West Windsor-Plainsboro Regional School District
Course Title: Honors Chemistry
Grade: 10-12

The Mission of the West Windsor-Plainsboro Science Department

Our mission is to cultivate science learners who have the foundational knowledge to make ethical, scientifically literate decisions and the ability to apply scientific practices in order to contribute to the needs of society and a changing world.

- **Vision**

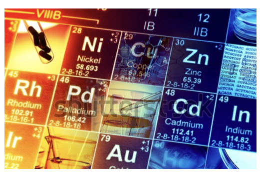
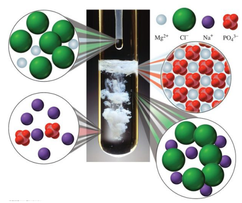
  We envision a K-12 science experience that supports and challenges every student in their science learning journey. We will:
  - *Capitalize on diversity by reaching and exciting students at all levels and interests by differentiating learning within classrooms and by offering a robust program of studies.*
  - *Emphasize authentic science and engineering practices and leverage the interdisciplinary nature of science with arts, technology, math, reading, and writing.*
  - *Integrate scientific knowledge and 21st century competencies to prepare students to make informed decisions and take action to address real world problems.*
  - *Cultivate an inclusive and diverse community where all learners are welcomed, valued, respected, and celebrated.*

Honors Chemistry Storyboard

Through the lens of Honors Chemistry, students will explore our dynamic world and gain a deeper understanding of the fundamental principles that govern our universe; journeying from the unseen submicroscopic realm to the observable macroscopic scale to understand the environmental, technological, and societal implications of chemistry and its' applications.

Essential Questions:

- How can chemistry help you understand the world and address real world problems?
- How can macroscopic observations and models be used to explain microscopic phenomena and vice versa?
- How does energy and stability play a role in chemical processes?
- What are the environmental, technological, and societal implications of chemical processes and their applications?

Lab Safety, Procedures, Measurement and Matter *Unit 1* 	**Chemical Foundations** *Units 2* 	**Chemical Bonding & Reactions** *Units 3 and 4* 	**The Mole, Stoichiometry, Solutions and Gas Laws** *Units 5 and 6* 	**Electronic Structure and Energy** *Units 7 and 8* 
How can Chemistry help you understand the world?	*How does the structure of matter relate to its function?*	*How can we predict and understand the behavior of elements and compounds to cause chemical change?*	*How can we quantify changes in chemical systems and optimize them?*	*How does energy impact the structure of matter?*
The Focus of the Story	**The Focus of the Story**	**The Focus of the Story**	**The Focus of the Story**	**The Focus of the Story**
This unit is designed to introduce students to essential and fundamental concepts in chemistry while emphasizing safety	In this group of units, students explore the fundamental building blocks of matter, the intricate world of nuclear interactions, and how scientists	In this group of units, students deepen their understanding of the substructure of atoms and how they interact and bond to form compounds, enabling	In this group of units, students utilize mathematical thinking as it applies to chemical behavior and reactions, allowing them to quantitatively	In this group of units, students explore how an atom and energy are related. The concepts of energy and stability related to the atom are

practices and techniques in the laboratory. Students will develop critical skills in measurement, data analysis, and graphing, while gaining a deeper understanding of the properties and behavior of matter.	came to understand the world at the sub-microscopic level to explain macroscopic phenomena.	them to better comprehend the properties and behaviors of different substances and mechanisms for chemical reactions. Students will explore the role of energy in transforming reactants into products, thereby gaining insights into the driving forces behind chemical change. Focus is given to the importance of chemical reactions in everyday life and their impact on various aspects of society and the environment.	and qualitatively predict the behavior of chemical systems, outcomes of reactions, and how to optimize yields and limit waste. Students explore the impact of various factors on the stability of chemical systems and reactions and deepen their understanding of the changes that occur within these systems.	explored, as well as the real world applications of chemical concepts learned throughout the year.
Learning Targets	**Learning Targets**	**Learning Targets**	**Learning Targets**	**Learning Targets**
● I can employ laboratory techniques to gather data and analyze the properties of substances accurately. ● I can construct models to represent various systems and the relationships between them. ● I can formulate descriptive questions about observable phenomena and design an investigation to	● I can understand the structure of matter and the impact on its behavior and interactions. ● I can analyze, interpret, and communicate my findings by developing explanations and supporting them with evidence and reasoning from investigations.	● I can apply knowledge of matter's structure and properties and patterns in the periodic table to predict and explain chemical bonding, reactions, and their outcomes. ● I can construct models based on evidence from observations and data to communicate the causal relationship between the submicroscopic and macroscopic scales of matter, energy, and stability.	● I can design and conduct experiments to investigate and explain the factors that influence chemical systems using scientific evidence, computational thinking, and models. ● I can use mathematical and computational skills to communicate the relationship between different types of matter.	● I can explain the relationship between energy and stability as it relates to the structure of matter and its interactions. ● I can design and conduct experiments to explain the relationship between energy and color ● I can apply knowledge of matter and energy to explain real-world phenomena and to

construct explanations to those questions.				design solutions to real-world problems.

Unit 1: Lab Safety, Procedures, Measurement and Matter	
Content Area: Science	
Course & Grade Level: Honors Chemistry, 10-12	
Summary and Rationale	
This unit introduces students to basic chemical laboratory techniques, safety standards, and data analysis methods. The proper handling, storage and disposal of chemicals during a lab is emphasized. Students are expected to communicate scientific and technical information using scientific tools with proper significant figures and units. The crosscutting concepts of *structure and function*, *patterns*, *energy and matter* are called out as the framework for understanding the disciplinary core ideas. Students use *developing and using models*, *planning and conducting investigations*, *using mathematical thinking*, and *constructing explanations and designing solutions*. Students are also expected to use the science and engineering practices to demonstrate proficiency with the core ideas.	
Recommended Pacing	
15 days	
New Jersey Student Learning Standards for Science	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
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.** [Clarification Statement: Emphasis is placed on safety in the laboratory as well as the environmental impact of our actions.]
HS-PS1-7	**Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.** [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.]
HS-ETS1-2	**Designing a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.** [Clarification Statement: Solving many mathematical problems involves a series of sequential steps.]
New Jersey Student Learning Standards for English Language Arts Companion Standards	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
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.
NJSLSA.W7	Draw evidence from literary or informational texts to support analysis, reflection, and research.
W.9-10.7	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.
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
9.4.12.CT	Identify problem-solving strategies used in the development of an innovative product or practice.
9.4.12.TL.1	Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.3	Analyze the effectiveness of the process and quality of collaborative environments.
New Jersey Student Learning Standards for Computer Science and Design Thinking	
CPI #	**Cumulative Progress Indicator (CPI)**
8.1.2.DA.1	Collect and present data, including climate change data, in various visual formats.
8.1.2.DA.3	Identify and describe patterns in data visualizations.
8.1.2.DA.4	Make predictions based on data using charts or graphs.
8.1.5.DA.1	Collect, organize, and display data in order to highlight relationships or support a claim.
8.1.5.DA.4	Organize and present climate change data visually to highlight relationships or support a claim.
8.1.5.DA.5	Propose cause and effect relationships, predict outcomes, or communicate ideas using data.
Interdisciplinary Standards (Mathematics and Social Studies)	
N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
A-SSE.A.1	Interpret expressions that represent a quantity in terms of context
A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A-REI.A.1	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
A-REI.D.10	Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
Standard 6.1 U.S. History: America in the World	All students will acquire the knowledge and skills to think analytically about how past and present interactions of people, cultures, and the environment shape the American heritage. Such knowledge and skills enable students to make informed decisions that reflect fundamental rights and core democratic values as productive citizens in local, national, and global communities.
Standard 6.2 World History: Global Studies	All students will acquire the knowledge and skills to think analytically and systematically about how past interactions of people, cultures, and the environment affect issues across time and cultures. Such knowledge and skills enable students to make informed decisions as socially and ethically responsible world citizens in the 21st century.

Instructional Focus

Unit Enduring Understandings

- Clear, accurate, organized and concise communication is essential for scientists.
- Safety in the chemistry laboratory requires using your common sense at all times!
- Different systems of measurement are used for different purposes.
- Correct selection of measurement instruments and measurement language will ensure accurate results**.**
- Most things are made up of parts and the whole is greater than the sum of its parts. All matter is made up of atoms - positive nuclei surrounded by negative particles.
- Everything in the universe is either energy or matter.

Unit Essential Questions

- Are all laboratory activities approached in the same manner?
- Why do we need to practice safe habits in the chemistry laboratory?

