Park Hill School District

Building Successful Futures • Each Student • Every Day

High School Accelerated Chemistry Curriculum

Course Description: Accelerated Chemistry is a college preparatory course designed to offer students the opportunity to master the conceptual and mathematical principles of chemistry. College-bound students or those pursuing a science related career, such as medical professions, engineering, lab technology, etc. should consider taking this course. Accelerated Chemistry is a pre-requisite for AP Chemistry.

Scope and Sequence:

Timeframe	Unit	Instructional Topics
8-10 days	Unit 1: Matter and Measurement	Topic 1: Introduction Topic 2: Math Topic 3: Measurement and Calculations Topic 4: Matter
10-12 days	Unit 2: The Atom	Topic 1: Atom Topic 2: Electrons Topic 3: Periodic Table
10-12 days	Unit 3: Nomenclature	Topic 1: Ionic Nomenclature Topic 2: Covalent Nomenclature Topic 3: Acid Nomenclature Topic 4: Simple Organic Nomenclature
11-13 days	Unit 4: Mole and Stoichiometry	Topic 1: Mole Topic 2: Stoichiometry
9-11 days	Unit 5: Chemical Reactions and Solutions	Topic 1: Types of Reactions Topic 2: Solutions Topic 3: Solubility
3-5 days	Unit 6: States of Matter	Topic 1: Inter vs. Intra Topic 2: Gases
7-9 days	Unit 7: Thermochemistry	Topic 1: Introduction to Energy Topic 2: Energy of Physical Processes Topic 3: Energy and Chemical Reactions
13-15 days	Unit 8: Rates of Reaction and Equilibrium	Topic 1: Kinetics Topic 2: Equilibrium Topic 3: Acids and Bases

Unit 1: Matter and Measurement

Subject: Accelerated Chemistry
Grade: 9-12
Name of Unit: Matter and Measurement
Length of Unit: 8-10 days
Overview of Unit: This unit is an introduction to scientific practices such as lab safety, lab equipment and procedures, as well as analyzing and displaying data in science. Students will become familiar with qualitative and quantitative measurements used in lab experiments and how to approach a problem thinking logically and scientifically.

Supporting Standards for unit:

- EK 1.A.2 LO 1.2 The student is able to select and apply mathematical routines to mass data to identify or infer the composition of pure substances and/or mixtures.
- EK 1.E.2 LO 1.18 The student is able to apply conservation of atoms to the rearrangement of atom in various processes.
- EK 2.A.3 LO 2.10 The student can design and/or interpret the results of a separation experiment (filtration, paper chromatography, column chromatography, or distillation) in terms of the relative strength of interactions among and between the components.
- EK 3.C.1 LO 3.10 The student is able to evaluate the classification of a process as a physical change, chemical change, or ambiguous change based on both macroscopic observations and the distinction between rearrangement of covalent interactions and noncovalent interactions.
- 9-12-ETS-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- 9-12-ETS-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.
- 9-12-ETS3-3 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.
- 9-12-ETS-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.

Essential Questions:

1. Why is lab safety important in Chemistry?
2. How are quantitative and qualitative measurements observed and analyzed in scientific experiments?
3. Why is it important to understand the mathematical relationships of the units of the metric system?

4. How is matter classified based on its composition?

Enduring Understanding/Big Ideas:

1. Lab safety is important in the chemistry lab to ensure that learning can occur in a safe environment free from distractions or harmful interactions.
2. Quantitative and qualitative measurements can be collected using scientific tools of measurement. Measurements are recorded using the metric system. Measurements can be evaluated on their accuracy and precision.
3. Conversions between units is often an essential part of unit-conversion (dimensional analysis) process. It provides a student with a basic understanding of how different units relate to one another.
4. Matter can be classified as pure substances including elements or compounds and mixtures including heterogeneous mixtures and solutions. The type of matter can be determined based on the chemical composition and distribution of particles.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
Metric System/International System of Units (SI)	Scientific method
Meter (m)	Observation
Centimeter (cm)	Hypothesis
Volume (V)	Experiment
Cubic meter (m^3)	Theory
Cubic centimeter (cm^3)	Mixture
Liter (L)	Thermometer
Milliliter (mL)	Chromatography
Mass	Paper chromatography
Weight	Distillation
Kilogram (kg)	Beaker
Gram (g)	Flask
Celsius (°C) temperature scale	Graduated cylinder
Kelvin (K) temperature scale	Pipet
Second (s)	Bunsen burner
Scientific (exponential) notation	Element
Measured numbers	Dimensional analysis
Prefix	Natural law
Accuracy	Random error
Precision	Systematic error
Uncertainty	Heterogeneous mixture
	Homogeneous mixture

Significant figures Compound Filtration Density Matter	Chemical change

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Introduction

Engaging Experience 1

Title: Safety First - Lab Safety POGIL

Suggested Length of Time: 1 day

Detailed Description/Instructions: Through the use of a POGIL activity, students will discover lab safety features and techniques to prevent accidents and injuries in the lab.

