for counting of individual unseen articles simply by weighing a larger portion. ● Predict common formulas of ionic compounds using the periodic table model. ● Collect and report data with correct accuracy from classroom scientific equipment for length, mass, volume, and density. ● Discuss measurements, units in terms of experimental design when developing a scientific argument. ● Assessment of skills such as Problem Solving, Creating and Interpreting Graphs, and/or Creating Scientific Explanations by taking quizzes as well as the Unit

	used to predict formulas of ionic compounds. - Use mathematical models to understand how the empirical and molecular formulas of compounds have been experimentally determined		Test ● Assessment of written and verbal mastery of unit-specific vocabulary. ● Assessment of modeling skills by drawing and labeling diagrams, making analogies, building a 3D structure, and/or making observational sketches.
Resources/Materials	- Explore Learning: Moles, Measuring Volume, Temperature and Particle Motion - POGIL: Particle Connections - What's in a Name? - Classroom activity: Element Scavenger Hunt - Classroom Lab: Counting by Weighing - Classroom Lab: Mole Ratio of Magnesium Oxide - Classroom Investigation: Visualizations of Kinetic Molecular Theory Activity - Flinn: Gro-Dino Measurement Lab (Example) & Mole Lab - Coding Project: Using a Computer Model to Count by Weighing - Modeling Earth's Layers: How Can Thermal Convection Cause Earth's Materials to Move? - Inferred Properties of Earth's Interior - Earth's Interior Jot Chart		
ELA Companion Standards	**RST.11-12.1** - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. **RST.9-10.7** - Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. **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. **WHST.11-12.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. **WHST.11-12.9** - Draw evidence from informational texts to support analysis, reflection, and research. **WHST.9-12.2** - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.		
Interdisciplinary Connections	***ELA/Literacy*** **SL.9-10.1**. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.		

	SL.9-10.4. Present information, findings, and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. **SL.9-10.5**. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. ***Mathematics*** **HSN-Q.A.1** - Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. **HSN-Q.A.2** - Define appropriate quantities for the purpose of descriptive modeling. **HSN-Q.A.3** - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **MP.4** - Model with mathematics.
Career Readiness, Life Literacies, and Key Skills	**9.4.12.CI.1**: Demonstrate the ability to reflect, analyze, and use creative skills and ideas **9.4.12.CT.1**: Identify problem-solving strategies used in the development of an innovative product or practice. **9.4.12.CT.2**: Explain the potential benefits of collaborating to enhance critical thinking and problem solving. **9.4.12.IML.3**: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2:** Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data. **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.DA.5**: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. **8.2.12.ED.1**: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. **8.2.12.ED.2**: Create scaled engineering drawings for a new product or system and make modifications to increase optimization based on feedback. **8.2.12.ED.3**: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis. **8.2.12.ED.4**: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience. **8.2.12.ED.5**: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).

	8.2.12.ED.6: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor). **8.2.12.ETW.4**: Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● Display labeled images of designs and parts. ● Use body movement and gestures to further explain concepts to students. ● Restate design steps aloud before project activity. ● Assign a native language partner.	● Provide adequate scaffolds for concept development and note-taking. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Use color to identify and differentiate important aspects of concepts and problem-solving. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm or cues to help with time management ● Work with a partner	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide peer mentoring to improve techniques. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Share understanding through peer tutoring ● Evaluate concepts through scientific literature. ● Provide AP Chem options for problem-solving.

Honors Chemistry

Unit 4: Compounds, Bonding and Molecular Structure

Time Allotted: Approximately 3-4 Weeks

New Jersey Student Learning Standards (NJSLS)

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

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

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

HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics as well as possible social, cultural, and environmental impacts.

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.

Obtaining, Evaluating, and Communicating Information

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

Asking Questions and Defining Problems

- Analyze complex real-world problems by specifying criteria and constraints for successful solutions.

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.

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)*

ESS2.C: The Roles of Water in Earth's Surface Processes

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

ETS1.A: Defining and Delimiting Engineering Problems

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.
- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering.

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.

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.
- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Connections to Engineering, Technology, and Applications of Science

Constructing Explanations and Designing Solutions • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	These global challenges also may have manifestations in local communities. **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. **ETS1.C: Optimizing the Design Solution** • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.	**Influence of Science, Engineering, and Technology on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- What can we learn and/or predict from the composition of matter? - How do we predict the properties of substances? - How can a model be used to represent matter at the atomic scale? - How can an atomic-scale model be used to make predictions about the physical and chemical properties of matter? - How can the understanding of properties drive the design of materials? - How is matter held together? - What different types of bonding exist, and how are they different? - How do ionic and covalent bonds form? Why do they work?	- Evaluate natural resource extraction through mining - Apply techniques of percent composition to make predictions about natural resource availability and cost. - Use and relate computer models, physical models and Lewis Dot structures to provide information about molecular geometry and/or predict polarity - Plan and conduct an investigation to evaluate how the molecular shape of a molecule impacts its chemical and/or physical properties - Apply scientific reasoning, theory, and/or models to link evidence to the claims that certain gaseous molecules act as greenhouse gases.	- Name compounds and access SDS to develop hazard awareness - Manipulate the Breaking Chemical Bond simulation to evaluate changes in intramolecular bond energy. - Natural resources; natural resources; evaluating ore lab - Manipulate models (computer or physical) to evaluate molecular shapes and predict polarity. - Design of molecular mimic, including identification of its molecular geometry features that contribute to its function. - Use/develop various models to both predict shapes of various covalent molecules and strength of polarity - Carry out various tasks to investigate the properties of water. - Plan and carry out investigation on how to alter the properties of water to best perform a task - Complete Heating it Up Tutorial;	• Assessment of lab skills (Experimental Design, Data Analysis, and/or Arguing a Scientific Claim) by submitting Lab Reports • Performance task assessment to predict molecular geometry and polarity of a simple molecule. • Employ math representations on collected data to quantify the components of a mixture. • Debate/discussions about representations of molecular structure and function. • Carry out experiments to evaluate how physical changes such as temperature or concentration affect the properties of water. • Assessment of skills such as Problem Solving, Creating and Interpreting Graphs, and/or Creating Scientific Explanations by

