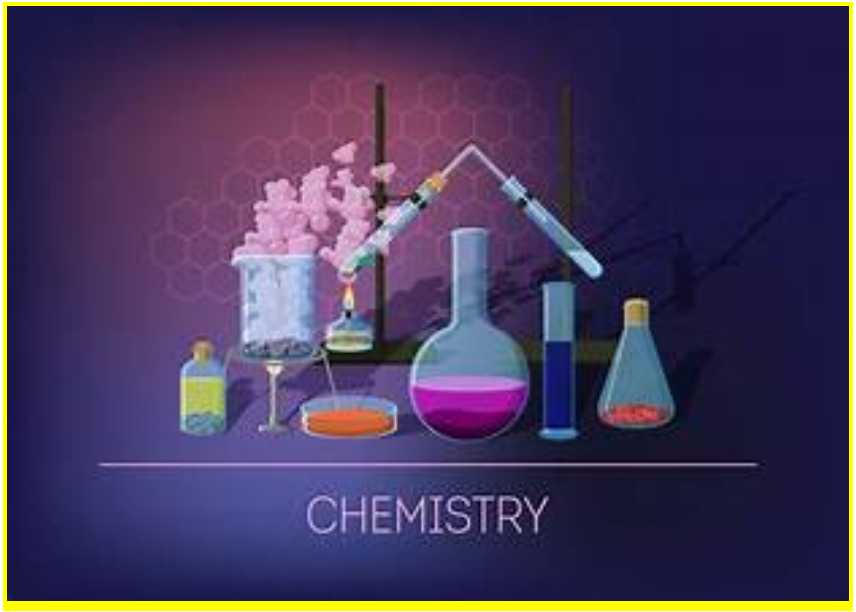
CHEMISTRY CURRICULUM



Grade Level(s): 10-12

Curriculum Author(s): Melissa Hodges

Course Description: Chemistry provides a deep dive into the study and understanding of matter and energy, their properties and transformations. Throughout the course, students familiarize themselves with concepts of atomic theory, the periodic table, chemical bonding, reactions, stoichiometry, states of matter, properties of gasses, and thermodynamics.

Year At A Glance			
Unit Title	**Overarching Essential Question**	**Overarching Enduring Understanding**	**Vision of A Learner "I Can" Statements**
Scientific Reasoning, Matter, Chemical/Physical Properties & Problem Solving (5 weeks)	How is scientific knowledge created and communicated?	Biological, chemical and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules.	TI1(9-12); TCC3(9-12); CCE2(9-12): AA2(9-12)
Light & the Periodic Table (3 weeks)	How is an elements' properties related to its position on the periodic table?	The electron arrangement of atoms is governed by specific rules and that electron arrangement controls all chemical and physical properties of those elements.	TCC4(9-12); CCE3(9-12)
Structure of Matter: The Atom, Bonding & Nuclear Energy (3 weeks)	How does the structure of matter affect the properties and the uses of materials?	The periodic table is used to determine an atoms' mass number, atomic number, amount of each subatomic particle and its ability to create metallic, covalent or ionic bonds.	CCE1(9-12); TCC2(9-12)
Bonding & Molecular Structure (4 weeks)	How does the 3D structure of compounds relate to their physical and chemical properties?	Atoms in compounds will arrange themselves in a molecule to minimize repulsion and maximize attraction. The physical and chemical properties of those compounds can be explained by the attractive forces between them.	CCE2(9-12); CCE3(9-12)
Formula Writing, Naming Compounds	How are formulas of compounds created and what do they tell us about the properties of the substance?	Atoms react with one another to form new compounds so that each element	P1(9-12); P2(9-12)

(3 weeks)		has a complete octet in its valence shell.	
The Mole (4 weeks)	How do we mathematically describe amounts of matter?	The mole is a unit used to measure the number of atoms, molecules, or (in the case of ionic compounds) formula units in a given mass or volume of a substance.	P1(9-12); AA2(9-12)
Types of Reactions, Balancing Equations & Reaction Rates (4 weeks)	How can we predict the products and rate of a chemical reaction?	Atoms react with one another to form new substances in predictable patterns. Matter is neither created or destroyed during these processes.	CCE3(9-12); DE4(9-12)
Solutions, Equilibrium & Acids & Bases (4 weeks)	How do reactions respond to disturbances to the equilibrium mixture? How are solutes measured and how do they affect the properties of the solvent?	Once equilibrium is achieved, the amount of each reactant and product remains constant, even though the reaction continues or when external stresses are applied.	TI1(9-12), TCC2(9-12)
Stoichiometry (4 weeks)	What are the quantitative relationships in chemical reactions?	The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants.	P4(9-12); TCC2(9-12)
Thermochemistry (3 weeks)	How is energy transferred during both chemical and physical processes and why do substances absorb/release heat at different rates?	Energy is conserved during all chemical and physical processes; it only changes form.	TI1(9-12); TCC2(9-12)
Gas Laws (3 weeks)	How do the properties of gasses change with temperature, pressure, amount of gas, and volume?	We can predict how a gas will change given changes in moles of gas, temperature, pressure and volume.	TI3(9-12); CCE3(9-12); TCC4(9-12)

Unit 1 - Scientific Reasoning, Matter, Chemical/Physical Properties & Problem Solving

Desired Results - Students will collect accurate data and communicate that data effectively.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

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

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

NGSS Standards:

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

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.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
- TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.
- CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.
- AA2(9-12): I can assess my past successes and mistakes to change my approach.

Understandings: Students will understand that…

- communicating the results of scientific laboratory investigations includes using data and results to prove or disprove a hypothesis.
- scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data & ideas.

Essential Questions:

- How is scientific knowledge created and communicated?
- How does the structure of matter affect the properties and uses of materials

Students will know…

- basic safety rules when working in the laboratory including safety and laboratory equipment.

Students will be able to...

- work in the chemical laboratory, demonstrating proper use of the lab & safety equipment.