- Is it necessary to use a common set of measurement units? Why or why not?
- Is there a “best way” to solve all scientific problems?
- Do all problems have solutions?
- To what extent is data reliable?
- If scientific notation did not exist, would scientists need to invent it?

Objectives

We are learning to/that:

- Demonstrate safe behavior in the laboratory.
- Properly use common laboratory equipment (Bunsen burner may be covered later).
- Demonstrate proficient setup and data collection/analysis in lab handout.
- Demonstrate proper graphical analysis techniques; including preparing and reading graphs, identifying the dependent and independent variables, interpolating and extrapolating data.
- Appropriately use measurement tools in the laboratory.
- Record measurements to the correct number of significant figures, with the correct uncertainty value, and with the correct label.
- Use the rules for significant figures in calculations to correctly round off numbers and perform addition, subtraction, multiplication and division.
- Use the uncertainty in recorded measurements.
- Use mathematics and computational thinking to calculate percent error in a determined value.
- Analyze and interpret data to explain why the milliliter and cubic centimeter have the same volume.
- Use mathematics and computational thinking to convert between the Celsius and Kelvin temperature scales.
- Use mathematics and computational thinking to apply the techniques of dimensional analysis to a variety of conversion problems.
- Decipher the difference between a solid, liquid and gas on the microscopic level

Evidence of Learning

☑ **Formative Assessment -** Teachers will choose the most appropriate formative assessment strategy in order to assess students' understanding of the above objectives prior to a summative assessment and inform future instruction.

☑ **Summative Assessment -** Students will complete the three dimensional performance tasks listed below to demonstrate their proficiency in achieving mastery of the unit performance expectations and objectives. The focus is on having students apply their understanding of disciplinary core ideas and cross cutting concepts in the context of engaging in a science or engineering practice. The format or method in which these tasks are carried out are chosen by the teacher based on student needs and how best to demonstrate three-dimensional science proficiency; including but not limited to constructing models, designing and conducting investigations, constructing explanations for natural phenomena, or analyzing and interpreting data. Teachers - see “Integrating Science Practices Into Assessment Tasks” under resources for more examples.

☑ **Alternative Assessment -** During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students via differentiation and/or accommodations in process and product in order to provide an alternative modality for students to demonstrate three-dimensional science proficiency.

☑ **Benchmark -** Students will complete the common assessment(s) listed below to demonstrate their three-dimensional science proficiency. Students apply their understanding of disciplinary core ideas and cross cutting concepts as well as engage in science and engineering practices in order to solve a problem or explain a natural phenomenon.

Assessment Statement for Science Curriculum

The assessment plan includes teacher-designed formative and summative assessments, including common assessments, self-assessments, and performance tasks aligned with the NJSLS-S and the NJSLS-S for Climate Change. During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students. Accommodations
Sample Performance Task:
• Use mathematics and computational thinking to optimize the design solution and recognize stability and change. **[HS-PS1-7, HS-ETS1-2]** • Much of science deals with constructing explanations of how things change, therefore criteria may need to be broken down into simpler ones that can be approached systematically using mathematical representations of phenomena. **[HS-PS1-7]** • Design and conduct an experiment to support the Law of Conservation of Mass. **[HS-PS1-7, HS-ETS1-2]** • SWBAT optimize the design solution, by choosing the proper equipment for the job. **[HS-ETS1-2]**
Resources
Core Text: Chemistry, Wilbraham, et al., Pearson Prentice Hall, ISBN 131152629 **Suggested Activities:** • Chem Chat • Equipment Scavenger Hunt • Measure the Rainbow Lab • 4-Sided Ruler Activity • Measurement Station Activity • Turtle Island Activity • Water Density Graphing Lab • Classification of Matter Activity • Chromatography Lab • Material Identification Lab • cm^3 to mL Conversions Lab

Unit 2: Chemical Foundations and Periodicity	
Content Area: Science	
Course & Grade Level: Honors Chemistry, 10-12	
Summary and Rationale	
In this unit students build on the model of the atom as a foundation for explaining chemical formulas and reactions. A study of atomic models is essential to investigate atomic isotopes and radioactivity. Nuclear chemistry is explored as an alternative energy source. A comparison of fission versus fusion is made with respect to the parameters of available energy released, radioactive waste, and efficiency of the process. . Students will use the periodic table as a tool to explain and predict the properties of elements. The crosscutting concepts of *energy and matter*; *scale, proportion, and quantity*; and *stability and change* are called out as organizing concepts for this unit. Students are expected to demonstrate proficiency in *developing and using models*; *constructing explanations and designing solutions; using mathematical and computational thinking; and obtaining, evaluating, and communicating information*; and they are expected to use these practices to demonstrate understanding of the core ideas and they are expected to use these practices to demonstrate an understanding of how scientists use the periodic table to predict chemical reactivity.	
Recommended Pacing	
17 days	
New Jersey Student Learning Standards for Science	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
HS-PS1-7	**Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.** [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.]
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.** [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.]
HS-ESS1-3	**Communicate scientific ideas about the way stars, over their life cycle, produce elements.** [Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime.]
HS-ESS1-1	**Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation.** [Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.]
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.** [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts).

	Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]
New Jersey Student Learning Standards for English Language Arts Companion Standards	
Standard:	
CPI#	**Cumulative Progress Indicator (CPI)**
NJSLSA.W2.	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
NJSLSA.W7	Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas
9.4.12.IML.4	Assess and critique the appropriateness and impact of existing data visualizations for an intended audience
9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
New Jersey Student Learning Standards for Computer Science and Design Thinking	
CPI #	**Cumulative Progress Indicator (CPI)**
8.1.2.DA.1	Collect and present data, including climate change data, in various visual formats.
8.1.2.DA.3	Identify and describe patterns in data visualizations.
8.1.2.DA.4	Make predictions based on data using charts or graphs.
8.1.5.DA.1	Collect, organize, and display data in order to highlight relationships or support a claim.
8.1.5.DA.4	Organize and present climate change data visually to highlight relationships or support a claim.
8.1.5.DA.5	Propose cause and effect relationships, predict outcomes, or communicate ideas using data.
8.1.12.DA.5	Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.
8.2.5.ED.2	Collaborate with peers to collect information, brainstorm to solve a problem, and evaluate all possible solutions to provide the best results with supporting sketches or models.
8.2.12.ETW.3	Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution.
Interdisciplinary Standards (Mathematics and Social Studies)	
N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
A-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

Standard 6.1 U.S. History: America in the World	All students will acquire the knowledge and skills to think analytically about how past and present interactions of people, cultures, and the environment shape the American heritage. Such knowledge and skills enable students to make informed decisions that reflect fundamental rights and core democratic values as productive citizens in local, national, and global communities.
Standard 6.2 World History: Global Studies	All students will acquire the knowledge and skills to think analytically and systematically about how past interactions of people, cultures, and the environment affect issues across time and cultures. Such knowledge and skills enable students to make informed decisions as socially and ethically responsible world citizens in the 21st century.

Instructional Focus

Unit Enduring Understandings

- Different models of the atom have been developed over time to include explanations of unexpected nuclear occurrences.
- The periodic table is a system of organized groups of related elements.
- Understanding of regularities and patterns in the periodic table allows for predictions of interactions among the elements.

Unit Essential Questions

- How are the properties of the parts of the atom measured?
- To what extent are all atoms the same and/or different?
- Why is the energy released in a nuclear reaction very much greater than the energy given off in a chemical reaction?
- How can the predictability of radioactive decay be used for estimating the age of materials that contain radioactive substances?
- What information does the periodic table provide?
- How can periodic trends be explained?
- Is there more than one accurate way to organize the elements in a useful manner?
- How can the physical and chemical properties of matter be explained? What determines these properties?

Objectives

We are learning to/that:

- Determine the number of subatomic particles given the isotopic symbol or atomic number and mass number.
- Use the concepts of isotopes to explain why the atomic masses of elements are not whole numbers.
- Calculate the average atomic mass of an element from isotope data.
- Write balanced nuclear equations for alpha and beta decay.
- Use the half-life to calculate the amount of radioisotope remaining at a given time.
- Differentiate among classifications of nuclear reactions including fission, fusion, natural radioactivity and artificial radioactivity.
- Students develop and use radioactive decay models that illustrate the differences in type of energy and type of particle released during alpha, beta, and gamma radioactive decay, and any change from one element to another that can occur due to the process.
- Explain the origin of the periodic table.
- Distinguish between a period and a group on the periodic table.
- State the periodic law.
- Identify the s, p, d and f blocks on the periodic table.
- Identify an element as an alkali metal, alkaline earth metal, halogen, noble gas, actinide or lanthanide.
- Construct an explanation for why an element is classified as a representative element, noble gas, transition metal or inner transition metal.
- Construct explanations to compare and contrast physical and chemical properties in any group of representative elements.