		Use Molecular Interactions model to investigate the global warming potential of various gases. - Construct a database of molecules to interrelate the concepts of molecular geometry, hybridization, bonding and polarity. *Scientist Spotlight*: • **Dorothy Crowfoot Hodgkin:** x-ray crystallography and molecular structure. • **Bettye Washing Greene**: An industrial Chemist and Inventor who Lit a Path for Innovation.	taking quizzes as well as the Unit Test • Assessment of written and verbal mastery of unit-specific vocabulary. • Assessment of modeling skills by drawing and labeling diagrams, making analogies, building a 3D structure, and/or making observational sketches. • Chemistry Benchmark #2
Resources/Materials	- Beyond Benign: Chemical Hazard Awareness - Phet: Molecular Shapes, Molecular Shapes Basics & Molecule Polarity - Classroom Lab: Empirical Formula of a Hydrate - Classroom Lab: Molecular Geometry - Classroom Activity: Water Olympics - Concord Consortium; Breaking a Chemical Bond - Teach Engineering: Molecular Molecules and 3D Printing (CAD) - Classroom Lab: Natural Resources; Evaluating Ore Samples (Wards' Classroom Mineral Collection) - Oreo Percent Composition Performance Task - Heating it Up; The Chemistry of the Greenhouse Effect ; Molecular Interactions with Electromagnetic Radiation learning tool.		
	RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research.		

Interdisciplinary Connections	***ELA/Literacy*** **SL.9-10.1**. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.9-10.5**. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. ***Mathematics*** **MP.2** Reason abstractly and quantitatively. **MP.4** Model with mathematics. **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
Career Readiness, Life Literacies, and Key Skills	**9.4.12.CI.1**: Demonstrate the ability to reflect, analyze, and use creative skills and ideas **9.4.12.CT.1**: Identify problem-solving strategies used in the development of an innovative product or practice. **9.4.12.CT.2**: Explain the potential benefits of collaborating to enhance critical thinking and problem solving. **9.4.12.IML.3**: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2**: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data. **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.DA.5**: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. **8.2.12.ED.5**: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics). **8.2.12.ED.6**: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor). **8.2.12.ETW.4**: Research historical tensions between environmental and economic considerations as driven by human

	needs and wants in the development of a technological product and present the competing viewpoints

Modifications			
Multi-Lingual Learners	**Special Education**	**At-Risk**	**Gifted and Talented**
● Display labeled images of designs and parts. ● Use body movement and gestures to further explain concepts to students. ● Restate design steps aloud before project activity. ● Assign a native language partner.	● Provide adequate scaffolds for concept development and note-taking. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Use color to identify and differentiate important aspects of concepts and problem-solving. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm or cues to help with time management ● Work with a partner	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide peer mentoring to improve techniques. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Share understanding through peer tutoring ● Evaluate concepts through scientific literature. ● Provide AP Chem options for problem-solving.

Honors Chemistry

Unit 5:Chemical Reactions

Time Allotted: Approximately 4-5 Weeks

New Jersey Student Learning Standards (NJSLS)

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

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

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

Science & Engineering Practices

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.

Using Mathematics and Computational Thinking

- Use mathematical representations of phenomena to support claims.

Engaging in Argument from Evidence

- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

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

PS1.B: Chemical Reactions

- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

ESS3.A: Natural Resources

- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary)*

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.

Energy and Matter

- The total amount of energy and matter in closed systems is conserved.

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Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes the universe is a vast single system in which basic laws are consistent.
- Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions.
- Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.
- Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.

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Connections to Engineering, Technology, and Applications of Science

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

- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.
- Analysis of costs and benefits is a critical aspect of decisions about technology.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- What is a chemical reaction? What does this tell you about energy and matter? How is a chemical change different from a physical change? - What signs suggest a chemical reaction has happened? - Why do chemists write chemical and word equations? - Why is there a change in temperature when a chemical reaction occurs? - How can we create new substances? - What is the format for representing a chemical reaction with a chemical equation? - How are chemical equations balanced to satisfy the law of conservation of matter? - What are 5 major types of chemical reactions and their identifying characteristics? - How do you predict the products of common chemical reactions? - How are the quantities of the chemicals in a reaction interrelated?	- Construct and/or revise an explanation using evidence that differentiates chemical and physical changes in matter. - Use math representations to explain/validate the Law of Conservation of Matter during chemical reactions. - Develop and/or use particulate models, such as balanced chemical equations to demonstrate how mass is conserved during a chemical reaction. - 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) to predict whether a chemical reaction between two substances is likely or not, as if so predict the products of the reaction. - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence to evaluate recycling solutions over extraction of metals from ore. - Use math representations, based on balanced equations to make quantitative predictions about chemical reactions.	- Carry out various tasks to investigate properties of substances and to determine types of evidence that can be used to indicate a chemical change has occurred. - Use/develop various models such as the Balancing Equation simulation to discover/demonstrate how chemical equations represent that mass is conserved during a chemical reaction. - Develop an activity series for metals from evidence collected from an experiment. - Plan and conduct an investigation individually and collaboratively to produce data that evaluates the potential for solutions of two ionic compounds to react and form a precipitate. - Plan and carry out an investigation to employ a chemical reaction to isolate a metal resource from a natural ore. - Plan and carry out an investigation to determine the concepts of the activity series for a given set of metals and for a set of nonmetals. *Scientist Spotlight*: • **Dr. Carolyn Bertozzi** - She is the inventor of "bioorthogonal chemistry", a class of chemical reactions compatible with living systems that enable molecular imaging and drug targeting	• Assessment of lab skills (Experimental Design, Data Analysis, and/or Arguing a Scientific Claim) by submitting Lab Reports • Debate/discussions about representations of atomic structure • Assessment of skills such as Problem Solving, Creating and Interpreting Graphs, and/or Creating Scientific Explanations by taking quizzes as well as the Unit Test • Assessment of written and verbal mastery of unit-specific vocabulary. • Assessment of modeling skills by drawing and labeling diagrams, making analogies, building a 3D structure, and/or making observational sketches.