• the parts of a chemical lab report. • the rules of proper significant figures based on the precision of the measuring device. • the difference between precision and accuracy. • the rules for calculating with scientific notation. • the formula for density. • differences between physical and chemical properties and changes. • the differences between intensive and extensive properties. • the process of dimensional analysis. • The density of a substance is calculated using D=M/V	• communicate their laboratory findings by writing a chemical laboratory report. • collect valid data to determine mass, volume, density and temperature. • determine what data indicates precision and/or accuracy. • perform calculations with numbers in scientific notation. • determine density of various samples of matter. • separate a mixture of substances based on their physical and chemical properties. • classify which properties of a substance are intensive or extensive. • apply dimensional analysis to solve problems.

Key Vocabulary: Hypothesis, theory, law, physical properties, chemical properties, intensive property, extensive property, physical change, chemical change, dimensional analysis, scientific notation, significant figures, matter, mass, substance, heterogeneous mixture, homogeneous mixture, solutions, element, compound, qualitative measurements, quantitative measurements, accuracy, precision, accepted value, experimental value, error, percent error, International System of Units (SI), density, Kelvin scale, absolute zero

Assessment Evidence

Performance Tasks:
• Study of Chemical Changes Lab
• Measurement Lab
• Paper towel Lab (Cost analysis Honors Only)
  ○ This assessment allows students to demonstrate correct measurement techniques, procedure writing, data analysis and error analysis
• Graphical Analysis and Density Lab
• Unit Conversion lab (Complex Unit Honors Only)
• Separating a Mixture Lab Summative
  ○ Students will be given a mixture of salt, sand, iron and water and must develop a plan to separate them. They will take observations of the mixture before and after separating, including mass data, and will reflect on how successfully they achieved their goal in a formal lab report.
	Other Evidence:
	• Scientific Notation Worksheet
	• Scientific Notation Calculation Worksheet
	• Sig Fig Worksheet
	• Physical Chemical Change Worksheet
	• Element, Compound, Mixture Worksheet
	• Unit Quiz
	• Density Worksheet
	• Dimensional Analysis Worksheets
	• Unit Test
	• Lab Safety Quiz

Learning Plan

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

- Use mass and volume data to determine the density of substances

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

- Write laboratory procedures
- Write conclusions based on analysis of data

HSN-Q.A.1 - Use units as a way to understand 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

- Graphically use mass and volume data to determine the density of substance
- Accurately measure objects and choose appropriate units
- Use scientific notation to accurately display data
- Use metric conversions appropriate to the size and quantity of data

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

- Write data consistent with the accuracy of the measuring device

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

- Correlate mass and volume data to a substance's density

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.

- Determine which brand of paper towel is most effective

VOL Common Assessments:
THINK CRITICALLY AND CREATIVELY
TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

- Separating a mixture Lab

TAKE INITIATIVE
TI (9-12): I Can implement a realistic plan and adapt when necessary to achieve my goals.

- Paper Towel Lab

COLLABORATE AND COMMUNICATE EFFECTIVELY
CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

- Use the actionable feedback on the Paper Towel Lab to enhance performance on the Separating a Mixture Lab
- A Study of Chemical Changes Lab

ADAPT AND ADJUST
AA2(9-12): I can assess my past successes and mistakes to change my approach.

- Use the actionable feedback on the Paper Towel Lab to enhance performance on the Separating a Mixture Lab
- Measurement Lab

Teacher Resources: Flinn Safety Laboratory video, Safety Contract & Assessment, Kendall Hunt Chemistry Textbook.Formula + Reference Sheets, Conclusion Writing Guide

Unit 2 - Light & the Periodic Table

Desired Results - Students will use the periodic table to predict properties of elements.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

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

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

NGSS Standards:

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

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

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

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

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

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

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

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.
- CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.

Understandings: Students will understand that...	**Essential Questions:**

• Electrons are arranged in atoms according to rules governing electron configuration. • atoms produce characteristic colors of light due to unique electron transitions. • Wavelength and frequency determine types of electromagnetic radiation. • the position of an element on the periodic table gives us information about its chemical and physical properties.	• Why do elements and compounds produce different colors when ignited? • How is an elements' properties related to its position on the periodic table?
Students will know… • the energy of light can be calculated using E = hv. • the wavelength and frequency of light can be calculated using c = λv. • every element and compound produces characteristic light when ignited that can be used to identify that element or compound. • the rules that govern where electrons exist in an atom. (2 electrons per orbital; electrons fill orbitals lowest in energy first; electrons sharing the same orbital will have opposite spins; electrons will fill separate orbitals before pairing) • periodic trends are all a result of the attraction between the nucleus and valence electrons.	**Students will be able to…** • explain and predict the arrangement of electrons in an atom. • use flame tests or electromagnetic spectra as a way of identifying elements. • predict chemical and physical properties of elements based on their position on the periodic table. • explain the why behind the periodic trends. • explain the relationship between frequency, wavelength and frequency of light.
Key Vocabulary: flame test, electron configuration, ionization energy, electronegativity, atomic radius, atomic orbital, wavelength, frequency, emission spectra, alkali metal, alkali earth metal, transition metal, halogen, noble gas	
Assessment Evidence	

Performance Tasks:
• The Periodic Table: It's in the Cards
  ○ Students will use their knowledge of electron structure, atomic number, effective nuclear charge, and periodic trends to create their own periodic table using only the properties of each element.
• Flame Tests Lab
  ○ Students will investigate the characteristic colors elements produce when heated or when electricity is applied to them.
	Other Evidence:
	• Structure of the Periodic Table and Periodic Trends POGIL
	• Periodic Trends Worksheet
	  ○ Periodic Trends Worksheet #2
	• Electron Configuration POGIL
	• Electron Configuration Worksheet
	• Wave nature of light POGIL
	• Electromagnetic Spectrum Calculations Worksheet
	• How Sunglasses Work Reading
	• Unit Test