- Students analyze and interpret data from the periodic table to construct explanations of the patterns of behavior of the elements based on the attraction and repulsion between electrically charged particles and the patterns of the outermost electrons and determine the typical reactivity of an atom.
- Students analyze and interpret data from the periodic table to construct explanations for following patterns of properties:
  - the number and charges in stable ions that form from atoms in a group of the periodic table
  - the trend in reactivity and electronegativity of atoms down a group and across a row in the periodic table, based on attractions of valence electrons to the nucleus
  - the relative sizes of atoms both across a row and down a group in the periodic table.
  - ionization energy both across a row and down a group on the periodic table.
  - ionic radii both across a row and down a group on the periodic table.
- Students construct an explanation that describes the causal relationship between the observable macroscopic patterns of reactivity of elements in the periodic table and the patterns of outermost electrons for each atom and its relative electronegativity.

Evidence of Learning (include sample assessments in each corresponding checkbox row)

☑ **Formative Assessment -** Teachers will choose the most appropriate formative assessment strategy in order to assess students' understanding of the above objectives prior to a summative assessment and inform future instruction.

☑ **Summative Assessment -** Students will complete the three dimensional performance tasks listed below to demonstrate their proficiency in achieving mastery of the unit performance expectations and objectives. The focus is on having students apply their understanding of disciplinary core ideas and cross cutting concepts in the context of engaging in a science or engineering practice. The format or method in which these tasks are carried out are chosen by the teacher based on student needs and how best to demonstrate three-dimensional science proficiency; including but not limited to constructing models, designing and conducting investigations, constructing explanations for natural phenomena, or analyzing and interpreting data. Teachers - see “Integrating Science Practices Into Assessment Tasks” under resources for more examples.

☑ **Alternative Assessment -** During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students via differentiation and/or accommodations in process and product in order to provide an alternative modality for students to demonstrate three-dimensional science proficiency.

☑ **Benchmark -** Students will complete the common assessment(s) listed below to demonstrate their three-dimensional science proficiency. Students apply their understanding of disciplinary core ideas and cross cutting concepts as well as engage in science and engineering practices in order to solve a problem or explain a natural phenomenon.

Assessment Statement for Science Curriculum

The assessment plan includes teacher-designed formative and summative assessments, including common assessments, self-assessments, and performance tasks aligned with the NJSLS-S and the NJSLS-S for Climate Change. During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students. Accommodations

Sample Performance Tasks

- Using mathematics and computational thinking to explain structure and properties in matter using patterns. **[HS-PS1-7]**

● Develop a model based on evidence to illustrate the total number of neutrons plus protons does not change in any nuclear process and the total amount of energy and matter is conserved. **[HS-PS1-8]** ● SWBAT describe the nuclear process of half-life decay. **[HS-PS1-7, HS-PS1-8]** ● Given the properties of unknown elements, synthesize a periodic table which demonstrates the principles of patterns and periodicity. **[HS-PS1-1, HS-PS1-2]**
Resources
Core Text: Chemistry, Wilbraham, et al., Pearson Prentice Hall, ISBN 131152629 **Suggested Activities:** ● Rutherford Scattering Activity (Example: PhET Interactive Simulations) ● History of Atom Videos ● Average Atomic Mass POGIL ● Manhattan Project Movie ● Fission and Fusion POGIL ● Isotopic Compositions and Climate Change ● Half Life Lab (Example: Gizmo or Candium Lab) ● It's in the Cards Activity ● Periodic Table WebQuest ● Coulombic Attraction POGIL ● Periodic Trends POGIL

Unit 3: Chemical Bonding, Organic Chemistry and Nomenclature	
Content Area: Science	
Course & Grade Level: Honors Chemistry, 10-12	
Summary and Rationale	
In this unit of study, students develop an understanding of the substructure of atoms and to provide more mechanistic explanations of the properties of substances. The formation of ions from neutral atoms is determined which leads to the creation of compounds from oppositely charged ions. Alloys illustrate on a molecular level how structure is aligned to function. A study of the different kinds of bonds that atoms can make with one another lays the foundation for a more focused investigation of molecular compounds. The patterns of electron sharing and lone pair electrons are the driving force in molecular geometry. Students will learn how to write chemical formulas and to name compounds according to certain conventions. The difference between ionic and molecular compounds is demonstrated in their naming systems. The crosscutting concepts of *patterns, energy and matter*, and *stability and change* are the organizing concepts for these disciplinary core ideas. Students are expected to demonstrate proficiency in *developing and using models*, *planning and conducting investigations*, *using mathematical thinking*, and *constructing explanations and designing solutions*.	
Recommended Pacing	
22 days	
New Jersey Student Learning Standards for Science	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
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.** [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.]
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.**[Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.]
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.** [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.]
HS-PS2-6	**Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.** [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.]
HS-ETS1-2	**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.**
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.** [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe

	weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]
New Jersey Student Learning Standards for English Language Arts Companion Standards	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
W.9-10.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
NJSLSA.W9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas
9.4.12.CT.3	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others
9.4.12.IML.4	Assess and critique the appropriateness and impact of existing data visualizations for an intended audience
9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately
9.4.12.TL.4	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
New Jersey Student Learning Standards for Computer Science and Design Thinking	
CPI #	**Cumulative Progress Indicator (CPI)**
8.1.2.DA.3	Identify and describe patterns in data visualizations.
8.1.5.DA.1	Collect, organize, and display data in order to highlight relationships or support a claim.
8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.
8.2.5.ED.2	Collaborate with peers to collect information, brainstorm to solve a problem, and evaluate all possible solutions to provide the best results with supporting sketches or models.
Interdisciplinary Standards (Mathematics and Social Studies)	
G-MG.A.1	Use geometric shapes, their measures, and their properties to describe objects
A-SSE.A.1	Interpret expressions that represent a quantity in terms of context
Standard 6.1 U.S. History: America in the World	All students will acquire the knowledge and skills to think analytically about how past and present interactions of people, cultures, and the environment shape the American heritage. Such knowledge and skills enable students to make informed decisions that reflect fundamental rights and core democratic values as productive citizens in local, national, and global communities.
Standard 6.2 World History: Global Studies	All students will acquire the knowledge and skills to think analytically and systematically about how past interactions of people, cultures, and the environment affect issues across time and cultures. Such knowledge and skills enable students to make informed decisions as socially and ethically responsible world citizens in the 21st century.
Instructional Focus	
Unit Enduring Understandings	

- Structure and function of an atoms valence electrons which determines how it interacts with other atoms to form bonds
- Models of molecules are structures that correspond to real objects and help scientists understand reactions.
- The naming of chemicals and formulas depends on the regularities and patterns inherent in the periodic table.
- Chemical formulas are shorthand for describing compounds.

Unit Essential Questions

- Are atoms more stable alone or bonded?
- Why are carbon-based molecules so versatile as chemical building blocks?
- Why do hydrocarbons make such good fuels?
- How much flexibility is there in writing a chemical formula?
- How can a formula be derived from the name of a compound?
- How can its chemical formula be used to name a substance?

Objectives

We are learning to/that:

- Develop and use models such as electron dot structures for the representative elements.
- Develop and use models such as electron dot structures to show cation formation from metals and anion formation from nonmetals.
- Construct an explanation for the electrical conductivity of molten and aqueous solutions of ionic compounds.
- Analyze and interpret data from the periodic table identify a compound as having ionic bonds.
- Students construct explanations to describe the causal relationship between the observable macroscopic patterns of reactivity of elements in the periodic table and the patterns of outermost electrons for each atom and its relative electronegativity.
- Students develop and use models to clearly depict both a macroscopic and a molecular/atomic-level representation of the system to distinguish among strong electrolytes, weak electrolytes and nonelectrolytes, giving examples of each.
- Analyze and interpret data from the periodic table to determine the charge of an ion.
- Construct explanation for the physical properties of metals and the importance of alloys using the theory of metallic bonding.
- Obtain, evaluate, and communicate information to:
    - Distinguish between a polyatomic ion and a monatomic ion.
    - Write the chemical formula of any ionic compound when given the name of the compound
    - Write the name of any ionic compound when given the formula of the compound
    - Write the chemical formula of a binary molecular compound when given the formula of the compound.
    - Write the name of a binary molecular compound when given the formula of the compound.
    - Write the chemical formula of an inorganic acid when given the name of the acid.
    - Write the name of an inorganic acid when given the formula of the acid.
- Analyze and interpret data to differentiate between polar covalent, nonpolar covalent, and ionic bonds using electronegativity differences as well as location of elements on the periodic table.
- Develop and use models such as electron dot structures to illustrate how atoms are bonded to each other in covalent bonds
- Explain the octet rule and its exceptions.
- Describe the relationship between atomic and molecular orbitals.
- Describe how VSEPR theory helps predict the shapes of molecules.
- Identify the ways in which orbital hybridization is useful in describing molecules.
- Draw and identify resonance structures of covalent compounds
- Describe how electronegativity values determine the charge distribution in a polar molecule.
- Evaluate the strengths of intermolecular attractions compared with the strengths of ionic and covalent bonds.
- Explain why the properties of covalent compounds are so diverse.
- Obtain and evaluate information to name and draw the structural formula of an alkane, alkene or alkyne given using IUPAC