Resources/Materials	- Classroom Lab: Evidence for Chemical Change - Classroom Lab: Types of Reactions Lab - Classroom Lab: Mole Ratio - Concord Consortium: Baggie Chemistry - Phet: Balancing Equations Simulation & Reactant,Products & Leftovers - Beyond Benign (Green Chemistry): Reactions Lab - CK12: Balancing Chemical Equations - Classroom Lab: Developing an Activity Series - Teach Engineering: If You're Not Part of the Solution, You're Part of the Precipitate! - Flinn Kit: Copper Mining Lab - Recycling of Materials (Video) - Teach Engineering: Create Silver Nanoparticles - POGIL: Limiting Reactants - Flinn: Stoichiometry of Self-inflating Balloon
ELA Companion Standards	**RST.9-10.7** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research.
Interdisciplinary Connections	***ELA/Literacy*** **SL.9-10.1**. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.9-10.2**. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source. **SL.9-10.4**. Present information, findings, and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. **SL.9-10.5**. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest.

	Mathematics **MP.2** Reason abstractly and quantitatively. **MP.4** Model with mathematics. **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
Career Readiness, Life Literacies, and Key Skills	**9.4.12.CI.1**: Demonstrate the ability to reflect, analyze, and use creative skills and ideas **9.4.12.CT.1**: Identify problem-solving strategies used in the development of an innovative product or practice. **9.4.12.IML.3**: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.1.12.CFR.3**: Research companies with corporate governance policies supporting the common good and human rights. **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.DA.5**: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● Display labeled images of designs and parts. ● Use body movement and gestures to further explain concepts to students. ● Restate design steps aloud before project activity. ● Assign a native language partner.	● Provide adequate scaffolds for concept development and note-taking. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Use color to identify and differentiate important aspects of concepts and problem-solving. ● Provide an outline of lessons ● Get a written list of instructions	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide peer mentoring to improve techniques. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Share understanding through peer tutoring ● Evaluate concepts through scientific literature. ● Provide AP Chem options for problem-solving.

	• Work or take a test in a different setting, such as a quiet room with few distractions • Sit where they learn best (for example, near the teacher) • Use an alarm or cues to help with time management • Work with a partner		

Honors Chemistry

Unit 6: Intermolecular Forces, States of Matter & Phase Changes

Time Allotted: Approximately 4-5 Weeks

New Jersey Student Learning Standards (NJSLS)

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

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

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

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics as well as possible social, cultural, and environmental impacts.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Planning and Carrying Out Investigations • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. **Obtaining, Evaluating, and Communicating Information** • Communicate scientific and technical information (e.g. about the process of	**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. **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. • Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) • Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.	**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. **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.

development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Constructing Explanations and Designing Solutions

- Construct 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.
- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

PS3.A: Definitions of Energy

- "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. *(secondary)*

ESS3.A: Natural Resources

- Resource availability has guided the development of human society.

ESS3.B: Natural Hazards

- Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.

ESS2.C: The Roles of Water in Earth's Surface Processes

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.

ETS1.C: Optimizing the Design Solution

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

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Connections to Engineering, Technology, and Applications of Science

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

- Modern civilization depends on major technological systems.
- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- How does molecular shape impact the strength of intermolecular forces? - How can the understanding of properties drive the design of materials? - How does the behavior of atoms and molecules determine the physical properties of solids, liquids, and gases?	- Construct and/or revise an explanation using evidence that relates the strengths of intermolecular forces to the melting/points of different substances . - Develop and/or use particulate models to demonstrate how intermolecular forces are changed during a phase change. - Construct and revise an	- Carry out several experiments to compare the melting points of different solids and the boiling points of different liquids to compare the relative strengths of the intermolecular forces and relate them to the types of molecules to identify the types of intermolecular forces present. - Utilize online simulations to analyze a phase change and understand why	● Assessment of lab skills (Experimental Design, Data Analysis, and/or Arguing a Scientific Claim) by submitting Lab Reports ● Debate/discussions about representations of atomic structure ● Assessment of skills such as Problem Solving, Creating and

- What defines the state of matter for a given substance? - What is a phase change, on a macroscopic and a microscopic level? - Why is water a unique chemical substance?	explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) to how the size of molecules/atoms affect the strength of intermolecular forces and thus melting/boiling points. - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence to evaluate phase changes to intermolecular forces. -	it is a physical change and not a chemical change. - Conduct research in teams to identify why water is so unique and relate this to the hydrogen bonding. - Plan and carry out an experimental investigation into the types of solids and how they can be identified. - Plan and carry out an experimental investigation to identify unknown materials on the merits of the intermolecular forces and/or the types of solids. - Interpret phase diagrams to relate the relative strengths of the chemicals based on the shapes of the graphs and the key points. *Scientist Spotlight*: • **John Cornforth** – an Australian-British chemist whose life and career were shaped by a hearing disorder that left him profoundly deaf by the age of 20.	Interpreting Graphs, and/or Creating Scientific Explanations by taking quizzes as well as the Unit Test • Assessment of written and verbal mastery of unit-specific vocabulary. • Assessment of modeling skills by drawing and labeling diagrams, making analogies, building a 3D structure, and/or making observational sketches.
Resources/Materials	- Phet: Atomic Interactions - POGIL: Intermolecular Forces - Vernier Lab: Evaporation and Intermolecular Forces - Davidson College: Phase Change Virtual Experiment - Classroom Lab: Vapor Pressure and Intermolecular Forces - Classroom Lab: Qualitative Analysis and Intermolecular Forces - Explore Learning: Sticky Molecules Simulation - Concord Consortium: Boiling Point of Nonpolar and Polar Substance - Data Nuggets: Sticky situations: Big and small animals with sticky feet - MyNASA Data: Earth System: Matter and Energy Cycles		
ELA Companion Standards	**RST.9-10.7** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.		

	WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research.
Interdisciplinary Connections	***ELA/Literacy*** **SL.9-10.1**. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.9-10.5**. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. ***Mathematics*** **MP.2** Reason abstractly and quantitatively. **MP.4** Model with mathematics. **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
Career Readiness, Life Literacies, and Key Skills	**9.4.12.CI.1**: Demonstrate the ability to reflect, analyze, and use creative skills and ideas **9.4.12.CT.1**: Identify problem-solving strategies used in the development of an innovative product or practice. **9.4.12.CT.2**: Explain the potential benefits of collaborating to enhance critical thinking and problem solving. **9.4.12.IML.3**: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively.

	● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.DA.5**: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. **8.2.12.ED.4**: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience. **8.2.12.ED.5**: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics). **8.2.12.ED.6**: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● Display labeled images of designs and parts. ● Use body movement and gestures to further explain concepts to students. ● Restate design steps aloud before project activity. ● Assign a native language partner.	● Provide adequate scaffolds for concept development and note-taking. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Use color to identify and differentiate important aspects of concepts and problem-solving. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm or cues to help with time management ● Work with a partner	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide peer mentoring to improve techniques. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Share understanding through peer tutoring ● Evaluate concepts through scientific literature. ● Provide AP Chem options for problem-solving.

Honors Chemistry

Unit 7: Gas Laws and Atmosphere

Time Allotted: Approximately 2-3 Weeks

New Jersey Student Learning Standards (NJSLS)

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

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

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics as well as possible social, cultural, and environmental impacts.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
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. • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. **Using Mathematics and Computational Thinking** • Use mathematical representations of phenomena to support claims.	**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. • 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. **ETS1.A: Defining and Delimiting Engineering Problems** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. • Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.	**Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable. **Energy and Matter** • The total amount of energy and matter in closed systems is conserved. **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. - *Connections to Nature of Science*

• Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. **Asking Questions and Defining Problems** • Analyze complex real-world problems by specifying criteria and constraints for successful solutions.	**ETS1.C: Optimizing the Design Solution** • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. **ESS2.D: Weather and Climate** • Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. *(secondary)* **ESS3.D: Global Climate Change** • Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.	**Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes the universe is a vast single system in which basic laws are consistent. - *Connections to Engineering, Technology, and Applications of Science* **Influence of Science, Engineering, and Technology on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- How are gases different from solids and liquids and why do they exhibit "ideal behavior?" - What factors influence the behavior of gases and what are the mathematical relationships between them? - How do changes in volume, pressure, temperature, number of moles, and mass affect the behavior of gases? - How is weather related to the energy transfer between different states of matter on Earth? - Has the composition of our atmosphere remained consistent over time?	- Relate pressure, volume and temperature of a gas graphically and mathematically. - Discuss the contribution of Boyle, Charles and Gay-Lussac in the derivation of the combined gas law. - Evaluate Kinetic molecular theory by comparing real and ideal gases. - Conduct a series of demonstrations to which the students must associate the different gas laws - Relate pressure, temperature, volume and moles of gas to the ideal gas law. Combine the ideal gas law with stoichiometry. - Review the different chemical reactions involved in the production of carbon dioxide in our atmosphere	- Utilize online simulations to develop an understanding of the four basic gas laws. - Plan and carry out an experiment to determine the temperature of absolute zero in Kelvin. - Use data analysis to develop an understanding of what air is and how this can help us to understand Dalton's Law of Partial Pressures. - Utilize online simulations to investigate greenhouse gases and their impact on our environment. - Plan and carry out an experimental investigation to prove that gases have mass. - Plan and carry out an experimental investigation to compare gases behaving more/less ideally based on the conditions.	• Assessment of lab skills (Experimental Design, Data Analysis, and/or Arguing a Scientific Claim) by submitting Lab Reports • Debate/discussions about representations of atomic structure • Assessment of skills such as Problem Solving, Creating and Interpreting Graphs, and/or Creating Scientific Explanations by taking quizzes as well as the Unit Test • Assessment of written and verbal mastery of unit-specific vocabulary.

- How do the molar masses of molecules relate to their ability to diffuse or to their overall motion?	- Use models to explain how energy flow affects climate changes. - Make predictions on climate change based on published data and global climate models. - Make predictions how different gases would escape from similar containers based on Graham's Law	*Scientist Spotlight*: • **Eunice Foot** – amateur scientists from the mid-1800s whose experiments foreshadowed the discovery of Earth's Greenhouse effect.	• Assessment of modeling skills by drawing and labeling diagrams, making analogies, building a 3D structure, and/or making observational sketches.
Resources/Materials	- Teach Engineering: Understanding Air Through Data Analysis - Vernier Lab: Behavior of Gas - Phet Simulations: Introduction to Gases ,Gas Properties, Greenhouse Effect - Classroom Lab: Absolute Zero Lab - Explore Learning: Boyles' Law & Charles' Law & Ideal Gas Law - Flinn: Micromole Rocket - Classroom Lab: Determining Mass of CO_2 from a Chemical Reaction - Data Nuggets: The Ground has Gas! - Greenhouse Gases; A Closer Look (IR Windows Learning Tool) - Concord Consortium: Greenhouse gases		
ELA Companion Standards	**WHST.9-12.1** Write arguments focused on discipline-specific content. **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.		
Interdisciplinary Connections	***ELA/Literacy*** **SL.9-10.1**. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.9-10.2**. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source. **SL.9-10.3**. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any false reasoning or distorted evidence. **SL.9-10.4**. Present information, findings, and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. **SL.9-10.5**. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. ***Mathematics*** **MP.2** Reason abstractly and quantitatively. **MP.4** Model with mathematics. **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.		

	HSA-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. **HSA-CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. **HSF-BF.A.1** Write a function that describes a relationship between two quantities. **HSF-IF.B.5** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. **HSS-ID.A.1** Represent data with plots on the real number line. **HSS-ID.B.6** Represent data on two quantitative variables on a scatter plot, and describe how those variables are related.
Career Readiness, Life Literacies, and Key Skills	**9.4.12.CI.1**: Demonstrate the ability to reflect, analyze, and use creative skills and ideas **9.4.12.CT.1**: Identify problem-solving strategies used in the development of an innovative product or practice. **9.4.12.CT.2**: Explain the potential benefits of collaborating to enhance critical thinking and problem solving. **9.4.12.IML.3**: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2**: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data. **9.1.12.CFR.2**: Summarize causes important to you and compare organizations you seek to support to other organizations with similar missions. **9.1.12.CFR.3**: Research companies with corporate governance policies supporting the common good and human rights. **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.2.12.ED.1**: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. **8.2.12.ED.3**: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis. **8.2.12.ED.4**: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience. **8.2.12.ED.5**: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).