Bloom's Levels: Understand

Webb's DOK: 2

Topic 2: Math

Engaging Experience 1

Title: Significant Zeros POGIL

Suggested Length of Time: 1 day

Detailed Description/Instructions: Students will use a POGIL activity to learn how to determine which digits in a measurement are significant and which are not.

Bloom's Levels: Apply

Webb's DOK: 2

Topic 3: Measurement and Calculations

Engaging Experience 1

Title: Significant Digits and Measurement POGIL

Suggested Length of Time: 1 day

Detailed Description/Instructions: Through the use of a POGIL activity, students will be able to determine how to accurately read laboratory measuring tools

Bloom's Levels: Apply

Webb's DOK: 2

Topic 4: Matter

Engaging Experience

Title: Separation Challenge

Suggested Length of Time: 1 day

Standards Addressed

Supporting:

- EK 2.A.3 LO 2.10 The student can design and/or interpret the results of a separation experiment (filtration, paper chromatography, column chromatography, or distillation) in terms of the relative strength of interactions among and between the components.
- EK 3.C.1 LO 3.10 The student is able to evaluate the classification of a process as a physical change, chemical change, or ambiguous change based on both macroscopic observations and the distinction between rearrangement of covalent interactions and noncovalent interactions.

Detailed Description/Instructions: Students will be given a mixture which includes four different items, sand, salt, plastic pellets, and iron beads. Students must design and carry out a procedure to separate the mixture using laboratory procedures such as, filtration, separation by density, evaporation, etc.

Bloom's Levels: Apply

Webb's DOK: 3

Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.)

Experiment 0: This scenario is a lab activity in which students work through a series of stations to experience the use of different laboratory measuring tools and how different tools can provide varying levels of precision in measurement, emphasizing the concepts of estimating and uncertainty in laboratory measurements. The lab includes measuring length with a ruler, temperature using a digital thermometer, volume with a graduated cylinder, mass with a digital balance, and calculating the density of an unknown liquid and an unknown solid. The scenario also includes the use of metric measurements and conversions between units. Students will collect data digitally.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Introduction	Safety First - Lab Safety POGIL	Through the use of a POGIL activity, students will discover lab safety features and techniques to prevent accidents and injuries in the lab.	1 day
Math	Significant Zeros POGIL	Students will use a POGIL activity to learn how to determine which digits in a measurement are significant and which are not.	1 day
Measurement and Calculations	Significant Digits and Measurement POGIL	Through the use of a POGIL activity, students will be able to determine how to accurately read laboratory measuring tools	1 day
Matter	Separation Challenge	Students will be given a mixture which includes four different items, sand, salt, plastic pellets, and iron beads. Students must design and carry out a procedure to separate the mixture using laboratory procedures such as, filtration, separation by density, evaporation, etc.	1 day

Unit 2: The Atom

Subject: Accelerated Chemistry
Grade: 9-12
Name of Unit: The Atom
Length of Unit: 10-12 days
Overview of Unit: This unit will introduce atomic theory history, the structure of the atom and how it is related to the chemical properties of an atom and the arrangement of elements on the periodic table.

Priority Standards for unit:

- 9-12-PS1 -1 Use the organization of the periodic table 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.]
- 9-12-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.]
- 9-12-PS4-2 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. [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.]
- 9-12-PS4-3 Communicate technical information about how electromagnetic radiation interacts with matter. [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.]

Supporting Standards for unit:

- EK 1.B.2 LO 1.7 The student is able to describe the electronic structure of the atom, using PES data, ionization energy data, and/or Coulomb's law to construct explanations of how the energies of electrons within shells in atoms vary.
- EK 1.B.2 LO 1.8 The student is able to explain the distribution of electrons using Coulomb's law to analyze measured energies.
- EK 1.B.1 LO 1.5 The student is able to explain the distribution of electrons in an atom or ion based upon data.