- Analyze and interpret data to relate differences in physical properties of classes of organic compounds to molecular structure.
- Evaluate the strengths of intermolecular attractions compared with the strengths of ionic and covalent bonds.
- Students develop and use models to clearly depict both a macroscopic and a molecular/atomic-level representation of the system to describe the IMFs (hydrogen bonding) that occur in water on the basis of its molecular structure and use the concept of hydrogen bonding to explain the unusual properties of water.
- Students engage in argument from evidence to describe the phenomenon under investigation, which includes the following idea: the relationship between the measurable properties (e.g., melting point, boiling point, vapor pressure, surface tension) of a substance and the strength of the electrical forces between the particles of the substance.

Sample Performance Tasks

- Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims related to the attraction and repulsion between electric charges at the atomic scale to determine properties of different materials, structures of different components to reveal its function. **[HS-PS1-1, HS-PS1-3]**
- Develop and use molecular models to predict the molecular geometry and identify the patterns of VSEPR which guide the organization and classification of molecules. [**HS-PS1-1, HS-PS2-6]**
- Perform a dehydration synthesis reaction to produce an ester. While observing the product, argue from evidence regarding the identity of the ester including the structure. [**HS-PS1-2, HS-PS1-3, HS-PS2-6]**
- SWBAT show the types of interactions between polar covalent bonds and polar molecules. [**HS-PS1-2, HS-PS2-6]**
- Construct and revise explanations based on reliable evidence including models and the assumption that theories and laws describe the natural world as it operates today, did in the past and will in the future based on different patterns that can be observed in the arrangement of the periodic table. **[HS-PS1-1, HS-PS1-2]**
- Using a computer simulation, construct an explanation and predict the chemical formulas of compounds through illustrations and calculations. **[HS-PS1-1, HS-PS1-2]**
- SWBAT identify the patterns in chemical nomenclature. **[HS-PS1-1, HS-PS2-2]**

Evidence of Learning

☑ **Formative Assessment -** Teachers will choose the most appropriate formative assessment strategy in order to assess students' understanding of the above objectives prior to a summative assessment and inform future instruction.

☑ **Summative Assessment -** Students will complete the three dimensional performance tasks listed below to demonstrate their proficiency in achieving mastery of the unit performance expectations and objectives. The focus is on having students apply their understanding of disciplinary core ideas and cross cutting concepts in the context of engaging in a science or engineering practice. The format or method in which these tasks are carried out are chosen by the teacher based on student needs and how best to demonstrate three-dimensional science proficiency; including but not limited to constructing models, designing and conducting investigations, constructing explanations for natural phenomena, or analyzing and interpreting data. Teachers - see "Integrating Science Practices Into Assessment Tasks" under resources for more examples.

☑ **Alternative Assessment -** During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students via differentiation and/or accommodations in process and product in order to provide an alternative modality for students to demonstrate three-dimensional science proficiency.

☑ **Benchmark -** Students will complete the common assessment(s) listed below to demonstrate their three-dimensional science proficiency. Students apply their understanding of disciplinary core ideas and cross cutting concepts as well as engage in science and engineering practices in order to solve a problem or explain a natural phenomenon.

Assessment Statement for Science Curriculum

The assessment plan includes teacher-designed formative and summative assessments, including common assessments, self-assessments, and performance tasks aligned with the NJSLS-S and the NJSLS-S for Climate Change. During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students. Accommodations

Resources

Core Text: Chemistry, Wilbraham, et al., Pearson Prentice Hall, ISBN 131152629

Suggested Activities

- Conductivity Lab
- Hydrocarbons and Climate Change
- Ion Formation of Collisions
- Ionic Puzzle Piece Activity
- Metal Alloys WebQuest
- Metal, Nonmetal, Metalloid Lab
- Name Game
- Naming Ionic Compounds Scavenger Hunt
- Hybrid Orbitals Video
- Molecular Geometry PhET
- Polar Bears and Penguins Comic
- Alkane Boiling Point Activity
- Intermolecular Forces Lab

Unit 4: Chemical Reactions and Electrochemistry	
Content Area: Science	
Course & Grade Level: Honors Chemistry, 10-12	
Summary and Rationale	
By understanding the regularities and patterns in the periodic table we can predict the interactions among the elements. The representation of a chemical reaction by a balanced chemical equation reinforces the Law of Conservation of Mass. The prediction of products from particular reactants is emphasized. Chemical reactions can be understood by students at this level in terms of the collisions of molecules and the rearrangements of atoms. These chemical reactions obey the law of conservation of mass and energy which can be quantified. They will study the types of interactions between acids and bases and apply their understanding of pH and chemical reactions to solve scientific problems. Students are expected to demonstrate proficiency in asking questions that can be investigated within the scope of the school laboratory, and, when appropriate, frame a hypothesis based on a model or theory. The crosscutting concepts of *patterns, energy and matter*, and *stability and change* are the organizing concepts for these disciplinary core ideas. Students are expected to demonstrate proficiency in *developing and using models*, *planning and conducting investigations*, *using mathematical thinking*, and *constructing explanations and designing solutions*.	
Recommended Pacing	
30 days	
New Jersey Student Learning Standards for Science	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
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.** [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.]
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.** [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.]
HS-PS1-7	**Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.** [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.]
HS-PS2-6	**Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*** [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.]
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.** [Clarification Statement: Emphasis is on students identifying the scientific principle(s) and/or relationship(s) being used by the model and identifying which variables can be changed by the user to evaluate the proposed solutions, trade offs, or other decisions. Emphasis is

	also placed on students identifying the model's limitations and the possible negative consequences of solutions that outweigh the benefits.]
HS-ESS3-4	**Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems.** [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]
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**. [Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]
New Jersey Student Learning Standards for English Language Arts Companion Standards	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
NJSLSA.SL5	Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.
NJSLSA.R1	Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
NJSLSA.W1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLSA.W7	Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
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.3	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others
9.4.12.IML.4	Assess and critique the appropriateness and impact of existing data visualizations for an intended audience
9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately
9.4.12.TL.4	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

9.4.12.TL.3	Analyze the effectiveness of the process and quality of collaborative environments.
New Jersey Student Learning Standards for Computer Science and Design Thinking	
CPI #	**Cumulative Progress Indicator (CPI)**
8.1.2.DA.1	Collect and present data, including climate change data, in various visual formats.
8.1.2.DA.3	Identify and describe patterns in data visualizations.
8.1.2.DA.4	Make predictions based on data using charts or graphs.
8.1.5.DA.1	Collect, organize, and display data in order to highlight relationships or support a claim.
8.1.5.DA.4	Organize and present climate change data visually to highlight relationships or support a claim.
8.1.5.DA.	Propose cause and effect relationships, predict outcomes, or communicate ideas using data.
8.1.12.DA.5	Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.
8.2.5.ED.2	Collaborate with peers to collect information, brainstorm to solve a problem, and evaluate all possible solutions to provide the best results with supporting sketches or models.
8.2.12.ETW.3	Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution.
Interdisciplinary Standards (Mathematics and Social Studies)	
N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling
A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
Standard 6.1 U.S. History: America in the World	All students will acquire the knowledge and skills to think analytically and systematically about how past interactions of people, cultures, and the environment affect issues across time and cultures. Such knowledge and skills enable students to make informed decisions as socially and ethically responsible world citizens in the 21st century.

Instructional Focus

Unit Enduring Understandings

- Understanding of regularities and patterns in the periodic table allow for predictions of interactions among the elements.
- Chemical reactions occur naturally (in the environment and biologically) or are engineered (industrial products).
- A chemical equation needs verification through experimentation and observation.
- Energy can be transferred and matter can be changed in chemical reactions.
- A number of important reactions involve the transfer of electrons between reacting ions, molecules or atoms.
- Mass is conserved when substances undergo chemical change.
- The terms “strong” and “weak” are not interchangeable with “concentrated” and “dilute” in terms of acids and bases.
- The pH scale is used to describe the acidity or basicity of a substance.