	8.2.12.ED.6: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor). **8.2.12.ETW.4**: Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● Display labeled images of designs and parts. ● Use body movement and gestures to further explain concepts to students. ● Restate design steps aloud before project activity. ● Assign a native language partner.	● Provide adequate scaffolds for concept development and note-taking. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Use color to identify and differentiate important aspects of concepts and problem-solving. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm or cues to help with time management ● Work with a partner	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide peer mentoring to improve techniques. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Share understanding through peer tutoring ● Evaluate concepts through scientific literature. ● Provide AP Chem options for problem-solving.

Honors Chemistry

Unit 8: Solution Chemistry

Time Allotted: Approximately 4 Weeks

New Jersey Student Learning Standards (NJSLS)

HS-PS1-2 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

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

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

Science & Engineering Practices

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.

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.

Analyzing and Interpreting Data

- Analyze data using computational models in order to make valid and reliable scientific claims.

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Science investigations use diverse methods and do not always use the same set of procedures to obtain data.
- New technologies advance scientific knowledge.

Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based on empirical evidence.
- Science arguments are strengthened by multiple lines of evidence supporting a single explanation.

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

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

PS1.B: Chemical Reactions

- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

ESS2.C: The Roles of Water in Earth's Surface Processes

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

ESS3.D: Global Climate Change

- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.

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.

Structure and Function

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Stability and Change

- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- What is the solvation process? - What are the electrolytes and how do they help the human body? - What are some ways that we can quantify the concentration/strength of a solution? - How do we differentiate, qualitatively and quantitatively, an unsaturated solution, a saturated solution, and a supersaturated solution? - Why do different solutes have different solubilities in a given solvent and how does temperature affect this? - What steps of the water cycle are natural purification techniques? - What happens to a substance when it dissolves? - Why are some substances soluble in water and others aren't?	- Relate the concepts of intermolecular forces to solvation and solubility. - Construct and/or interpret solubility graphs - Quantify the strength of a solution via molarity, molality, mole fraction, and mass percent. - Differentiate among saturated, unsaturated, and supersaturated solutions. - Express a given reaction as a complete molecular equation as well as a net ionic equation. - Rank a set of potential solutes in terms of their electrolytic strengths - Predict the change in boiling point or freezing point for a given solution.	- Plan and carry out an experimental investigation to create a solubility curve for a given substance. - Plan and carry out an experimental investigation to differentiate between saturated, supersaturated and unsaturated solutions.. - Plan and carry out an experimental investigation to identify a set of unknown solutions by mixing them and looking for precipitates. - Plan and carry out an experimental investigation to prepare a solution to be mixed with another person's solution in order to make and collect a designated mass of precipitate. - Analyze monthly satellite data of the North Atlantic in order to make valid and reliable scientific claims about how the water cycle affects ocean salinity and how climate change has impacted the cycle and the effected ecosystems. - Plan and carry out an experimental investigation to determine the molar mass of a nonelectrolyte from freezing point depression. - Conduct research into the quantitative aspects of solution concentration and the different types.	● Assessment of lab skills (Experimental Design, Data Analysis, and/or Arguing a Scientific Claim) by submitting Lab Reports ● Debate/discussions about representations of atomic structure ● Assessment of skills such as Problem Solving, Creating and Interpreting Graphs, and/or Creating Scientific Explanations by taking quizzes as well as the Unit Test ● Assessment of written and verbal mastery of unit-specific vocabulary. ● Assessment of modeling skills by drawing and labeling diagrams, making analogies, building a 3D structure, and/or making observational sketches.
Resources/Materials	- Classroom lab; Solubility of a Salt - Classroom lab; Are We Saturated Yet? - Classroom Lab: Solution Identification via Precipitation - Classroom lab: Molar Mass by Freezing Point Depression - Vernier lab; Conductivity of Ionic Solutions - AACT; Preparing Solutions Simulation		

	- Phet: Concentration, Molarity & Beer's Law Lab (*G/T & HONORS*) - MyNASA Data: Inferring Relationships Among Sea Surface Salinity & Other Variables in the North Atlantic - Teach Engineering; Kidney Stone Crystallization
ELA Companion Standards	**WHST.9-12.1** Write arguments focused on discipline-specific content. **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
Interdisciplinary Connections	***ELA/Literacy*** **SL.9-10.1**. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.9-10.4**. Present information, findings, and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. **SL.9-10.5**. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. ***Mathematics*** **MP.2** Reason abstractly and quantitatively. **MP.4** Model with mathematics. **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **HSA-CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. **HSA-CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. **HSF-BF.A.1** Write a function that describes a relationship between two quantities. **HSF-IF.B.5** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. **HSS-ID.A.1** Represent data with plots on the real number line. **HSS-ID.B.6** Represent data on two quantitative variables on a scatter plot, and describe how those variables are related.
Career Readiness, Life Literacies, and Key Skills	**9.4.12.CI.1**: Demonstrate the ability to reflect, analyze, and use creative skills and ideas **9.4.12.CT.1**: Identify problem-solving strategies used in the development of an innovative product or practice. **9.4.12.CT.2**: Explain the potential benefits of collaborating to enhance critical thinking and problem solving. **9.4.12.IML.3**: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2**: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data. **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest.

	Career Readiness, Life Literacies, and Key Skills Practices ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.DA.5**: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. **8.2.12.ED.1**: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. **8.2.12.ED.6:** Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● Display labeled images of designs and parts. ● Use body movement and gestures to further explain concepts to students. ● Restate design steps aloud before project activity. ● Assign a native language partner.	● Provide adequate scaffolds for concept development and note-taking. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Use color to identify and differentiate important aspects of concepts and problem-solving. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm or cues to help with time management ● Work with a partner	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide peer mentoring to improve techniques. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Share understanding through peer tutoring ● Evaluate concepts through scientific literature. ● Provide AP Chem options for problem-solving.