- EK 1.B.1 LO 1.6 The student is able to analyze data relating to electron energies for patterns and relationships.
- EK 1.C.2 LO 1.12 The student is able to explain why a given set of data suggests, or does not suggest, the need to refine the atomic model from a classical shell model with the quantum mechanical model.
- EK 1.D.1 LO 1.13 Given information about a particular model of the atom, the student is able to determine if the model is consistent with specified evidence.
- BI 5 LO 5.1 The student is able to create or use graphical representations in order to connect the dependence of potential energy to the distance between atom and factors, such as bond order (for covalent interactions) and polarity (for intermolecular interactions), which influence the interaction strength.
- EK 1.C.1 LO 1.9 The student is able to predict and/or justify trends in atomic properties based on location on the periodic table and/or the shell model.
- EK 1.C.1 LO 1.10 Students can justify with evidence the arrangement of the periodic table and can apply periodic properties to chemical reactivity.
- EK 1.C.1 LO 1.11 The student can analyze data, based on periodicity and the properties of binary compounds, to identify patterns and generate hypotheses related to the molecular design of compounds for which data are not supplied.
- 9-12-ETS-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- 9-12-ETS-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.
- 9-12-ETS3-3 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.
- 9-12-ETS-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.
- ISTE-EMPOWERED LEARNER.1: Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences

Unwrapped Concepts (Students need to know)	**Unwrapped Skills (Students need to be able to do)**	**Bloom's Taxonomy Levels**	**Webb's DOK**
the organization of the periodic table	Use	Apply	2
the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.	Predict	Evaluate	4

mathematical representations to	Use	Apply	2
a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.	Support	evaluate	3
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.	Evaluate	evaluate	3
technical information about how electromagnetic radiation interacts with matter.	Communicate	understand	2

Essential Questions:

1. What is an atom made of?
2. How has the development of the atomic theory helped with the current understanding of the structure of the atom?
3. How can the arrangement of the periodic table be used to predict physical and chemical properties of an element?

Enduring Understanding/Big Ideas:

1. The atom is composed of negatively charged electrons, which can leave the atom, and a positively charged nucleus that is made of protons and neutrons.
2. The atomic theory has changed over time with the discovery of the subatomic particles within an atom, the nucleus, and energy levels of the electron cloud. Each subatomic particle affects the identity, stability and reactivity of the atom.
3. Elements have several physical and chemical properties, such as electron distribution. The repetition of these properties among the known elements places them within groups, or families, that share similar properties. Therefore, the location of an element on the periodic table can be used to predict what physical and chemical properties an element possesses.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
	Atom Proton Neutron Electron Nucleus Bohr model Quantum mechanical model Atomic number Mass number Average atomic mass Group Period Alkali metals Alkaline earth metals Transition metals Halogens Noble gases Metals Nonmetals Metalloids Amu Nuclide notation Hyphen notation Isotope Valence electron Atomic radius Electronegativity Reactivity Lewis (electron) dot structure Lewis (electron) dot diagram Ion Cation Anion Ionic bond Covalent bond Octet rule Oxidation number

	Chemical formula Formula unit Molecules Electromagnetic radiation Shell model Electron configuration Orbital (box) diagram Law of definite proportions Law of multiple proportions

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Atom

Engaging Experience 1

Title: Build an Atom PhET Simulation

Suggested Length of Time: 1 day

Standards Addressed

Priority:

- 9-12-PS1 -1 Use the organization of the periodic table to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

Supporting:

- 9-12-ETS-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.
- ISTE-EMPOWERED LEARNER1: Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences

Detailed Description/Instructions: Students use an online simulation to discover the structure of the atom, including the charge and location of subatomic particles. Magnitude and charges of ions are also introduced.

Bloom's Levels: Evaluate

Webb's DOK: 3

Topic 2: Electrons

Engaging Experience 1

Title: Electron Configuration POGIL Activity

Suggested Length of Time: 1 day

Standards Addressed

Priority:

- 9-12-PS1 -1 Use the organization of the periodic table to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
- 9-12-PS1 -1 Use the organization of the periodic table to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

Supporting:

- EK 1.B.1 LO 1.5 The student is able to explain the distribution of electrons in an atom or ion based upon data.

Detailed Description/Instructions: The student will utilize a guided discovery activity to determine the electronic structure of an atom based upon its location on the periodic table.

Bloom's Levels: Apply

Webb's DOK: 2

Topic 3: Periodic Table

Engaging Experience 1

Title: Organizing the Periodic Table Activity

Suggested Length of Time: 1 day

Standards Addressed

Priority:

- 9-12-PS1 -1 Use the organization of the periodic table to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

Supporting:

- EK 1.C.1 LO 1.9 The student is able to predict and/or justify trends in atomic properties based on location on the periodic table and/or the shell model.

Detailed Description/Instructions: The student will be able to describe the atomic structure of an element and how it relates to the organization of the periodic table.