Unit Essential Questions

- To what extent are all chemical reactions the same?
- How can chemical changes be produced or caused by electrical energy?

- How do we know how atoms and molecules combine in reactions if we cannot see them?
- How is a symbol system used to make the understanding/interpretation of chemical reactions uniform among scientists?
- How can matter be modified to make it more useful?
- What information do chemical equations convey about matter and its changes?
- How can you balance redox reactions?
- How can energy be produced or drive an electrochemical process?
- To what extent can the strengths of acids and bases be quantified?
- How are acidity and pH related?

Objectives

We are learning to/that:

- Identify the reactants and products in a chemical equation.
- Use appropriate symbols to accurately communicate a chemical reaction.
- Obtain and evaluate information to communicate a balanced chemical equation.
- Analyze and interpret data, such as the activity series of metals to predict the products of single-replacement reactions.
- Engage in argument from evidence to justify the products of the double-replacement reaction between two ionic compounds.
- Engage in argument from evidence to justify the products for complete and incomplete combustion reactions.
- Classify a reaction as synthesis, decomposition, single replacement, double-replacement or combustion
- List properties of acids and bases.
- Define Bronsted-Lowry acids and bases
- Explain the steps of a titration
- Analyze and interpret data such as the hydrogen-ion or hydroxide-ion concentration, to classify a solution as neutral, acidic, or basic.
- Use mathematics and computational thinking to calculate the pH of a solution, given the hydrogen-ion or hydroxide-ion concentration, and vice versa.
- Analyze and interpret data to identify conjugate acid-base pairs in acid-base reactions.
- Distinguish between strong and weak acids and bases.
- Define oxidation and reduction in terms of the loss, gain, or shift of electrons.
- Give the characteristics of a redox reaction.
- Identify the oxidizing and reducing agents in a redox reaction.
- Define oxidation and reduction in terms of a change in oxidation number.
- Sketch a voltaic cell, labeling the cathode, the anode, and the direction of electron flow.
- Describe how a battery produces electrochemical energy.
- Define cell potential and describe how it is determined.
- Define the Standard Hydrogen Electrode potential of an electrode.
- Distinguish between electrolytic and voltaic cells.
- List some possible uses of an electrolytic cell
- Engage in argument from evidence to justify the products of simple combination and decomposition reactions.

Evidence of Learning

☑ **Formative Assessment -** Teachers will choose the most appropriate formative assessment strategy in order to assess students' understanding of the above objectives prior to a summative assessment and inform future instruction.

☑ **Summative Assessment -** Students will complete the three dimensional performance tasks listed below to demonstrate their proficiency in achieving mastery of the unit performance expectations and objectives. The focus is on having students apply their understanding of disciplinary core ideas and cross cutting concepts in the context of engaging in a science or engineering practice. The format or method in which these tasks are carried out are chosen by the teacher based on student needs and how best to demonstrate three-dimensional science proficiency; including but not limited to constructing models, designing and conducting investigations, constructing explanations for natural phenomena, or analyzing and interpreting data. Teachers - see “Integrating Science Practices Into Assessment Tasks” under resources for more examples.

☑ **Alternative Assessment -** During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students via differentiation and/or accommodations in process and product in order to provide an alternative modality for students to demonstrate three-dimensional science proficiency.

☑ **Benchmark -** Students will complete the common assessment(s) listed below to demonstrate their three-dimensional science proficiency. Students apply their understanding of disciplinary core ideas and cross cutting concepts as well as engage in science and engineering practices in order to solve a problem or explain a natural phenomenon.

Assessment Statement for Science Curriculum

The assessment plan includes teacher-designed formative and summative assessments, including common assessments, self-assessments, and performance tasks aligned with the NJSLS-S and the NJSLS-S for Climate Change. During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students. Accommodations

Sample Performance Task

- Construct and revise an explanation based on models, theories, and patterns that illustrates the fact that atoms are conserved together with the knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. **[HS-PS1-2, HS-PS1-7]**
- Carry out an investigation to analyze the colors of various solutions and precipitates and observe the patterns that exist. **[HS-PS1-1]**
- SWBAT break a redox reaction into oxidation and reduction half-reactions. **[HS-PS1-7]**
- Using algebraic thinking and analysis, calculation of the molarity of acid and base, chemical reactions, requires the detailed examination of the properties of the solutions. **[HS-PS1-1, HS-PS1-7]**
- Plan and conduct an investigation to observe the cause and effect of a chemical reaction between an acid and a base. **[HS-PS1-3]**
- SWBAT complete and balance a neutralization reaction. **[HS-PS1-7]**

Resources

Core Text: Core Text: Chemistry, Wilbraham, et al., Pearson Prentice Hall, ISBN 131152629

Suggested Resources:

- Law of Conservation of Mass Mini Lab
- Balancing Chemical Equations PhET
- Law of Conservation of Mass Lab
- “Shall We Dance?”–Classifying Types of Reactions
- Evidence of Chemical Reactions Lab
- Metals in Aqueous Solutions on AACT
- Net Ionic How-To
- Precipitate Lab
- Types of Reactions Lab
- Voltaic Cell Lab
- Acid/base Station Activity
- Titration of a solution of unknown concentration (Example “Titration” Gizmo on explorelearning.com)

Unit 5: The Mole, Stoichiometry, and Solutions	
Content Area:Science	
Course & Grade Level: Honors Chemistry, 10-12	
Summary and Rationale	
Chemistry is quantifiable. We can use mathematics to calculate ratios among reactants and products. We can make quantitative predictions about the outcomes of reactions. The "mole" is the central amount for quantifying chemical reactions. This unit focuses on mathematical thinking as it applies to chemical reactions. Students apply knowledge of water's properties to build an understanding of aqueous solutions. The unit includes factors that affect solution formation and solubility, concentration calculations (including dilution), solution stoichiometry, and properties that depend on solution concentration. Students explore the impact of various factors on reaction rates. Students *develop and use models*, *plan and carry out investigations*, *analyze and interpret data,* and *engage in argument from evidence* to make sense of matter as a quantitative property of a system—a property that depends on the interactions of matter within that system. Students will also use these practices to demonstrate understanding of these core ideas.	
Recommended Pacing	
30 days	
New Jersey Student Learning Standards for Science	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
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.** [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.]
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.** [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.]
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.** [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.]
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.** [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.]
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.** [Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.]
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.** [Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including

	descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.]
HS-PS1-7	**Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.** [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.]
HS-PS3-5	**Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.** [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.]
HS-ESS3-6	**Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity (i.e., climate change).** [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]
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.**[Clarification Statement: Solving many mathematical problems involve a series of sequential steps.]
New Jersey Student Learning Standards for English Language Arts Companion Standards	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
NJSLSA.SL5	Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.
NJSLSA.R1	Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
NJSLSA.W7	Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
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.TL.1	Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specific task.

9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.3	Analyze the effectiveness of the process and quality of collaborative environments.
9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately.
9.4.12.IML.6	Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity.
9.4.12.IML.7	Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change.
New Jersey Student Learning Standards for Computer Science and Design Thinking	
CPI #	**Cumulative Progress Indicator (CPI)**
8.1.5.DA.1	Collect, organize, and display data in order to highlight relationships or support a claim.
8.1.5.DA.5	Propose cause and effect relationships, predict outcomes, or communicate ideas using data.
8.1.12.DA.5	Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.
8.2.5.ED.2	Collaborate with peers to collect information, brainstorm to solve a problem, and evaluate all possible solutions to provide the best results with supporting sketches or models.
Interdisciplinary Standards (Mathematics and Social Studies)	
N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
A-SSE.A.1	Interpret expressions that represent a quantity in terms of context
A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A-REI.A.1	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
A-REI.D.10	Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
Standard 6.1 U.S. History: America in the World	All students will acquire the knowledge and skills to think analytically about how past and present interactions of people, cultures, and the environment shape the American heritage. Such knowledge and skills enable students to make informed decisions that reflect fundamental rights and core democratic values as productive citizens in local, national, and global communities.
Standard 6.2 World History: Global Studies	All students will acquire the knowledge and skills to think analytically and systematically about how past interactions of people, cultures, and the environment affect issues across time and cultures. Such knowledge and skills enable students to make informed decisions as socially and ethically responsible world citizens in the 21st century.
Instructional Focus	
Unit Enduring Understandings	

- Chemical formulas can provide much information about the amount of chemicals that can be used or produced during a reaction.
- The mole is an important unit of measurement that aides in the quantification of matter.