Honors Chemistry
Unit 9: Thermochemistry and Climate Change
Time Allotted: Approximately 3 Weeks
New Jersey Student Learning Standards (NJSLS)
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-PS3-1** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known **HS-PS3-2** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). **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-PS3-4** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperatures are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). **HS-ESS2-2** Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems. **HS-ESS2-4** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. **HS-ESS3-5** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Developing and Using Models • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. • Use a model to provide mechanistic accounts of phenomena. **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system. **Constructing Explanations and Designing Solutions** • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-	**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 . **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. **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. • 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	**Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. **Systems and System Models** • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and

generated sources of evidence, prioritized criteria, and tradeoff considerations.

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.

Analyzing and Interpreting Data

- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
- Analyze data using computational models in order to make valid and reliable scientific claims.

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science arguments are strengthened by multiple lines of evidence supporting a single explanation.
- Science knowledge is based on empirical evidence.

Scientific Investigations Use a Variety of Methods

- Science investigations use diverse methods and do not always use the same set of procedures to obtain data.
- New technologies advance scientific knowledge.

is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.

- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

PS3.B: Conservation of Energy and Energy Transfer

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

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.

ESS1.B: Earth and the Solar System

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. *(secondary)*

ESS2.A: Earth Materials and Systems

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers,

approximations inherent in 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.

Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system.
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes the universe is a vast single system in which basic laws are consistent.

Connections to Engineering, Technology, and Applications of Science

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

- Modern civilization depends on major technological systems.

	vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. **ESS2.D: Weather and Climate** • The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. **ESS3.D: Global Climate Change** • Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. **ETS1.A: Defining and Delimiting an Engineering Problem** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. *(secondary)*	Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- What is a thermodynamic process? - How can a thermodynamic process be used to analyze the energy within a system? - Why does the amount of heat needed to raise the temperature of a substance by 1C˚ vary for every substance? - How does conservation play a role in chemical reactions? - Why are some processes spontaneous at room temperature? What factors affect spontaneity? - Why are some processes spontaneous at some temperatures but not all?	- Construct a macroscopic model that represents how energy is transferred and explain how their perception of hot and cold is related to heat and temperature. - Evaluate energy diagrams for different reactions and compare how energy is absorbed and released during the reaction process; connect the energy diagrams with each reaction type. - Create virtual and mathematical models to relate the concepts of specific heat to temperature change and to quantity of heat. - Analyze laboratory data to demonstrate the concepts of Hess's Laws.	- Plan and carry out an experimental investigation to determine the specific heat of an unknown metal as a potential means of identifying the metal. - Observe a demonstration of a heating curve as heat is slowly but constantly added to ice. - Plan and carry out an experimental investigation to measure the heats of 3 reactions to prove/disprove Hess's Law. - Plan and carry out an experimental investigation to prove how the spontaneity of a process depends on temperature. - Use a climate model and/or simulation to evaluate how changes	• Assessment of lab skills (Experimental Design, Data Analysis, and/or Arguing a Scientific Claim) by submitting Lab Reports • Debate/discussions about representations of atomic structure • Assessment of skills such as Problem Solving, Creating and Interpreting Graphs, and/or Creating Scientific Explanations by taking quizzes as well as the Unit Test • Assessment of written and verbal mastery of unit-specific

	- Analyze sets of reactions to infer the impact of the change of enthalpy and the change in entropy on the spontaneity of those reactions at room temperature. - Create a model to demonstrate the effect of temperature to positively or negatively affect the spontaneity of a reaction. - Communicate scientific information or ideas in multiple formats (including orally, graphically, textually, and mathematically) to explain how energy is transferred to account for Earth's energy budget. - Apply scientific reasoning, theory, and/or climate models to link evidence to determine how reasoning and data support the explanation of climate feedback.	in Earth's energy budget will impact further changes that will result in climate feedback. *Scientist Spotlight:* • **Winifred Burks-Houck**: An environmental organic chemist and the first woman president of the National Organization for the Professional Advancement of Black Chemists and chemical Engineers.	vocabulary. • Assessment of modeling skills by drawing and labeling diagrams, making analogies, building a 3D structure, and/or making observational sketches.
Resources/Materials	- Phet: Energy Forms and Changes , Molecules and Light - AACT : Energy Changes and Chemical Reactions Simulation - Vernier Lab: Determining the Enthalpy of a Chemical Reaction - Teach Engineering: The Reaction Exposed;The Big Chill & Heat Transfer: From Hot to Not - Flinn Lab/project: Designing a Hand Warmer - Classroom Lab: - Concord Consortium: Exploring Climate Change - Data Nuggets: The Arctic is Melting – So What? - MyNASA Data: Surface and Air Temperatures Throughout the Day - MyNASA Data: Positive Feedback - Arctic Albedo - Science News for Students (Current events & articles related to climate change research)		
ELA Companion Standards	**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.9-12.1** Write arguments focused on discipline-specific content. **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.		

	WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research.
Interdisciplinary Connections	***ELA/Literacy*** **SL.9-10.1**. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.9-10.2**. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source. **SL.9-10.3**. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any false reasoning or distorted evidence. **SL.9-10.4**. Present information, findings, and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. **SL.9-10.5**. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. ***Mathematics*** **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. **HSA-SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. **HSA-CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. **HSF-BF.A.1** Write a function that describes a relationship between two quantities. **MP.2** Reason abstractly and quantitatively. **MP.4** Model with mathematics. **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
Career Readiness, Life Literacies, and Key Skills	**9.4.12.CT.2**: Explain the potential benefits of collaborating to enhance critical thinking and problem solving. **9.4.12.IML.3**: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2**: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data. **9.1.12.CFR.2**: Summarize causes important to you and compare organizations you seek to support to other organizations with similar missions. **9.1.12.CFR.3**: Research companies with corporate governance policies supporting the common good and human rights. **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors.