Bloom's Levels: Apply

Webb's DOK: 2

Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.) Element Project: This scenario involves each student selecting an element to research and present. The presentation of element information will include atomic structure, most common isotopes, physical and chemical properties, and examples of compounds formed by the element. Presentations will utilize digital tools chosen by the student, per teacher approval.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Atom	Build an Atom PhET Simulation 	Students use an online simulation to discover the structure of the atom, including the charge and location of subatomic particles. Magnitude and charges of ions are also introduced.	1 day
Electrons	Electron Configuration POGIL Activity	The student will utilize a guided discovery activity to determine the electronic structure of an atom based upon its location on the periodic table.	1 day
Periodic Table	Organizing the Periodic Table Activity	The student will be able to describe the atomic structure of an element and how it relates to the organization of the periodic table.	1 day

Unit 3: Nomenclature

Subject: Accelerated Chemistry
Grade: 9-12
Name of Unit: Nomenclature
Length of Unit: 10-12 days
Overview of Unit: In this unit, students will be able to name compounds and write formulas for compounds, including ionic, covalent, acidic, and simple organic compounds.

Priority Standards for Unit:

- 9-12-PS1-2 Construct and revise an explanation for the products 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, or of oxygen and hydrogen.]

Supporting Standards for unit:

- EK 3.B.1 LO 3.6 The student is able to use data from synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.

Essential Questions:

1. Why is it important to distinguish between the four main types of compounds? (ionic, covalent, acidic and organic)
2. How does identifying the type of compound allow one to write and name common compounds (ionic, covalent, acidic and organic)?

Enduring Understanding/Big Ideas:

1. There are four different systems in place for each of the different types of compounds (ionic, covalent, acidic and organic). One must understand which process must be followed.
2. Being able to identify the basic type of compound will allow one to give the proper name and/or formula of the compound.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
	Anion Cation Binary compound Ternary compound

	Ionic Covalent Acid Organic Oxidation number (charge) Prefix Mono- Di- Tri- Tetra- Penta- Hexa- Hepta- Octa- Nona- Deca- Polyatomic ion

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Ionic Nomenclature

Engaging Experience 1

Title: Naming Ionic Compounds & Polyatomic Ions POGIL

Suggested Length of Time: 1 day

Standards Addressed:

Priority:

- 9-12-PS1-2 Construct and revise an explanation for the products 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.

Supporting:

- EK 3.B.1 LO 3.6 The student is able to use data from synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.

Detailed Description/Instructions: Through the use of a POGIL activity, the student will be able to write the names of ionic compounds, given the formula, and write the formula, given the name. This includes both binary and ternary ionic compounds.

Bloom's Levels: Apply

Webb's DOK: 2

Topic 2: Covalent (Molecular) Nomenclature

Engaging Experience 1

Title: Naming Molecular Compounds POGIL

Suggested Length of Time: 1 day

Standards Addressed:

Priority:

- 9-12-PS1-2 Construct and revise an explanation for the products 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.

Supporting:

- EK 3.B.1 LO 3.6 The student is able to use data from synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.

Detailed Description/Instructions: Through the use of a POGIL activity, the student will be able to write the names of molecular compounds, given the formula, and write the formula, given the name, for binary compounds.

Bloom's Levels: Apply

Webb's DOK: 2

Topic 3: Acid Nomenclature

Engaging Experience 1

Title: Naming Acids POGIL Activity

Suggested Length of Time: 1 day

Standards Addressed:

Priority:

- 9-12-PS1-2 Construct and revise an explanation for the products 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.

Supporting:

- EK 3.B.1 LO 3.6 The student is able to use data from synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.

Detailed Description/Instructions: Through the use of a POGIL activity, the student will be able to write the names of acid compounds, given the formula, and write the formula, given the name.

Bloom's Levels: Apply

Webb's DOK: 2

Topic 4: Simple Organic Nomenclature

Engaging Experience 1

Title: Organic Nomenclature POGIL

Suggested Length of Time: 1 day

Standards Addressed:

Priority:

- 9-12-PS1-2 Construct and revise an explanation for the products 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.

Supporting:

- EK 3.B.1 LO 3.6 The student is able to use data from synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.

Detailed Description/Instructions: Through the use of a POGIL activity, the student will be able to write the names of simple organic compounds, given the formula, and write the formula, given the name.

Bloom's Levels: Apply

Webb's DOK: 2

Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.)

Nomenclature and Household compounds: Students will take a variety of household substances to identify the name and formula of the main ingredient of the substance and any safety issues attributed to each.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Ionic Nomenclature	Naming Ionic Compounds & Polyatomic Ions POGIL	Through the use of a POGIL activity, the student will be able to write the names of ionic compounds, given the formula, and write the formula, given the name. This includes both binary and ternary ionic compounds.	1 day
Covalent (Molecular) Nomenclature	Naming Molecular Compounds POGIL	Through the use of a POGIL activity, the student will be able to write the names of molecular compounds, given the formula, and write the formula, given the name, for binary compounds.	1 day
Acid Nomenclature	Naming Acids POGIL Activity	Through the use of a POGIL activity, the student will be able to write the names of acid compounds, given the formula, and write the formula, given the name.	1 day
Simple Organic Nomenclature	Organic Nomenclature POGIL	Through the use of a POGIL activity, the student will be able to write the names of simple organic compounds, given the formula, and write the formula, given the name.	1 day

Unit 4: Mole and Stoichiometry

Subject: Accelerated Chemistry
Grade: 9-12
Name of Unit: Mole and Stoichiometry
Length of Unit: 11-13 days
Overview of Unit: This unit focuses on the mole and its application to chemical reactions. Students will mathematically determine the quantitative relationship between reactants and products, limiting and excess reactants, and balance chemical equations using mole ratios.