- Changes in systems can be quantified.
- Quantities of all reactants are not always completely consumed
- Water is vital to life largely because of its unique properties.
- Solution concentrations can be described mathematically in a variety of terms.
- The rate of a chemical reaction is influenced by controllable outside forces.
- The rate of a chemical reaction does not determine the quantity of the product.

Unit Essential Questions

- To what extent is it advantageous to look at chemical composition in terms of moles instead of mass?
- To what extent can you determine which reactant will be used up first?
- Why is predicting the solubility of a substance difficult?
- How can a solubility curve be used to describe the effect of temperature on solubility?
- To what extent does the polarity of a substance determine its solubility in a particular solvent?
- How are the various expressions of solution concentration related?
- To what extent do temperature, surface area, concentration of reactant, and pressure affect reaction rates?

Objectives

We are learning to/that:

- Name the basic SI unit for measuring the amount of a substance.
- Identify the representative particle of elements and compounds.
- Distinguish between the terms atomic mass and molar mass.
- Distinguish between an empirical and a molecular formula.
- Construct an explanation for how Avogadro's number is related to a mole of any substance.
- Use mathematics and computational thinking to convert among measurements of mass, volume of gas at STP, and number of particles using the mole.
- Use mathematics and computational thinking to calculate the percentage composition of a substance from its chemical formula or experimental data.
- Analyze and interpret data to derive empirical and molecular formulas from appropriate experimental data.
- Use mathematics and computational thinking to calculate the percent of water in a hydrate.
- Plan and carry out an investigation to experimentally determine the percent of water in a hydrate.
- Construct mole ratios from balanced chemical equations for use as conversion factors in stoichiometric problems.
- Use mathematics and computational thinking to determine a specific mass of a product if the mass of a reactant is known.
- Based on the limiting reagent, use mathematics and computational thinking to calculate the maximum amount of product(s) produced and the amount of any unreacted excess reagent.
- Given information from which any two of the following may be determined, calculate the third: theoretical yield, actual yield, and percentage yield.
- Students develop and use models to clearly depict both a macroscopic and a molecular/atomic-level representation of the system.
  - Define the following terms, giving an example of each: solution, aqueous solution, solute, solvent.
  - List factors that determine solubility and rate of solution formation.
  - Explain the difference between saturated, unsaturated, and supersaturated solutions.
  - Explain, at the molecular level, the effect of the addition of a solute on the properties of a solvent.
- Construct an explanation to predict the solubility of one substance in another using the rule "like dissolves like."
- Analyze and interpret data from solubility curves with respect to solution concentration.
- Analyze and interpret data to experimentally determine solution concentration.
- Define and use mathematics and computational thinking to perform calculations involving solution concentration: molarity, molality, and percent [(v/v) and (m/m)] concentration.
- Plan and carry out investigations to prepare a solution of a specific desired molarity.
- Plan and carry out investigations to prepare dilute solutions from concentrated solutions of known molarity.

- Students engage in argument from evidence to describe why data about bulk properties would provide information about the strength of electrical forces between particles of the chosen substance, including the following descriptions
  - The patterns of interactions between particles at the molecular scale are reflected in patterns of behavior at the macroscopic scale.
  - Together, patterns observed at multiple scales can provide evidence of the causal relationships between the strength of the electrical forces between particles and the structure of substances at the bulk scale
- Define reaction rate.
- List the factors which affect rates of reaction.

Evidence of Learning

- ☑ **Formative Assessment -** Teachers will choose the most appropriate formative assessment strategy in order to assess students' understanding of the above objectives prior to a summative assessment and inform future instruction.
- ☑ **Summative Assessment -** Students will complete the three dimensional performance tasks listed below to demonstrate their proficiency in achieving mastery of the unit performance expectations and objectives. The focus is on having students apply their understanding of disciplinary core ideas and cross cutting concepts in the context of engaging in a science or engineering practice. The format or method in which these tasks are carried out are chosen by the teacher based on student needs and how best to demonstrate three-dimensional science proficiency; including but not limited to constructing models, designing and conducting investigations, constructing explanations for natural phenomena, or analyzing and interpreting data. Teachers - see “Integrating Science Practices Into Assessment Tasks” under resources for more examples.
- ☑ **Alternative Assessment -** During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students via differentiation and/or accommodations in process and product in order to provide an alternative modality for students to demonstrate three-dimensional science proficiency.
- ☑ **Benchmark -** Students will complete the common assessment(s) listed below to demonstrate their three-dimensional science proficiency. Students apply their understanding of disciplinary core ideas and cross cutting concepts as well as engage in science and engineering practices in order to solve a problem or explain a natural phenomenon.

Assessment Statement for Science Curriculum

The assessment plan includes teacher-designed formative and summative assessments, including common assessments, self-assessments, and performance tasks aligned with the NJSLS-S and the NJSLS-S for Climate Change. During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students. Accommodations

Sample Performance Tasks

- Design a solution to a complex real-world problem, based on scientific knowledge, student generated evidence, and patterns to describe mathematically and qualitatively the fact that matter is conserved and can be used to describe chemical reactions. **[HS-PS1-1, HS-PS1-4, HS-PS1-7, HS-ETS1-2]**
- Design and conduct an experiment to determine the formula of a hydrate. **[HS-PS1-1, HS-PS1-4, HS-PS1-7]**
- SWBAT identify the limiting reagent in a chemical reaction. **[HS-PS1-2,HS-PS1-7]**
- Develop and use a model based on evidence to explain the structure and interaction of matter at the bulk scale are determined by electrical forces within and between atoms that follow predictable patterns. **[HS-PS1-3]**

- Compare and contrast various types of data sets to explain the structure and interactions of matter and determine how solubility of a substance changes with different solvents. **[HS-PS1-3, HS-PS3-5]**
- SWBAT explain and identify the structure and properties of matter (liquids). **[HS-PS1-3]**

Resources

Core Text: Chemistry, Wilbraham, et al., Pearson Prentice Hall, ISBN 131152629

Suggested Resources:

- Mole Video
- The Mole Concept POGIL
- Percent Composition How-To
- Empirical Formulas How-To
- Hydrate Lab
- Stoichiometry How-To
- Quantitative Study of a Reaction
- Factors of Solubility Lab
- Saturated and Unsaturated Solutions and Solubility POGIL
- Kool Aid Concentration Activity
- Equilibrium and Concentration Gizmo on explorelearning.com
- Rate of reaction lab with starch and iodine

Unit 6: States of Matter and Gas Laws	
Content Area: Science	
Course & Grade Level: Honors Chemistry, 10-12	
Summary and Rationale	
In this unit of study, students use investigations, simulations, and models to make sense of the substructure of atoms and to provide more mechanistic explanations of the properties of gasses. The nature of gasses can be understood by students in terms of the collisions of molecules and the spatial arrangement of atoms. This unit starts with a close examination of gasses—their properties (especially in contrast to solids and liquids), gas law calculations (for one set of conditions, or changing conditions), and gas stoichiometry. An understanding of the kinetic molecular theory allows students to delve deeper into the behavior of gasses. Students will study the gas laws and learn to use mathematical formulas to make predictions about how gasses behave under varying conditions such as temperature and pressure. The crosscutting concept of structure and function is called out as the framework for understanding the disciplinary core ideas.	
Recommended Pacing	
7 days	
New Jersey Student Learning Standards for Science	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
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.** [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.]
HS-PS1-7	**Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.** [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.]
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.** [Clarification Statement: Emphasis is on students identifying the scientific principle(s) and/or relationship(s) being used by the model and identifying which variables can be changed by the user to evaluate the proposed solutions, trade offs, or other decisions. Emphasis is also placed on students identifying the model's limitations and the possible negative consequences of solutions that outweigh the benefits.]
New Jersey Student Learning Standards for English Language Arts Companion Standards	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
NJSLSA.R1	Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
NJSLSA.W2	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

NJSLSA.SL4	Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
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.TL.1	Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specific task.
9.4.12.TL.3	Analyze the effectiveness of the process and quality of collaborative environments.
9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.IML.9	Evaluate media sources for point of view, bias, and motivations
New Jersey Student Learning Standards for Computer Science and Design Thinking	
CPI #	**Cumulative Progress Indicator (CPI)**
8.1.2.DA.3	Identify and describe patterns in data visualizations.
8.1.2.DA.4	Make predictions based on data using charts or graphs.
8.1.5.DA.1	Collect, organize, and display data in order to highlight relationships or support a claim.
8.1.5.DA.5	Propose cause and effect relationships, predict outcomes, or communicate ideas using data.
8.1.12.DA.5	Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.
Interdisciplinary Standards (Mathematics and Social Studies)	
N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
A-SSE.A.1	Interpret expressions that represent a quantity in terms of context
A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A-REI.A.1	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
A-REI.D.10	Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
Standard 6.1 U.S. History: America in the World	All students will acquire the knowledge and skills to think analytically about how past and present interactions of people, cultures, and the environment shape the American heritage. Such knowledge and skills enable students to make informed decisions that reflect fundamental rights and core democratic values as productive citizens in local, national, and global communities.
Standard 6.2 World History: Global Studies	All students will acquire the knowledge and skills to think analytically and systematically about how past interactions of people, cultures, and the environment affect issues across time and cultures. Such knowledge and skills enable students to make informed decisions as socially and ethically responsible world citizens in the 21st century.