Learning Plan	
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words ● Use electron configurations to explain the electronic structure of atoms ● Use wavelength and frequency to determine characteristics types of light RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes ● Explain how an elements' position on the periodic table is related to its' radius, electronegativity and ionization energy HSN-Q.A.1 - Use units as a way to understand 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 ● Calculated the wavelength, frequency and energy of electromagnetic radiation HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities ● Use spectroscopes to measure the wavelength and color of emission spectra 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 ● Use an elements position on the Periodic Table to predict its atomic radius, electronegativity or ionization energy ● Graphically analyze atomic number vs. atomic radius, electronegativity and ionization energy 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 ● Use electron configurations to determine an element's amount of valence electrons ● Determine characteristic properties of groups of elements on the periodic table HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. ● Use Coulomb's Law to explain periodic trends HS-PS4-1 - Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media ● Calculate the wavelength, frequency and energy of electromagnetic radiation ● Use wavelength and frequency to determine characteristics types of light HS-PS4-3 - Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other ● Analyze how elements produce characteristic colors and types of light HS-PS-4-4 - Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter ● Correlate wavelength and frequency to the type of electromagnetic radiation ● Discuss the practical applications of the various types of electromagnetic radiation	

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

- Use emission spectra to determine the composition of stars

VOL Common Assessments:
THINK CRITICALLY AND CREATIVELY
TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.

- Flame test lab relates to the composition of stars and the effects of electromagnetic radiation

COLLABORATE AND COMMUNICATE EFFECTIVELY
CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.

- It's in the Cards group activity

Teacher Resources: POGIL assignments, Kendall Hunt Textbook, teachengineering.org, Formula + Reference Sheets, Conclusion Writing Guide

Unit 3 - Structure of Matter: The Atom, Bonding & Nuclear Energy

Desired Results - Students will use the Periodic Table to determine with structure of atoms.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

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

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

NGSS Standards:

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

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

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

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

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.
- TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

Understandings: Students will understand that…

- atomic number, number of subatomic particles and mass number are related to the location of an element on the periodic table.
- atoms bond to complete their valence shell of electrons.
- chemical and physical properties of compounds are related to how the atoms are bonded.

Essential Questions:

- How does the structure of matter affect the properties and the uses of materials?
- How do science and technology affect the quality of our lives?
- What is the role of nuclear energy in our world?

• Nuclear energy does not produce greenhouse gasses, and therefore does not contribute to climate change. • Certain isotopes of elements are radioactive, which have practical medical and technological applications.	
Students will know… • the properties related to the three types of bonding. (ionic, covalent & metallic) • how to use the subatomic particle makeup of an atom to determine mass number, atomic number, identity of an element and ionic charge. • the difference between fission and fusion. • how nuclear half-life is determined. • Average atomic mass can be calculated using: Average Atomic Mass = (mass isotope)(%/100) + (mass isotope)(%/100) + …. • Atoms react with one another to form new molecules or formula units based on how their valence electrons are shared or exchanged.	**Students will be able to...** • determine whether various elements will react with each other covalently, ionically or metallically. • determine the properties of a compound based on the elements involved in the formula. • calculate mass number, atomic number, ionic charge using the number of subatomic particles of a particular element. • calculate average atomic mass of an element, given the percent abundance of its various isotopes. (Honors only: calculate percent abundance of the various isotopes if given the average atomic mass). • calculate the amount of radioactive substance that remains after a given period of time.
Key Vocabulary: Electrons, protons, neutrons, nucleus, atomic number, mass number, isotope, atomic mass, atomic mass unit, atom, molecule, molecular compounds, ionic compound, ions, cation, anions, chemical formula, formula unit, ionic bonds, covalent bonds & metallic bond, valence electrons	
Assessment Evidence	

Performance Tasks:
• Beanium Lab
  ○ Students will use lab data to simulate calculations of average atomic mass
• Types on Compounds Simulation
  ○ Students will investigate the properties of ionic, polar covalent and nonpolar covalent compounds
• Alpha Decay Simulation
• Beta Decay Simulation
• Future of Nuclear Power Discussion Response
  ○ Students will reflect on their previous understanding of climate change and their new understanding of nuclear energy to discuss the future of energy production.
	Other Evidence:
	• Atomic structure and Structure of the Periodic Table Worksheet
	• Nuclear Reactions Worksheet
	• Nuclear Reactions Video and Viewing Guide
	• Pro/Con of Nuclear Power Debate
	• Calculating Average Atomic Mass Worksheet
	• Unit Quiz

Learning Plan
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words ● Use percent abundance and mass to determine the average atomic mass of an element RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes ● Explain how to use data to determine the type of bonding in a compound HSN-Q.A.1 - Use units as a way to understand 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 ● Use mass and percent abundance of a fictitious element to determine that elements' average atomic mass ● Use average atomic mass and mass of isotopes to determine the percent abundance of each isotope (Honors Only) ● Use proton, neutron and electron data to determine the half life and type of nuclear decay of an element HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities ● Accurately measure the mass and percent abundance of the fictitious element beanium HS-PS-1-1 - 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 ● Use the periodic table to predict the type of bonding between 2 elements 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 ● Use simulation data to determine half life and type of nuclear decay 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 ● Use data to determine the type of bonding between atoms HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials ● Relate the type of bonding to the physical properties of compounds VOL Common Assessment: THINK CRITICALLY AND CREATIVELY TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. ● Beanium Lab ● Types of Compounds Simulation ● Alpha/Beta Decay Simulations COLLABORATE AND COMMUNICATE EFFECTIVELY CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.

• Future of Nuclear Power Discussion Response
Teacher Resources: Kendall Hunt Textbook, pHet.org, nuclear power CNBC video, nuclear technology CNBC video, Formula + Reference Sheets, Conclusion Writing Guide

Unit 4 - Bonding & Molecular Structure

Desired Results - Students will create and understand the 3D structure of compounds.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

NGSS Standards:

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

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

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

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.
- CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products

Understandings: Students will understand that…

- the physical and chemical properties of substances is related to how atoms are bonded
- atoms arrange themselves in compounds to minimize repulsion between electrons, but maximize attraction between neighboring atoms and compounds.

Essential Questions:

- How do atoms bond and how can we predict the type of bond that will form?
- How do atoms arrange themselves in 3-D space when they bond?
- What do ionic, metallic and covalent compounds look like on a microscopic level?