	Career Readiness, Life Literacies, and Key Skills Practices ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.DA.5**: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. **8.2.12.ETW.4**: Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints

Modifications			
Multi-Lingual Learners	**Special Education**	**At-Risk**	**Gifted and Talented**
● Display labeled images of designs and parts. ● Use body movement and gestures to further explain concepts to students. ● Restate design steps aloud before project activity. ● Assign a native language partner.	● Provide adequate scaffolds for concept development and note-taking. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Use color to identify and differentiate important aspects of concepts and problem-solving. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher) ● Use an alarm or cues to help with time management ● Work with a partner	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide peer mentoring to improve techniques. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Share understanding through peer tutoring ● Evaluate concepts through scientific literature. ● Provide AP Chem options for problem-solving.

Honors Chemistry

Unit 10: Kinetics and Equilibrium

Time Allotted: Approximately 3-4 Weeks

New Jersey Student Learning Standards (NJSLS)

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

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

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

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
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. **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. **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system.	**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. **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. **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. **PS3.B: Conservation of Energy and Energy Transfer** • Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. • Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. • The availability of energy limits what can occur in any system. **ETS1.C: Optimizing the Design Solution** • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. *(secondary)*	**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. **Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable. **Systems and System Models** • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. - *Connections to Nature of Science* **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes the universe is a vast single system in which basic laws are consistent.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- What causes chemical reactions to occur at different rates? - How can the rate of a reaction be increased or decreased? - Why aren't all reactions occurring in one step? - How does the presence of a catalyst affect the rate of a reaction? - Why do systems establish equilibrium? - When does equilibrium occur in a chemical reaction? - How does the idea of an equilibrium constant help to understand the relative amounts of reactants and products? - What happens on a molecular level as given stresses are applied to a reaction which is already at equilibrium?	- 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. - Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. - Connect the rate law for an elementary reaction to the frequency and success of molecular collisions, including connecting the frequency and success to the order and rate constant, respectively. - Use representations of the energy profile for an elementary reaction (from the reactants, through the transition state, to the products) to make qualitative predictions regarding the relative temperature dependence of the reaction rate. - Translate among reaction energy profile representations, particulate representations, and symbolic representations (chemical equations) of a chemical reaction occurring in the presence and absence of a catalyst. - Given a set of experimental observations regarding physical, chemical, biological, or environmental processes that are	- Design and/or interpret the results of an experiment regarding the factors (i.e., temperature, concentration, surface area) that may influence the rate of a reaction. - Explain the difference between collisions that convert reactants to products and those that do not in terms of energy distributions and molecular orientation. - Plan and carry out an experiment to investigate how given stresses will shift a given reaction which is at equilibrium - Plan and carry out an experiment to maximize the yield of a reversible process. - Demonstration of " Traffic Light" reaction to relate the concepts of reversibility and LeChatelier's Principle	● Assessment of lab skills (Experimental Design, Data Analysis, and/or Arguing a Scientific Claim) by submitting Lab Reports ● Debate/discussions about representations of atomic structure ● Assessment of skills such as Problem Solving, Creating and Interpreting Graphs, and/or Creating Scientific Explanations by taking quizzes as well as the Unit Test ● Assessment of written and verbal mastery of unit-specific vocabulary. ● Assessment of modeling skills by drawing and labeling diagrams, making analogies, building a 3D structure, and/or making observational sketches. ● Chemistry Benchmark #3

	reversible, construct an explanation that connects the observations to the reversibility of the underlying chemical reactions or processes. - Connect kinetics to equilibrium by using reasoning about equilibrium, such as Le Chatelier's principle, to infer the relative rates of the forward and reverse reactions.		
Resources/Materials	- AACT: Predicting Shifts in Equilibrium - Classroom Lab: Le Chatelier's Principle Using Iron Complex - Flinn: Iodine Clock Challenge - POGIL: Equilibrium and LeChatelier's Principle - Vernier: Ksp of Calcium Hydroxide		
ELA Companion Standards	**WHST.9-12.1** Write arguments focused on discipline-specific content. **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.		
Interdisciplinary Connections	***ELA/Literacy*** **SL.9-10.1**. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.9-10.2**. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source. **SL.9-10.4**. Present information, findings, and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. **SL.9-10.5**. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. ***Mathematics*** **MP.2** Reason abstractly and quantitatively. **MP.4** Model with mathematics. **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. **HSA-SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. **HSA-CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.		
Career Readiness, Life Literacies, and	**9.4.12.CI.1**: Demonstrate the ability to reflect, analyze, and use creative skills and ideas		

Key Skills	**9.4.12.CT.1**: Identify problem-solving strategies used in the development of an innovative product or practice. **9.4.12.CT.2:** Explain the potential benefits of collaborating to enhance critical thinking and problem solving. **9.4.12.IML.3**: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2**: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data. **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.
Computer Science and Design Thinking	**8.1.12.DA.5**: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. **8.2.12.ED.5**: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics). **8.2.12.ETW.4**: Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
● Display labeled images of designs and parts. ● Use body movement and gestures to further explain concepts to students. ● Restate design steps aloud before project activity. ● Assign a native language partner.	● Provide adequate scaffolds for concept development and note-taking. ● Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. ● Use color to identify and differentiate important aspects of concepts and problem-solving. ● Provide an outline of lessons ● Get a written list of instructions ● Work or take a test in a different setting, such as a quiet room with few distractions ● Sit where they learn best (for example, near the teacher)	● Incorporate student choice ● Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. ● Provide peer mentoring to improve techniques. ● Provide alternative assessments to demonstrate proficiency	● Lead the class in the deciphering of new learning. ● Share understanding through peer tutoring ● Evaluate concepts through scientific literature. ● Provide AP Chem options for problem-solving.