Instructional Focus
Unit Enduring Understandings
● The behaviors of gasses follow specific laws. ● The gas laws can predict, analyze and explain many everyday occurrences involving gasses. ● Mathematical formulas can be used to predict the outcome of an experiment involving gasses.
Unit Essential Questions
● In what way does the inter-relationship of the variables of pressure, volume, temperature and moles predict the behavior of gasses? ● How can the shape of a graph illustrate the relationship between gas variables?
Objectives
We are learning to/that: ● Describe the nature of a liquid in terms of the attractive forces between its particles. ● List six possible phase changes that matter can undergo. ● Identify the following from a heating (cooling) curve of a substance: melting point, boiling point, heat of fusion, heat of vaporization, (heat of solidification, heat of condensation). ● Identify the triple point, critical temperature, and critical pressure on a phase diagram. ● Obtain, evaluate, and communicate information to explain gas pressure as a result of kinetic theory. ● Use mathematics and computational thinking to convert between units of pressure: Pa, atm, mmHg, etc. ● Construct explanations for why a liquid has a vapor pressure and why a change in temperature causes a change in vapor pressure. ● Construct explanations of phase changes at the submicroscopic level. ● Obtain, evaluate, and communicate information found on phase diagrams. ● Use mathematics and computational thinking to calculate pressure – volume changes in a gas using Boyle's law. ● Use mathematics and computational thinking to calculate temperature – volume changes in a gas using Charles' law. ● Use mathematics and computational thinking to calculate temperature – pressure changes in a gas using Gay-Lussac's law. ● Use mathematics and computational thinking to calculate an unknown gas variable using the combined gas law. ● Use mathematics and computational thinking to calculate an unknown gas variable using the ideal gas law. ● Students develop and use models with a given computer simulation the proposed solution selecting logical and realistic inputs. ● Students analyze and interpret data to compare simulated results to expected results. ● Students construct explanations for the relationships between components in their models, including the idea that thermal energy includes both the kinetic and potential energy of particle vibrations in solids or molecules and the kinetic energy of freely moving particles (e.g., inert gas atoms, molecules) in liquids and gasses. ● Describe the motion of particles of a gas according to the kinetic theory. ● Relate temperature to the average kinetic energy of the particles in a substance. ● Explain the significance of absolute zero, giving its value in degrees Celsius and Kelvin. ● State the values of standard temperature and pressure. ● State Avogadro's hypothesis and explain its significance.
Sample Performance Task
● Use mathematical models or computer simulations to demonstrate the structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms in a single system in which basic laws are consistent. **[HS-ETS1-4, HS-PS1-3]** ● Develop an experiment and use mathematical and computational thinking to measure the molar volume of a gas. **[HS-PS1-7]** ● SWBAT explains and identifies the structure and properties of matter (gasses). **[HS-PS1-3]**
Evidence of Learning (include sample assessments in each corresponding check box row)

☑ **Formative Assessment -** Teachers will choose the most appropriate formative assessment strategy in order to assess students' understanding of the above objectives prior to a summative assessment and inform future instruction.
☑ **Summative Assessment -** Students will complete the three dimensional performance tasks listed below to demonstrate their proficiency in achieving mastery of the unit performance expectations and objectives. The focus is on having students apply their understanding of disciplinary core ideas and cross cutting concepts in the context of engaging in a science or engineering practice. The format or method in which these tasks are carried out are chosen by the teacher based on student needs and how best to demonstrate three-dimensional science proficiency; including but not limited to constructing models, designing and conducting investigations, constructing explanations for natural phenomena, or analyzing and interpreting data. Teachers - see "Integrating Science Practices Into Assessment Tasks" under resources for more examples.
☑ **Alternative Assessment -** During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students via differentiation and/or accommodations in process and product in order to provide an alternative modality for students to demonstrate three-dimensional science proficiency.
☑ **Benchmark -** Students will complete the common assessment(s) listed below to demonstrate their three-dimensional science proficiency. Students apply their understanding of disciplinary core ideas and cross cutting concepts as well as engage in science and engineering practices in order to solve a problem or explain a natural phenomenon.
Assessment Statement for Science Curriculum The assessment plan includes teacher-designed formative and summative assessments, including common assessments, self-assessments, and performance tasks aligned with the NJSLS-S and the NJSLS-S for Climate Change. During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students. Accommodations
Resources
Core Text: Chemistry, Wilbraham, et al., Pearson Prentice Hall, ISBN 131152629 **Suggested Resources:** ● Gas laws stations (Example: PivotInteractives simulations such as "Gas Laws: Pressure vs. Temperature" and "Gas Laws: Pressure vs. Volume"). ● Molar volume of hydrogen lab ● Gas laws project ● Molar Volume Lab

Unit 7: Electronic Structure	
Content Area: Science	
Course & Grade Level: Honors Chemistry, 10-12	
Summary and Rationale	
In this unit students are able to predict the pattern for electron configurations and determine an element's ionic charge from the configuration. The concept of the energy and stability in an atom is dependent on the electron organization. The crosscutting concepts of *energy and matter*; *scale, proportion, and quantity*; and *stability and change* are called out as organizing concepts for this unit. Students are expected to demonstrate proficiency in *developing and using models*; *constructing explanations and designing solutions; and obtaining, evaluating, and communicating information*	
Recommended Pacing	
8 days	
New Jersey Student Learning Standards for Science	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
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.** [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.]
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.** [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.]
HS-PS4-1	**Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.** [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.]
New Jersey Student Learning Standards for English Language Arts Companion Standards	
Standard:	
CPI #	**Cumulative Progress Indicator (CPI)**
NJSLSA.W2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
NJSLSA.W7	Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
9.4.12.CI.1	Demonstrate the ability to reflect, analyze and use creative skills and ideas
9.4.12.CT	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g. political, economic, cultural) may work better than others
9.4.12.IML.5	Evaluate, synthesize and apply information on climate change from various source appropriately
New Jersey Student Learning Standards for Computer Science and Design Thinking	
CPI #	**Cumulative Progress Indicator (CPI)**
8.1.2.DA.3	Identify and describe patterns in data visualizations.

8.1.2.DA.4	Make predictions based on data using charts or graphs.
8.1.5.DA.1	Collect, organize, and display data in order to highlight relationships or support a claim.
8.1.5.DA.5	Propose cause and effect relationships, predict outcomes, or communicate ideas using data.
8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.
8.1.12.DA.5	Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
8.2.5.ED.2	Collaborate with peers to collect information, brainstorm to solve a problem, and evaluate all possible solutions to provide the best results with supporting sketches or models.
8.2.12.ETW.3	Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution.
Interdisciplinary Standards (Mathematics and Social Studies)	
N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling
N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
Standard 6.1 U.S. History: America in the World	All students will acquire the knowledge and skills to think analytically about how past and present interactions of people, cultures, and the environment shape the American heritage. Such knowledge and skills enable students to make informed decisions that reflect fundamental rights and core democratic values as productive citizens in local, national, and global communities.
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Instructional Focus

Unit Enduring Understandings

- The periodic table is a system of organized groups of related elements.
- Understanding of regularities and patterns in the periodic table allows for predictions of interactions among the elements.
- The properties of elements determine use.

Unit Essential Questions

- How can the physical and chemical properties of matter be explained? What determines these properties?
- To what extent does an atom's electron configuration relate to its placement on the periodic table?

Objectives

We are learning to/that:

- Explain the significance of quantified energies of electrons.
- Distinguish among principle energy level, energy sublevel, and atomic orbital.
- Describe the general shape of s, p, and d orbitals.
- Explain why the electron configurations for chromium and copper differ from those assigned using the Aufbau diagram.
- Explain the origin of the atomic emission spectrum of an element.
- Students use mathematics and computational thinking to identify, describe and quantify the relationships between frequency, wavelength, and speed of waves.
- Use the Aufbau principle, the Pauli exclusion principle, and Hund's rule to write the electron configurations of the elements

- Analyze and interpret data from the periodic table to write the electron configuration of elements.