Students will know...

- bonding electrons arrange themselves in 3D space to minimize repulsion between them.
- electronegativity differences and average electronegativity values determine if bonds are nonpolar, polar, metallic or ionic.

Students will be able to…

- predict the type of bonding present between two atoms in a binary compound based on position in the periodic table and the electronegativity of the elements.

• the strength of ionic bonds is related to the size of the ions and their charge. • electrons are transferred to form ionic bonds; electrons and shared to form covalent bonds; electrons are shared in a “sea of electrons” to form metallic bonds. • bonds form so that atoms will have 8 electrons in their valence shell. • ionic compounds tend to dissolve in water, have high melting and boiling points, and conduct electricity when dissolved in water or as a liquid. • nonpolar covalent compounds do not dissolve in water, do not conduct electricity and have low melting and boiling points. • polar covalent compounds dissolve in water, do not conduct electricity and have medium melting and boiling points. • metallic compounds do not dissolve in water, conduct electricity and have a variety of melting and boiling points.	• use Lewis dot structures and VSEPR theory to predict the geometry of molecules and make predictions about molecular polarity, shape and bond angles. • Bond Angle and Shape Names (Honors Only) • describe the relationships between the properties of polar and nonpolar molecules and the forces of attraction between the particles. • explain the properties of ionic compounds. • explain the properties (phase, vapor pressure, viscosity, etc.) of small and large molecular compounds in terms of the strengths and types of intermolecular forces. • predict bond types based on physical and chemical properties. • build covalent molecules using model kits and draw them in 3-D space.
Key Vocabulary: Lewis Dot Structures, VSEPR theory, octet rule, bond polarity, molecular polarity, intermolecular forces, solubility, surface tension, boiling point, conductivity, polar, nonpolar, London Dispersion Forces, dipole-dipole forces, hydrogen bonding, resonance	
Assessment Evidence	

Performance Tasks:
• Lewis Dot Structure Puzzle Activity
• Molecular Modeling Activity
  ○ Students will first draw correct Lewis dot structures. They will then build those compounds using a molecular model kit and describe their shape and bond angles.
• IMFs and Properties Activity
  ○ Students will investigate how intermolecular properties affect the physical properties of substances
	Other Evidence:
	• Lewis Dot Structure Worksheets
	• Molecular Geometry POGIL
	• IMFs Worksheet
	• Polarity, IMFs, and Boiling Point activity
	• Unit Test

Learning Plan	
Curricula Calendars: • College Prep Chemistry Calendar • Honors Chemistry Calendar	

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

- Students will accurately draw molecules as a representation of their structure in 3D space

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

- Students will explain the properties of covalent compounds related to their 3D structure

HS-PS-1-1 - 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

- Students will use the periodic table to predict the number of valence electrons of each element in a compound, and will then use those valence electrons to draw 3D models of compounds

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

- Students will use data to predict the type of attractions or bonding between atoms and will use their 3D models to predict properties

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

- Students will use data to predict the type of attractions or bonding between atoms and will use their 3D models to predict properties

VOL Common Assessment:
COMMUNICATE AND COLLABORATE EFFECTIVELY
CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

- Unit Test - students will have developed throughout the unit

CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products

- Lewis Dot Structure Puzzle Activity
- Molecular Modeling Activity
- IMFs and Properties Activity

Teacher Resources: Kendall Hunt Textbook, POGIL, Formula + Reference Sheets, Conclusion Writing Guide

Unit 5 - Formula Writing, Naming Compounds

Desired Results - Students will write the formulas and names of compounds.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

HSN-Q.A.1 - Use units as a way to understand 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

NGSS Standards:

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

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

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

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- P1(9-12): I can self-reflect and seek feedback to build upon my strengths, apply those strengths to overcome obstacles, and share my strategies with others.
- P2(9-12): I can strengthen my weaknesses by identifying, initiating, and practicing appropriate strategies to become confident in my ability to overcome my challenges.

Understandings: Students will understand that…

- atoms react with one another to form new molecules.

Essential Questions:

- How are formulas of compounds created and what do they tell you about the properties of the substance?

Students will know…

- the rules of naming ionic compounds.
- how to balance the charges of ions to create the proper ionic compound formula.
- the rules of naming covalent compounds.
- how to use the name of a covalent compound to write the correct formula.
- the rules of naming acids.

Students will be able to…

- translate the formula of an ionic compound into the name.
- construct the correct chemical formula from the name of a given ionic compound.
- translate the formula of a covalent compound into the name.
- construct the correct chemical formula from the name of a given covalent compound.
- translate the formula of an acid into the name.

• how to use the name of an acid to develop the formula for the acid.	• construct the correct chemical formula from the name of a given acid.
Key Vocabulary: Polyatomic ion, acid, base, anion, cation, prefix, formula unit	
Assessment Evidence	

Performance Tasks:
• Ion Formula Writing Kit Activity
  ○ Students will use puzzle pieces that correspond to ions to build correct ionic compounds. The sizes of the puzzle pieces correlate to the charges on those ions. When the heights of the + and - cards match, students have built a correct ionic compound.
	Other Evidence:
	• Ionic Formula Writing Worksheet
	• Ionic Naming Worksheet
	• Covalent Formula/Naming Writing Worksheet
	• Acid Formula Writing/Naming Worksheet
	• Mixed Formulas Writing/Naming Worksheet
	• Unit Test
	  ○ CP test indicates formula type
	  ○ Honors test mixes all formula types with no indicators

Learning Plan	
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words • Students will translate the names of compounds to their appropriate chemical formulas and translate chemical formulas to appropriate names RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes • Students will explain the process of writing the formulas and names of compounds HSN-Q.A.1 - Use units as a way to understand 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 • Students will use the charges on ions to correctly determine the formula of ionic compounds 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 • Students will use an elements position on the periodic table to determine an element's charge • Students will use a nonmetal's position on the periodic table to predict patterns in covalent bonding HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials • Students will differentiate between the naming systems for ionic, covalent and acidic compounds 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 • Students will correlate naming systems to the physical and chemical properties of those compounds	

VOL Common Assessments
PERSEVERANCE:
P1(9-12): I can self-reflect and seek feedback to build upon my strengths, apply those strengths to overcome obstacles, and share my strategies with others.