Priority Standards for unit:

- 9-12-PS1-2 Construct and revise an explanation for the products 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, or of oxygen and hydrogen.]
- 9-12-PS1-8 Use symbolic representations and mathematical calculations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Clarification Statement: Emphasis is on conservation of matter and mass through balanced chemical equations, use of the mole concept and proportional relationships.]

Supporting Standards for unit:

- EK 1.A.1 LO 1.1 The student can justify the observation that the ratio of the masses of the constituent elements in any pure sample of that compound is always identical on the basis of the atomic molecular theory.
- EK 1.A.2 LO 1.3 The student is able to select and apply mathematical relationships to mass data in order to justify a claim regarding the identity and/or estimated purity of a substance.
- EK 1.A.3 LO 1.4 The student is able to connect the number of particles, moles, mass, and volume of substances to one another, both qualitatively and quantitatively.
- EK 1.D.2 LO 1.14 The student is able to use data from mass spectrometry to identify the elements and the masses of individual atoms of a specific element.
- EK 1.E.2 LO 1.19 The student can design, and/or interpret data from, an experiment that uses gravimetric analysis to determine the concentration of an analyte in a solution.
- EK 1.E.2 LO 1.20 The student can design, and/or interpret from, an experiment that uses titration to determine the concentration of an analyte solution.
- EK 3.A.2 LO 3.3 The student is able to use stoichiometric calculations to predict the results of performing a reaction in the laboratory and/or to analyze deviations from the expected results.

- EK 3.A.2 LO 3.4 The student is able to relate quantities (measured mass of substances, volumes of solutions, or volumes and pressures of gases) to identify stoichiometric relationships for a reaction, including situations involving limited reactants and situations in which the reaction has not gone to completion.
- 9-12-ETS-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- 9-12-ETS-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.
- 9-12-ETS3-3 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.
- 9-12-ETS-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.

Unwrapped Concepts (Students need to know)	**Unwrapped Skills (Students need to be able to do)**	**Bloom's Taxonomy Levels**	**Webb's DOK**
an explanation for the products 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	construct	understand	2
an explanation for the products 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	revise	analyze	3
symbolic representations and mathematical calculations.	use	apply	2
the claim that atoms, and therefore mass, are conserved during a chemical reaction.	support	evaluate	3

Essential Questions:

1. How can the mole be used as a means of counting particles in chemistry?
2. How can the ratio determined by a chemical reaction be used to determine an unknown?

Enduring Understanding/Big Ideas:

1. The mole is the fundamental unit for counting numbers of particles on the macroscopic level and allows quantitative connections to be drawn between laboratory experiments, which occur at the macroscopic level, and chemical processes, which occur at the atomic level.
2. Quantitative information can be derived from stoichiometric calculations that utilize the mole ratios from the balanced chemical equations.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
Coefficient Conversion factor	Mole Avogadro's number Molar mass Representative particles Dimensional analysis Average atomic mass Percent composition Empirical formula Molecular formula Mass spectrometry Chemical equation Chemical reaction Reactants products Stoichiometry Mole ratio Limiting reactant Excess reactant Theoretical yield Actual yield Percent yield Mass spectrometer

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Mole

Engaging Experience 1

Title: Percent Copper in Brass Lab (Flinn)

Suggested Length of Time: 2-3 days

Standards Addressed

Priority:

- 9-12-PS1-2 Use symbolic representations and mathematical calculations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Supporting:

- ISTE-EMPOWERED LEARNER1: Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.

Detailed Description/Instructions: Through the use of a laboratory activity, students will plan and conduct a laboratory procedure to determine the percent by mass of copper in a brass bead.

Bloom's Levels: Apply

Webb's DOK: 3

Topic 2: Stoichiometry

Engaging Experience 1

Title: S'mores Activity

Suggested Length of Time: 1 day

Standards Addressed

Priority:

- 9-12-PS1-8 Use symbolic representations and mathematical calculations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Detailed Description/Instructions: Through the use of a laboratory activity, students will learn the concepts of stoichiometry and the mole, and apply them to determine the correct ratio of parts to complete s'mores. The concepts of limiting and excess reactants are also addressed.