Sample Performance Task:

- Evaluate the validity and reliability of multiple claims that appear in the media or technical texts such as shorter wavelength electromagnetic radiation can ionize atoms and cause damage to living cells to predict cause and effect relationships for complex natural systems. **[HS-PS1-2]**
- SWBAT describes the types of interactions involved with light. **[HS-PS1-2, HS-PS4-1]**

Evidence of Learning (include sample assessments in each corresponding check box row)

☑ **Formative Assessment -** Teachers will choose the most appropriate formative assessment strategy in order to assess students' understanding of the above objectives prior to a summative assessment and inform future instruction.

☑ **Summative Assessment -** Students will complete the three dimensional performance tasks listed below to demonstrate their proficiency in achieving mastery of the unit performance expectations and objectives. The focus is on having students apply their understanding of disciplinary core ideas and cross cutting concepts in the context of engaging in a science or engineering practice. The format or method in which these tasks are carried out are chosen by the teacher based on student needs and how best to demonstrate three-dimensional science proficiency; including but not limited to constructing models, designing and conducting investigations, constructing explanations for natural phenomena, or analyzing and interpreting data. Teachers - see "Integrating Science Practices Into Assessment Tasks" under resources for more examples.

☑ **Alternative Assessment -** During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students via differentiation and/or accommodations in process and product in order to provide an alternative modality for students to demonstrate three-dimensional science proficiency.

☑ **Benchmark -** Students will complete the common assessment(s) listed below to demonstrate their three-dimensional science proficiency. Students apply their understanding of disciplinary core ideas and cross cutting concepts as well as engage in science and engineering practices in order to solve a problem or explain a natural phenomenon.

Assessment Statement for Science Curriculum

The assessment plan includes teacher-designed formative and summative assessments, including common assessments, self-assessments, and performance tasks aligned with the NJSLS-S and the NJSLS-S for Climate Change. During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students. Accommodations

Resources

Core Text: Chemistry, Wilbraham, et al., Pearson Prentice Hall, ISBN 131152629

Suggested Activities

- Emission Activity with Spectrum Tubes
- Flame Test Lab (Example: Pivot Interactives)

Unit 8: Energy	
Content Area: Science	
Course & Grade Level: Honors Chemistry, 10-12	
Summary and Rationale	
All chemical reactions involve flows of energy. Some absorb energy and some release it. Students will construct explanations for the role of energy changes that occur during chemical reactions and changes of state. They will apply mathematical concepts to develop evidence to support the explanation of conservation of energy. The crosscutting concept of matter and energy provides students with insights into the process of energy transfer in matter. Students are expected to develop and use models, plan and conduct investigations, use mathematical thinking, and construct explanations as they demonstrate proficiency with the disciplinary core ideas.	
Recommended Pacing	
6 days	
New Jersey Student Learning Standards for Science	
Standard:	
CPI #	
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.** [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.]
HS-PS1-7	**Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.** [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.]
HS-PS3-4	**Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).** [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.]
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.** [Clarification Statement: Emphasis is on students identifying the scientific principle(s) and/or relationship(s) being used by the model and identifying which variables can be changed by the user to evaluate the proposed solutions, trade offs, or other decisions. Emphasis is also placed on students identifying the model's limitations and the possible negative consequences of solutions that outweigh the benefits.]
New Jersey Student Learning Standards for English Language Arts Companion Standards	
Standard:	
CPI #	
NJSLSA.W6	Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

W.9-10.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	**Cumulative Progress Indicator (CPI)**
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.TL.3	Analyze the effectiveness of the process and quality of collaborative environments.
New Jersey Student Learning Standards for Computer Science and Design Thinking	
CPI #	**Cumulative Progress Indicator (CPI)**
8.1.2.DA.4	Make predictions based on data using charts or graphs.
8.1.5.DA.1	Collect, organize, and display data in order to highlight relationships or support a claim.
8.1.5.DA.5	Propose cause and effect relationships, predict outcomes, or communicate ideas using data.
8.2.5.ED.2	Collaborate with peers to collect information, brainstorm to solve a problem, and evaluate all possible solutions to provide the best results with supporting sketches or models.
8.1.12.DA.5	Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.
Interdisciplinary Standards (Mathematics and Social Studies)	
A-SSE.A.1	Interpret expressions that represent a quantity in terms of context
A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A-REI.A.1	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
A-REI.D.10	Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling
Standard 6.1 U.S. History	America in the World. All students will acquire the knowledge and skills to think analytically about how past and present interactions of people, cultures, and the environment shape the American heritage. Such knowledge and skills enable students to make informed decisions that reflect fundamental rights and core democratic values as productive citizens in local, national, and global communities.
Standard 6.2 World History	Global Studies: All students will acquire the knowledge and skills to think analytically and systematically about how past interactions of people, cultures, and the environment affect issues across time and cultures. Such knowledge and skills enable students to make informed decisions as socially and ethically responsible world citizens in the 21st century.
Instructional Focus	
Unit Enduring Understandings	

- There are several ways in which elements and compounds react to form new substances and each reaction involves the flow of energy.
- Matter can exist in four states (solid, liquid, gas and plasma) depending on temperature.
- The kinetic molecular theory conceptually describes the physical behavior of gasses.

Unit Essential Questions

- In what ways are bond energies of the reactants and products related to the enthalpy of reaction?
- How are the properties of substances changed by heating or cooling?
- How does the kinetic molecular theory explain the motion of gas particles?

Objectives

We are learning to/that:

- List and define the units of heat energy.
- Identify two factors that determine the heat capacity of an object.
- Define the enthalpy of a substance.
- Use mathematics and computational thinking to determine mass, specific heat, or change in temperature when any three values are given.
- Use mathematics and computational thinking to perform calculations relating to the heat of phase changes.
- Use mathematics and computational thinking to relate a change in enthalpy to the heat of reaction or heat of combustion for a reaction.

Sample Performance Tasks

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to prove that energy cannot be created or destroyed but can be transferred between systems when the boundaries and initial conditions of a system are defined. **[HS-PS1-3, HS-PS3-4]**
- Plan and carry out an investigation to illustrate the transfer of heat energy between objects to reach a stable thermodynamic system. [**HS-PS1-7, HS-PS3-4]**
- SWBAT classify reactions as exothermic or endothermic, based on conservation of energy. [**HS-PS1-1, HS-ETS1-4, HS-PS3-4]**

Evidence of Learning (include sample assessments in each corresponding check box row)

- ☑ **Formative Assessment -** Teachers will choose the most appropriate formative assessment strategy in order to assess students' understanding of the above objectives prior to a summative assessment and inform future instruction.
- ☑ **Summative Assessment -** Students will complete the three dimensional performance tasks listed below to demonstrate their proficiency in achieving mastery of the unit performance expectations and objectives. The focus is on having students apply their understanding of disciplinary core ideas and cross cutting concepts in the context of engaging in a science or engineering practice. The format or method in which these tasks are carried out are chosen by the teacher based on student needs and how best to demonstrate three-dimensional science proficiency; including but not limited to constructing models, designing and conducting investigations, constructing explanations for natural phenomena, or analyzing and interpreting data. Teachers - see "Integrating Science Practices Into Assessment Tasks" under resources for more examples.
- ☑ **Alternative Assessment -** During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students via differentiation and/or accommodations in process and product in order to provide an alternative modality for students to demonstrate three-dimensional science proficiency.
- ☑ **Benchmark -** Students will complete the common assessment(s) listed below to demonstrate their three-dimensional science proficiency. Students apply their understanding of disciplinary core ideas and

cross cutting concepts as well as engage in science and engineering practices in order to solve a problem or explain a natural phenomenon.

Assessment Statement for Science Curriculum

The assessment plan includes teacher-designed formative and summative assessments, including common assessments, self-assessments, and performance tasks aligned with the NJSLS-S and the NJSLS-S for Climate Change. During each common, formative, and summative assessment, teachers will provide alternative assessment opportunities that adhere to 504 and IEP requirements. Alternative assessments are individualized for the needs of all students. Accommodations

Resources

Core Text: Chemistry, Wilbraham, et al., Pearson Prentice Hall, ISBN 131152629

Suggested Activities:

- Lauric acid melting lab (Example: “Temperature during phase changes” PivotInteractives lab)
- Phase diagrams and phase equilibria lesson
- Phase Changes Gizmo on explorelearning.com
- Specific heat of a metal lab (Example: “Using specific heat to identify a substance” PivotInteractives lab)
- Hess’s Law lab
- Enthalpy of fusion of ice lab
- Alternative energy research project