- Unit Exam: Students will be constantly assessed for mistakes throughout the unit

P2(9-12): I can strengthen my weaknesses by identifying, initiating, and practicing appropriate strategies to become confident in my ability to overcome my challenges.

- Unit Exam: Students will use corrective feedback throughout the unit to find success on the unit exam
- Ionic Formula Writing Kit

Teacher Resources: Kendall Hunt Textbook, Formula + Reference Sheets, Conclusion Writing Guide

Unit 6 - The Mole

Desired Results - Students will recognize the mole as the foundation of mathematics in Chemistry.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

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

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

NGSS Standards:

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

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

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

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

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- P1(9-12): I can self-reflect and seek feedback to build upon my strengths, apply those strengths to overcome obstacles, and share my strategies with others.
- AA2(9-12): I can assess my past successes and mistakes to change my approach

Understandings: Students will understand that…

- Chemists use the mole to describe the amount of matter available in terms of number of particles, mass and volume
- Avogadro's number describes the amount of particles necessary to equal the mass on the periodic table.
- The percent composition or mass of each element in a compound can be used to calculate the empirical formula of that compound.

Essential Questions:

- How can we use data to determine the formula of a compound?
- How do Chemists calculate the amount of atoms or compounds?

Students will know…	**Students will be able to...**

• Avogadro's number (6.02×10^{23}) relates how many particles are required to equal the mass on the periodic table.
• The molar mass of a compound is the added masses of the relevant elements from the periodic table.
• percent composition of elements in a compound can be calculated using:
  ○ $\%\text{Composition} = \frac{\text{Mass of Element}}{\text{Mass of Compound}} \times 100$
• The empirical formula indicates the lowest whole number ratio of elements in a compound, while the molecule formula indicates the actual number of each element in a compound
• Hydrates are ionic compounds bonded to a fixed number of water molecules
	• calculate formula mass, molar mass, and percent composition of elements, compounds and hydrates.
	• calculate the amount of atoms within a given amount of a compound (Honors Only)
	• calculate the empirical formula of an unknown compound based on the percent composition of each element found in the compound
	  ○ and determine the identity of the molecular compound (Honors Only).

Key Vocabulary: Mole, Avogadro's number, percent composition, empirical formula, molecular formula, hydrate

Assessment Evidence

Performance Tasks:	**Other Evidence:**

• Mole Buffet lab
  ○ Students will convert measured quantities of various substances to moles, liters, and molecules using the conversions learned in the unit.
• % Composition of Sugar in Gum
• Formula of a Hydrate Lab
  ○ Students will calculate the formula of a hydrate by heating it and collecting mass data before and after heating it. They will discuss why only the water leaves the compound and how they can use that to determine the formula of the compound.
	• Mole Calculation Worksheets
	• Percent Composition Worksheets
	• Empirical Formula Worksheets
	• Unit Test

Learning Plan

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

- Use percent composition data to calculate the empirical and molecular formula of compounds

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

- Explain how to use data to calculate the empirical formula of a compound

HSN-Q.A.1 - Use units as a way to understand 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

- Convert between mass, atoms, molecules, formula units, volume and moles
- Convert between molecules/formula units and individual atoms in a compound (Honors Only)

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

- Accurately measure the mass of a hydrate before and after heating
- Accurately measure various quantities to convert them to moles

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.

- Describe the changes that are occurring during the heating of a hydrate

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

- Describe the changes that are occurring during the heating of a hydrate
- Use lab data to determine the percent composition of a substance

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

- Use the mass before an after heating a hydrated compound to determine its chemical formula

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

- Explain why only the water leaves a hydrated compound when it is heated
- Explain why chewing a piece of high sugar gum allows us to determine the amount of sugar in that gum

VOL Common Assessments:
PERSEVERANCE
P1(9-12): I can self-reflect and seek feedback to build upon my strengths, apply those strengths to overcome obstacles, and share my strategies with others.

- Formula of a Hydrate Lab

ADAPT AND ADJUST
AA2(9-12): I can assess my past successes and mistakes to change my approach

- Mole Buffet Lab
- % Composition of Sugar in Gum Lab

Teacher Resources: Kendall Hunt Textbook, Formula + Reference Sheets, Conclusion Writing Guide

Unit 7 - Types of Reactions, Balancing Equations & Reaction Rates

Desired Results - Students will predict the products of balanced chemical reactions and how chemists can affect the rate of those chemical reactions.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

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

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

NGSS Standards:

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

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

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

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

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

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

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.
- DE4(9-12): I can work respectfully with all members of my community and support the needs of others.

Understandings: Students will understand that…	**Essential Questions:**
● atoms react with one another to form new molecules in predictable ways.	● How can we affect the rate of a reaction? ● How can we predict the products of a chemical reaction?

• the conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants. • changes in temperature, concentration and surface area can affect the rate of a reaction.	
Students will know... • the rules related to writing and balancing a chemical equation. • the forms of evidence that a chemical reaction has occurred. • how to interpret a balanced chemical equation in terms of atoms, molecules & ions. • how to classify a reaction as synthesis, decomposition, single replacement, double replacement or combustion. • whether a reaction will occur using the activity series of metals. • whether a precipitate will be formed using the solubility rules. • how to predict the products of simple chemical reactions, given the reactants. • why some ionic solids dissolve while others do not. • the factors that will increase the rate of dissolution and rate of reaction. • how combustion reactions are related to climate change.	**Students will be able to...** • write, balance, classify and interpret a chemical equation. • increase or decrease the rate of a chemical reaction by adjusting various factors. • write the net ionic equation of a precipitation reaction. • collect data and use solubility tables to predict precipitate formation. • predict the products of various chemical reactions. • interpret how environmental data on carbon dioxide levels is linked to combustion reactions
Key Vocabulary: Chemical equation, skeleton equation, products, reactants, Law of conservation of mass & matter, reaction rate, catalyst, Synthesis/Combination Reactions, Decomposition Reaction, Single Replacement Reaction, Double Replacement Reaction, precipitate, Combustion Reaction & Net Ionic equations	
Assessment Evidence	