Bloom's Levels: Understand

Webb's DOK: 2

Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.)

Students will perform a lab activity to determine mole ratios within a chemical reaction that includes limiting and excess reactants.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Mole	Percent Copper in Brass Lab (Flinn) 	Through the use of a laboratory activity, students will plan and conduct a laboratory procedure to determine the percent by mass of copper in a brass bead.	2-3 days
Stoichiometry	S'mores Activity	Through the use of a laboratory activity, students will learn the concepts of stoichiometry and the mole, and apply them to determine the correct ratio of parts to complete s'mores. The concepts of limiting and excess reactants are also addressed.	1 day

Unit 5: Chemical Reactions and Solutions

Subject: Accelerated Chemistry
Grade: 9-12
Name of Unit: Chemical Reactions and Solutions
Length of Unit: 9-11 days
Overview of Unit: In this unit, students will be able to identify the four different types of chemical reactions. They will also develop an understanding of solutions, dilution, and the factors affecting solubility.

Priority Standards for unit:

- 9-12-PS1-2 Construct and revise an explanation for the products 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, or of oxygen and hydrogen.]
- EK 2.A.3 LO 2.9 The student is able to create or interpret representations that link the concept of molarity with particle views of solutions.

Supporting Standards for unit:

- EK BI 3 LO 3.1 Students can translate among macroscopic observations of change, chemical equations, and particle views.
- EK 3.A.1 LO 3.2 The student can translate an observed chemical change into a balanced chemical equation and justify the choice of equation type (molecular, ionic, or net ionic) in terms of utility for the given circumstances.
- EK 3.B.1 LO 3.5 The student is able to design a plan in order to collect data on the synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.
- EK 3.B.3 LO 3.8 The student is able to identify redox reactions and justify the identification in terms of electron transfer.
- EK 6.C.3 LO 6.23 The student can interpret data regarding the relative solubility of salts in terms of factors (common ions, pH) that influence the solubility.
- EK 1.E.1 LO 1.17 The student is able to express the law of conservation of mass quantitatively and qualitatively using symbolic representations and particulate drawings.
- 9-12-ETS-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- 9-12-ETS-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.
- 9-12-ETS3-3 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.

- 9-12-ETS-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.
- ISTE-EMPOWERED LEARNER.1: Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.

Unwrapped Concepts (Students need to know)	**Unwrapped Skills (Students need to be able to do)**	**Bloom's Taxonomy Levels**	**Webb's DOK**
Construct an explanation for the products 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	construct	understand	2
Revise an explanation for the products 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	revise	evaluate	3
Representations that link the concept of molarity with particle views of solutions	Create	Create	3
Representations that link the concept of molarity with particle views of solutions	Interpret	Analyze	3

Essential Questions:

1. How can chemical reactions be classified?
2. Why is it important to understand the composition of a solution?
3. What are some common factors that affect solubility of a substance?

Enduring Understanding/Big Ideas:

1. Chemical reactions can be classified into one of four groups, redox, precipitation, combustion and acid-base.
2. Solutions are composed of a solute, the substance being dissolved, and a solvent, the substance, usually present in greater amounts. The amount of solute/solvent allows one to determine concentration and its effect on absorption.
3. In a chemical setting there are some outside influences which will determine how much solute can be dissolved (temperature, nature of the substance, etc..).

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
Solution Solvent Solute Concentration Dilution Solubility	Redox reaction Chemical reaction Precipitation reaction Acid-base reaction Combustion reaction Molarity Beer's law Precipitate

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Types of Reactions

Engaging Experience 1

Title: Classifying Chemical Reactions Lab

Suggested Length of Time: 60 minutes

Standards Addressed

Priority:

- 9-12-PS1-2 Construct and revise an explanation for the products 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.

Supporting:

- EK 3.B.3 LO 3.8 The student is able to identify redox reactions and justify the identification in terms of electron transfer.
- ISTE-EMPOWERED LEARNER.1: Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.

Detailed Description/Instructions: The students will investigate different types of chemical reactions through the use of a laboratory investigation.

Bloom's Levels: Understand

Webb's DOK: 2

Topic 2: Solutions

Engaging Experience 1

Title: Beer's Law Lab PhET

Suggested Length of Time: 45-60 minutes

Standards Addressed

Priority:

- EK 2.A.3 LO 2.9 The student is able to create or interpret representations that link the concept of molarity with particle views of solutions.

Supporting:

- 9-12-ETS-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.
- ISTE-EMPOWERED LEARNER1: Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.

Detailed Description/Instructions: Through the use on an online PhET simulation activity, students will be introduced to Beer's law and the effect a solution's concentration on the amount of the amount of light transmitted through the solution.