	• Use an alarm or cues to help with time management • Work with a partner		

Honors Chemistry
Unit 11: Acids and Bases
Time Allotted: Approximately 3-4 Weeks
New Jersey Student Learning Standards (NJSLS)
HS-PS1-6 Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium **HS-PS1-5** 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-PS3-1** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. **HS-ESS3-5** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. **HS-ETS1-4** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
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. • Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system. • Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. **Analyzing and Interpreting Data** • Analyze data using computational models in order to make valid and reliable scientific claims. -	**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. • 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. **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. **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.	**Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable. • Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. **Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. **Systems and System Models** • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Science investigations use diverse methods and do not always use the same set of procedures to obtain data.
- New technologies advance scientific knowledge.

Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based on empirical evidence.
- Science arguments are strengthened by multiple lines of evidence supporting a single explanation.

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

ESS3.D: Global Climate Change

- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.

ETS1.B: Developing Possible Solutions

- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.

ETS1.C: Optimizing the Design Solution

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

assumptions and approximations inherent in 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.

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes the universe is a vast single system in which basic laws are consistent.

Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- Why are there multiple functional definitions of acids and bases? What are the pros and cons of each definition? - How are acid and bases affected by equilibrium shift? - What is the importance of pH values? - What is the significance of pH values to equilibrium? - What defines the strength of an acid or a base? - How is acid rain formed and what	- Construct a visual model to relate the strength of an acid to its conjugate base, or a base to its conjugate acid. - Differentiate between acid (or base) strength and pH. - List a given set of acids (or bases) in order of increasing strength from their equilibrium constants - Predict the pH of any given acid or base, from its equilibrium constant. - Predict the pH of an acid/base reaction at any given point in a	- Conduct a webquest to understand what acids and bases are, under the multiple systems for defining acids/bases. - Investigate the properties of acids and bases by analyzing several household products. - Conduct a webquest to investigate the pH system and the mathematics behind it as well as the implications of both pH and pOH. - Prepare acidic and basic solutions for use in a sample titration.	● Assessment of lab skills (Experimental Design, Data Analysis, and/or Arguing a Scientific Claim) by submitting Lab Reports ● Debate/discussions about representations of atomic structure ● Assessment of skills such as Problem Solving, Creating and Interpreting Graphs, and/or

are the consequences of acid rain? - What is the general shape of a titration curve and what does that indicate about the ion concentrations at any given point?	titration of a strong acid and a strong base. - Develop a plan to prevent the development of acid rain or to treat the ecological impacts of acid rain.	- Plan and conduct an experiment to create a titration curve in order to identify the concentration of an unknown strong acid. - Plan and conduct an experiment to investigate the pH ranges for a set of indicators. - Plan and conduct a research project into making acid rain and measuring its effects on a simple ecosystem. - Critically read "The Quest for a Clean Drink" from ACS to evaluate questions about how natural systems respond to changes in pH.	Creating Scientific Explanations by taking quizzes as well as the Unit Test • Assessment of written and verbal mastery of unit-specific vocabulary. • Assessment of modeling skills by drawing and labeling diagrams, making analogies, building a 3D structure, and/or making observational sketches.
Resources/Materials	- POGIL: Introduction to Acids & Bases - Teach Engineering: Basically Acidic Ink - Phet: pH Scale Basics, pH Scale & Acid Base Solution Simulation - Flinn: Microscale Acid/Base Titration		
ELA Companion Standards	**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.9-12.1** Write arguments focused on discipline-specific content. **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research.		
Interdisciplinary Connections	***ELA/Literacy*** **SL.9-10.1**. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **SL.9-10.2**. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source. **SL.9-10.3**. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any false reasoning or distorted evidence.		

	SL.9-10.4. Present information, findings, and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. **SL.9-10.5**. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. ***Mathematics*** **MP.2** Reason abstractly and quantitatively. **MP.4** Model with mathematics. **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. **HSA-SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. **HSA-CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. **HSA-CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. **HSS-ID.A.1** Represent data with plots on the real number line.
Career Readiness, Life Literacies, and Key Skills	**9.4.12.CI.1**: Demonstrate the ability to reflect, analyze, and use creative skills and ideas **9.4.12.CT.1**: Identify problem-solving strategies used in the development of an innovative product or practice. **9.4.12.CT.2**: Explain the potential benefits of collaborating to enhance critical thinking and problem solving. **9.4.12.IML.3**: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions **9.4.12.TL.2**: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data. **9.2.12.CAP.7**: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. **9.2.12.CAP.8**: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. **Career Readiness, Life Literacies, and Key Skills Practices** ● Act as a responsible and contributing community member and employee ● Consider the environmental, social, and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Model integrity, ethical leadership, and effective management. ● Use technology to enhance productivity, increase collaboration, and communicate effectively. ● Work productively in teams while using cultural/global competence.

Computer Science and Design Thinking	**8.1.12.DA.5**: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. **8.2.12.ED.1**: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. **8.2.12.ED.2**: Create scaled engineering drawings for a new product or system and make modifications to increase optimization based on feedback.8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis. **8.2.12.ED.4**: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience. **8.2.12.ETW.4**: Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints

Modifications

Multi-Lingual Learners	Special Education	At-Risk	Gifted and Talented
• Display labeled images of designs and parts. • Use body movement and gestures to further explain concepts to students. • Restate design steps aloud before project activity. • Assign a native language partner.	• Provide adequate scaffolds for concept development and note-taking. • Provide alternative choices (i.e. verbal or visual) to demonstrate proficiency. • Use color to identify and differentiate important aspects of concepts and problem-solving. • Provide an outline of lessons • Get a written list of instructions • Work or take a test in a different setting, such as a quiet room with few distractions • Sit where they learn best (for example, near the teacher) • Use an alarm or cues to help with time management • Work with a partner	• Incorporate student choice • Invite parents, neighbors, friends, the school principal and other community members to support classroom activities. • Provide peer mentoring to improve techniques. • Provide alternative assessments to demonstrate proficiency	• Lead the class in the deciphering of new learning. • Share understanding through peer tutoring • Evaluate concepts through scientific literature. • Provide AP Chem options for problem-solving.

Additional Resources to promote DEI:

- Structure Matters: Twenty-One Teaching Strategies to Promote Student Engagement and Cultivate Classroom Equity
- Race Matters
- Inclusive Teaching