Performance Tasks:
• Types of Reactions Lab
  ○ Students will perform several reactions and will use their observations as well as the formulas of the starting materials to predict reactions types and balanced chemical equations.
• Reaction Rate Lab
  ○ Groups of students will investigate how temperature, concentration and surface area affect the rate of
	Other Evidence:
	• Translating Word Equations Worksheet
	• Balancing Equations Game
	• Balancing Equations Worksheet
	• Types of Reactions POGIL
	• Single Replacement Reaction Worksheet
	• Double Replacement Reaction Worksheet
	• Mixed Predicting Products Worksheet
	• Unit Test

reaction. They will then share their findings with the class.	

Learning Plan

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

- Translate sentences describing chemical reactions into balanced chemical equations

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

- Write a laboratory report detailing the procedure and results of an experiment investigating how temperature, surface area and concentration affect the rate of a reaction

HSN-Q.A.1 - Use units as a way to understand 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

- Use the charges of ions to help predict products of a chemical reaction

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

- Accurately measure time, temperature, mass and volume as they relate concentration, surface area and rate of reactions

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.

- Accurately predict the formulas of compounds based on ionic charge of individual elements

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.

- Predict the products of a chemical reaction

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.

- Collaborate with peers to investigate and determine how temperature, concentration and surface area affect the rate of a reaction (Reaction Rate Lab)

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

- Balance chemical equations

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

- Use Coulomb's law to explain why some ionic compounds dissolve in water while others do not

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.

- Evaluate the products of combustion reactions as they relate to climate change

VOL Common Assessments:
COLLABORATE AND COMMUNICATE EFFECTIVELY

CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.

- Types of Reactions Lab

DEMONSTRATE EMPATHY

DE4(9-12): I can work respectfully with all members of my community and support the needs of others.

- Reaction Rate Lab

Teacher Resources: Kendall Hunt Textbook, POGIL, pHet.org, Formula + Reference Sheets, Conclusion Writing Guide

Unit 8 - Solutions, Equilibrium & Acids & Bases

Desired Results - Students will understand the properties of solutions.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

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

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

NGSS Standards:

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

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

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
- TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

Understandings: Students will understand that...

- reactions shift to establish a set ratio between products and reactants even when disturbed
- solids dissolve in water and that concentration can be measured.
- solutions have properties that are different than the original solvent

Essential Questions:

- How do reactions respond to disturbances to the equilibrium mixture?
- How are solutes measured and how do they affect the properties of the solvent?

Students will know...

- the change in freezing point of a solution can be calculated using: $\Delta T_f = K_f m_i$
- the change in boiling point of a solution can be calculated using: $\Delta T_b = K_b m_i$

Students will be able to...

- apply freezing point depression and boiling point elevation to real world applications.

• the concentration of a solution can be calculated using:
  • Molarity = moles solute/liters solution
  • Molality = moles solute/kg solvent
  • (%W/V) = mass solute/mL solution x 100
• chemical equilibrium occurs when a reaction and its reverse reaction proceed at the same rate.
• once equilibrium is achieved, the amount of each reactant and product remains constant, even though the reaction continues.
• Equilibrium constants relate concentrations the products to the concentration of reactants
• The equilibrium and reaction quotients are calculated for the generic reaction ($aA + bB \leftarrow \rightarrow cC + dD$) using the formula: $K \text{ or } Q = \frac{[C]^c[D]^b}{[A]^a[B]^b}$
• if a reaction at equilibrium is disturbed by a change in temperature, pressure, or the concentration of one of the components, the reaction will shift its equilibrium position to counteract the effect of the disturbance.
• acids are proton donors or begin with H and have pH values less than 7.
• bases are proton acceptors or end in OH and have pH values above 7.
• pH can be calculated using: pH = -log[H+]
• solutions have a lower freezing point and higher boiling point than the original solvent.
	• Calculate the new freezing point and boiling point of a solution as compared to the freezing and boiling points of the original solution.
	• Calculate the Equilibrium Constant and Reaction Quotient of a Reaction (Honors Only if time permits)
	• Calculate the concentration of a solution in terms of molarity, molality and %(W/V)
	• calculate the pH, [H+], [OH-] and pOH of acids and bases.
	• predict how a reaction will respond to changes in temperature, pressure and amount of product or reactant.
	• identify acids and bases based on their chemical formula.
	• explain the relationship between dissolved solid, amount of solvent and concentration.
	• interpret a solubility curve.

Key Vocabulary: molarity, molality, %(W/V), Arrhenius acids and bases, Bronstead-Lowry acids and bases, freezing point depression, boiling point elevation, equilibrium, Le Chatelier's principle, saturated, unsaturated, supersaturated, solubility curve, electrolyte, nonelectrolyte, weak electrolyte, strong electrolyte, equilibrium constant, reaction quotient	
Assessment Evidence	
Performance Tasks: • Concentration Lab ○ Students will be given a solution of unknown concentration and will have to design their own experiment to determine its molarity and %(W/V).	**Other Evidence:** • Concentration Worksheet • Dilutions Worksheet • pH worksheet • Acid/Base Property Worksheet

• Using Colligative Properties to Make Ice Cream Lab
• LeChatelier Principle Online Lab
  ○ Online Lab Handout
  ○ Students will investigate how they can affect the contents of a reaction mixture by adding/removing reactants and products, changing the pressure of the system, and heating or cooling the reaction vessel.
	• Solubility Curves Worksheet
	• Colligative properties worksheet
	• Equilibrium Simulation
	• Equilibrium Calculations
	• Calculating Q
	• Unit Test

Learning Plan

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words
- Calculate the concentration of solutions
- Calculate the pH of solutions
- Calculate the new freezing point and boiling point of a solution
- Calculate the Equilibrium Constant and Reaction Quotient for a reaction (Honors Only)