Bloom's Levels: Apply

Webb's DOK: 3

Topic 3: Solubility

Engaging Experience 1

Title: Solubility POGIL Activity

Suggested Length of Time: ~30-45 minutes

Standards Addressed

Priority:

- 9-12-PS1-2 Construct and revise an explanation for the products 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

Supporting:

- EK 6.C.3 LO 6.23 The student can interpret data regarding the relative solubility of salts in terms of factors (common ions, pH) that influence the solubility.

Detailed Description/Instructions: Through the use of a POGIL activity, students will learn the definition of solubility and that different substances have different solubilities. Students will also be exposed to factors that affect solubility as well as learn how to interpret a solubility curve.

Bloom's Levels: Apply

Webb's DOK: 2

Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.) Solutions lab: Students will perform a lab which will reinforce the concepts of solution composition, dilution and Beer's law.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Types of Reaction	Classifying Chemical Reactions Lab	The students will investigate different types of chemical reactions through the use of a laboratory investigation.	60 minutes
Solutions	Beer's Law Lab PhET	Through the use on an online PhET simulation activity, students will be introduced to Beer's law and the effect a solution's concentration on the amount of the amount of light transmitted through the solution.	45-60 minutes
Solubility	Solubility POGIL Activity	Through the use of a POGIL activity, students will learn the definition of solubility and that different substances have different solubilities. Students will also be exposed to factors that affect solubility as well as learn how to interpret a solubility curve.	30-45 minutes

Unit 6: States of Matter

Subject: Accelerated Chemistry
Grade: 9-12
Name of Unit: States of Matter
Length of Unit: 3-5 days
Overview of Unit: In this unit, students will learn about the basic differences between intramolecular and intermolecular forces. In addition, students will learn about the qualitative relationship among variables, such as, pressure, temperature, and volume, within gases.

Priority Standards for unit:

- 9-12-PS1-2 Construct and revise an explanation for the products 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, or of oxygen and hydrogen.]
- 9-12-PS1-3 Plan and conduct an investigation to gather evidence to compare physical and chemical properties of substances such as melting point, boiling point, vapor pressure, surface tension, and chemical reactivity to infer the relative strength of attractive forces between particles. [Clarification Statement: Emphasis is on understanding the relative strengths of forces between particles. Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite).
- 9-12-PS1-4 Apply the concepts of bonding and crystalline/molecular structure to explain the macroscopic properties of various categories of structural materials, i.e. metals, ionic (ceramics), and polymers. [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.]

Supporting Standards for unit:

- EK 2.A.2 LO 2.4 The student is able to use KMT and concepts of intermolecular forces to make predictions about the macroscopic properties of gases, including both ideal and nonideal behaviors.
- EK 2.A.2 LO 2.5 The student is able to refine multiple representations of a sample of matter in the gas phase to accurately represent the effect of changes in macroscopic properties on the sample.
- BI 2 LO 2.1 Students can predict properties of substances based on their chemical formulas, and provide explanations of their properties based on particle views.

- EK 2.B.3 LO 2.16 The student is able to explain the properties (phase, vapor pressure, viscosity, etc.) of small and large molecular compounds in terms of the strengths and types of intermolecular forces.
- EK 5.D.2 LO 5.10 The student can support the claim about whether a process is a chemical or physical change (or may be classified as both) based on whether the process involves changes in intramolecular versus intermolecular interactions.
- 9-12-ETS-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- 9-12-ETS-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.
- 9-12-ETS3-3 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.
- 9-12-ETS-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.

Unwrapped Concepts (Students need to know)	**Unwrapped Skills (Students need to be able to do)**	**Bloom's Taxonomy Levels**	**Webb's DOK**
an explanation for the products 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	construct	understand	2
an explanation for the products 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	revise	evaluate	3
an investigation to gather evidence to compare physical and chemical properties of substances such as melting point, boiling point, vapor pressure, surface tension, and chemical reactivity to infer the relative	plan	apply	3

strength of attractive forces between particles.			
an investigation to gather evidence to compare physical and chemical properties of substances such as melting point, boiling point, vapor pressure, surface tension, and chemical reactivity to infer the relative strength of attractive forces between particles.	conduct	apply	3
the concepts of bonding and crystalline/molecular structure to explain the macroscopic properties of various categories of structural materials, i.e. metals, ionic (ceramics), and polymers.	apply	Apply	2
the macroscopic properties of various categories of structural materials, i.e. metals, ionic (ceramics), and polymers.	explain	understand	3

Essential Questions:

1. How do the basic differences between intramolecular and intermolecular forces determine basic differences in physical properties of a substance?
2. How does the kinetic molecular theory allow us to understand the relationships between the different gas variables and their effect on one another?