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
- Design and run an experiment determining the concentration of a solution

HSN-Q.A.1 - Use units as a way to understand 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
- Calculate the concentration of solutions
- Calculate the pH of solutions
- Calculate the new freezing point and boiling point of a solution
- Calculate the Equilibrium Constant and Reaction Quotient for a reaction (Honors Only)
- Determine the amount of dissolved solid using a solubility curve

HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities
- Accurately measure temperature, mass and volume in order to accurately calculate concentration and freezing point depression

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.
- Understand how temperature affects both the rate of dissolution and amount of dissolved solid

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.
- Understand Le Chatelier's principle is related to and affects the amount of products and reactants in a chemical reaction

VOL Common Assessment
THINK CRITICALLY AND CREATIVELY

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Le Chatelier Simulation
- Using Colligative Properties to Make Ice Cream Lab

TAKE INITIATIVE

TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.

- Concentration Lab

Teacher Resources: Kendall Hunt Textbook, Formula + Reference Sheets, Conclusion Writing Guide

Unit 9 - Stoichiometry

Desired Results - Students will calculate the predicted amount of products or reactants necessary for a chemical reaction.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

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

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

NGSS Standards:

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

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- P4(9-12): I can take-on challenges and continuously engage in my own long-term strategies to overcome them to demonstrate through personal experience that failures are more instructive than discouraging.
- TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

Understandings: Students will understand that…

- The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants.

Essential Questions:

- What are the quantitative relationships in chemical reactions?

Students will know...

- the mass, volume, concentration and particle amount of a reactant or product in a balanced chemical equation can be used to determine the mass, volume, concentration and particle amount of another reactant or product in the same equation.
- The % yield of a reaction is calculated using:
  - Percent Yield = $\frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$

Students will be able to...

- calculate the mass, molar volume or number of molecules of product that can be formed by reacting specific quantities of reactants.
- calculate the percent yield of a reaction by comparing the predicted amount of product to a measured amount of product
- determine the limiting and excess reactants when given known quantities of all reactants.
- calculate the amount of excess reactant after a reaction has gone to completion. (Honors Only)

	• perform a titration.

Key Vocabulary: mole, Avogadro's number, molar volume, stoichiometry, limiting reactant, excess reactant, percent yield, titration, burette, indicator, equivalence point, end point, concentration, molarity

Assessment Evidence

Performance Tasks:

- Stoichiometry Lab
  - Students will perform a reaction and compare their calculated expected amount of product to their measured amount of product.
- Titration of Vinegar Lab
  - Students will titrate an unknown concentration of solution to determine its molarity.

Other Evidence:

- Stoichiometry Worksheet 1
- Stoichiometry Worksheet 2
- Stoichiometry POGIL
- Percent Yield Worksheet
- Limiting Reactant Worksheet
- Limiting Reactant POGIL
- Solution Stoichiometry Worksheet
- Titration Worksheet
- Unit Test

Learning Plan

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

- Calculate the predicted amount of products
- Calculate Percent Yield
- Calculate necessary amount of reactants
- Use visual representations of chemical reactions to determine the amount of product produced and the amount of reactants that remains

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

- Explain the necessary steps and results of a titration

HSN-Q.A.1 - Use units as a way to understand 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

- Calculate the predicted amount of products
- Calculate Percent Yield
- Calculate necessary amount of reactants

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

- Accurately measure mass and added volume using a burette

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

- Calculate the predicted amount of products
- Calculate necessary amount of reactants

VOL Common Assessment:
THINK CRITICALLY AND CREATIVELY
TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Stoichiometry Lab

PERSEVERANCE
P4(9-12): I can take-on challenges and continuously engage in my own long-term strategies to overcome them to demonstrate through personal experience that failures are more instructive than discouraging.

- Titration Lab

Teacher Resources: Kendall Hunt Textbook, POGIL, Formula + Reference Sheets, Conclusion Writing Guide

Unit 10 - Thermochemistry

Desired Results - Students will explain and quantify heat exchange during chemical and physical processes.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

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

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

NGSS Standards:

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

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

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

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

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
- TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

Understandings: Students will understand that...	**Essential Questions:**
● energy is conserved during all physical and chemical changes. ● heat interacts with substances differently causing them to change temperature at different rates.	● How is energy transferred during both chemical and physical processes? ● Why do objects absorb and/or release heat differently?
Students will know…	**Students will be able to…**
● energy is conserved during all chemical and physical processes; it only changes form.	

• endothermic processes require energy; exothermic processes release energy.
• temperature does not change during a phase change because the added or released heat goes to breaking or forming intermolecular forces.
• heat flows from warmer objects to colder objects.
• specific heat describes how much heat something can absorb before it changes temperature.
• ΔH can be calculated using:
  • Hess's Law
  • ΔH=mCΔT
  • ΔH = mHfus
  • ΔH = mHvap
  • ΔH = ΣΔHf°products – ΣΔHf° reactants
  • Enthalpy stoichiometry
	• use calorimetry as a means of identifying substances or determine the quantity of heat that was transferred between the two objects.
	• use calorimetry to calculate the specific heat of a substance
	• determine the final temperature of 2 objects after a heat exchange (Honors Only)
	• determine the state of matter when given a substances pressure and temperature
	• perform mathematical calculations to determine how much heat is absorbed or released during chemical and physical processes.
	• relate change in temperature to kinetic energy.
	• explain heat transfer during phase changes vs. heating or chemical reactions.
	• relate the units of energy Joules to calories and Calories (Food Calories).

Key Vocabulary: endothermic, exothermic, specific heat, calorimetry, enthalpy, heat of fusion, heat of vaporization, Hess's Law, heats of formation, energy stoichiometry, kinetic energy, temperature, potential energy, Joules, calories, Calories, phase diagram, vapor pressure	
Assessment Evidence	

Performance Tasks:
• Food Calorimetry Lab
• Specific Heat of a Metal Lab
  ○ Students will use calorimetry to experimentally determine the specific heat of a metal. They will then compare that value to a known set of values to determine the identity of the metal.
• Heat of Fusion of Ice Lab (College Prep)
  ○ Students will experimentally determine the heat of fusion for ice when given the correct mathematical formula.
• Heat of Fusion of Ice Lab (Honors)
  ○ Students must develop their own experimental plan to determine the heat of fusion of ice.
	Other Evidence:
	• Endo/Exothermic worksheet
	• Calorimetry POGIL
	• Specific Heat and Calorimetry Worksheet
	• Energy changes during a phase change
	• More Phase Change Calculations Worksheet
	• Heat stoichiometry Worksheet
	• Hess's Law worksheet
	• Heats of Formation Worksheet
	• Which Equation do I Use Worksheet
	• Unit Test

Learning Plan	
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed	

visually or mathematically into words
- Calculate the enthalpy change during chemical and physical processes
- Use potential energy diagrams to explain heat exchange

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
- Explain how substances absorb or release heat and that that heat exchange is related to temperature change
- Explain how to calculate the heat of fusion of a solid

HSN-Q.A.1 - Use units as a way to understand 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
- Calculate the enthalpy of chemical and physical processes

HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities
- Accurately measure temperature, volume and mass to calculate heat exchange

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.
- Calculate enthalpy changes during a chemical reaction
- Use potential energy diagrams to determine if a reaction is endothermic or exothermic

HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
- Use specific heat and calorimetry as an explanation for why substances do not change temperature at the same rate

HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
- Use calorimetry to calculate the specific heat or heat of fusion of materials
- Use calorimetry to calculate the amount of Calories in a known quantity of food
- Use calorimetry to calculate the final temperature of both objects after a heat exchange (Honors Only)

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).
- Use calorimetry to calculate the heat of fusion of ice
- Discuss the flaws in assuming energy is conserved during all heat exchanges as it relates to accurate experimental data

VOL Common Assessments:
TAKE INITIATIVE
TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
- Heat of Fusion of Ice Lab

THINK CRITICALLY AND CREATIVELY
TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.
- Unit Test

- Food Calorimetry Lab
- Specific Heat of a Metal Lab

Teacher Resources: Kendall Hunt Textbook, Formula + Reference Sheets, Conclusion Writing Guide

Unit 11 - Gas Laws

Desired Results - Students will predict how gasses are affected by temperature, pressure, volume and moles of gas.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

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

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

NGSS Standards:

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

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TI3(9-12): I can formulate and investigate probing questions to further my learning.
- CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.
- TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.

Understandings: Students will understand that...

- Pressure and Volume of a gas increase with increased temperature or moles of gas
- Pressure and volume of a gas are inversely related

Essential Questions:

- How do the properties of gasses change with temperature, pressure, amount of gas, and volume?
- How can we measure gasses?

Students will know…

- the total pressure of a mixture of gasses equals the sum of the pressures that each would exert if it were present alone.
- Kelvin temperature directly relates particle speed to temperature and must be used in all gas laws calculations.
- the pressure of a gas can be changed by changing the volume of the container or by changing the temperature.

Students will be able to...

- use the combined gas law to calculate the new pressure, temperature and volumes of gasses given an initial set of conditions.
- use the ideal gas law to calculate the pressure, volume, moles or temperature of a gas given the other variables.
- predict how a gas will change given changes in temperature, pressure and volume.

• pressure, volume, moles and temperature of a gas are related using the ideal gas law: PV = nRT. • the results of changes in temperature, pressure or volume of a gas can be predicted using the combined gas law: ○ $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$	• use a phase diagram to predict phase changes and current states of matter • use a vapor pressure curve to predict how temperature affects the rate at which a substance evaporates • calculate the molar mass and density of a gas given appropriate data (Honors Only) • explain what causes pressure • Calculate the amount of gas produced during a chemical reaction (Honors Only)
Key Vocabulary: Charles Law, Gay-Lussac's Law, Boyle's Law, combined gas law, ideal gas law, pressure, moles, partial pressure, kinetic molecular theory of gasses, Kelvin temperature, vapor pressure, phase diagram	
Assessment Evidence	

Performance Tasks:
• Charles Law Lab
• Soda Can Lab (College Prep)
  ○ Students will use the ideal gas law to experimentally determine the pressure of carbon dioxide in an unopened soda can.
• Soda Can Lab (Honors)
  ○ Students will use gas laws to experimentally determine the pressure of carbon dioxide in an unopened soda can. The Honors students must decide which formula presented in this unit is appropriate for solving the problem.
	Other Evidence:
	• Gas law simulation
	• KMT POGIL
	• Gas Behavior Worksheet
	• Gas Law Practice Problems
	• Mixed Gas Law Worksheet
	• Phase Diagram Worksheet
	• Vapor Pressure Worksheet
	• Gas law stoichiometry worksheet (Honors Only)
	• Applications of PV=nRT worksheet (Honors Only)
	• Unit Test

Learning Plan	
RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words • Calculate the pressure, temperature, volume or moles of a gas given the other quantities RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes • Explain how to calculate the pressure of a gas in a closed system • Explain how temperature, pressure, volume and moles of gasses are related and affect each other HSN-Q.A.1 - Use units as a way to understand 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	

- Interpret a vapor pressure curve
- Interpret a phase diagram
- Calculate the pressure, temperature, volume or moles of a gas given the other quantities

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

- Accurately measure mass, volume and temperature of gasses

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

- Predict and explain how temperature will affect the volume and pressure of a gas
- Explain how heat and pressure affect the state of matter
- Explain how temperature affects the amount and pressure of evaporated liquid

VOL Common Assessment

TAKE INITIATIVE

TI3(9-12): I can formulate and investigate probing questions to further my learning.

- Charles Law Lab

THINK CRITICALLY AND CREATIVELY

TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.

- Gas Laws Simulation

COLLABORATE AND COMMUNICATE EFFECTIVELY

CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.

- Pressure Inside a Soda Can Lab

Teacher Resources: Kendall Hunt Textbook, POGIL, Formula + Reference Sheets, Conclusion Writing Guide