Enduring Understanding/Big Ideas:

1. Students should be able to distinguish the between intermolecular and intramolecular attraction. A student should be able to use quantitative data to make a prediction on type of attraction is present.
2. The gas variables (temperature, pressure, volume and moles) are very much related to one another. Once a change in a gas variable is made, it will affect the others in some way.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
Melting point Boiling point Property	Intramolecular force Intermolecular force Chemical property Physical property Pressure Temperature Volume

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Inter vs. Intra

Engaging Experience 1

Title: Intermolecular Forces POGIL

Suggested Length of Time: 1 day

Standards Addressed

Priority:

- 9-12-PS1-3 Plan and conduct an investigation to gather evidence to compare physical and chemical properties of substances such as melting point, boiling point, vapor pressure, surface tension, and chemical reactivity to infer the relative strength of attractive forces between particles.

Supporting:

- EK 2.A.2 LO 2.4 The student is able to use KMT and concepts of intermolecular forces to make predictions about the macroscopic properties of gases, including both ideal and nonideal behaviors.

Detailed Description/Instructions: Through the use of a POGIL activity, the student will be introduced to the difference between intermolecular and intramolecular forces and their effects on the properties of a substance.

Bloom's Levels: Apply

Webb's DOK: 2

Topic 2: Gases

Engaging Experience 1

Title: Gas Variables POGIL

Suggested Length of Time: 1 day

Standards Addressed

Priority:

- 9-12-PS1-3 Plan and conduct an investigation to gather evidence to compare physical and chemical properties of substances such as melting point, boiling point, vapor pressure, surface tension, and chemical reactivity to infer the relative strength of attractive forces between particles.

Supporting:

- EK 2.A.2 LO 2.4 The student is able to use KMT and concepts of intermolecular forces to make predictions about the macroscopic properties of gases, including both ideal and nonideal behaviors.
- EK 2.A.2 LO 2.5 The student is able to refine multiple representations of a sample of matter in the gas phase to accurately represent the effect of changes in macroscopic properties on the sample.

Detailed Description/Instructions: Through the use of a POGIL activity, students will discover the qualitative relationship between pressure, temperature, and volume of gases.

Bloom's Levels: Apply

Webb's DOK: 2

Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.)

Students will be performing a lab dealing with the gas laws and how the gas variables relate to each other. Examples include the Vernier Boyle's Law and/or Charles Law labs.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Inter vs. Intra	Intermolecular Forces POGIL	Through the use of a POGIL activity, the student will be introduced to the difference between intermolecular and intramolecular forces and their effects on the properties of a substance.	1 day
Gases	Gas Variables POGIL	Through the use of a POGIL activity, students will discover the qualitative relationship between pressure, temperature, and volume of gases.	1 day

Unit 7: Thermochemistry

Subject: Accelerated Chemistry
Grade: 9-12
Name of Unit: Thermochemistry
Length of Unit: 7-9 days
Overview of Unit: Using the law of conservation of energy students will learn about the transformation of energy between different types such as potential and kinetic energy. Students will also learn about endothermic and exothermic processes, as well as enthalpy.

Priority Standards for unit:

- 9-12-PS1-5 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.]
- 9-12-PS3- 1 Create a computational model to calculate the change in the energy of one component in a system when the changes in energy are known. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.]
- 9-12-PS3 -3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.]
- 9-12-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.]

Supporting Standards for unit:

- EK 5.B.1 and 5.B.2 LO 5.5 The student is able to use conservation of energy to relate the magnitudes of the energy changes when two nonreacting substances are mixed or brought into contact with one another.

- EK 5.B.3 LO 5.6 The student is able to use calculations or estimates to relate energy changes associated with heating/cooling a substance to the heat capacity, relate energy changes associated with a phase transition to the enthalpy of fusion/vaporization, relate energy changes associated with a chemical reaction to the enthalpy of the reaction, and relate energy changes to PΔV work.
- EK 5.B.4 LO 5.7 The student is able to design and/or interpret the results of an experiment in which calorimetry is used to determine the change in enthalpy of a chemical process (heating/cooling, phase transition, or chemical reaction) at constant pressure.
- EK 5.C.2 LO 5.8 The student is able to draw qualitative and quantitative connections between the reaction enthalpy and the energies involved in the breaking and formation of chemical bonds.
- EK 3.C.2 LO 3.11 The student is able to interpret observations regarding macroscopic energy changes associated with a reaction or process to generate a relevant symbolic and/or graphical representation of the energy changes.
- 9-12-ETS-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- 9-12-ETS-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.
- 9-12-ETS3-3 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.
- 9-12-ETS-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.
- ISTE-EMPOWERED LEARNER.1: Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.

Unwrapped Concepts (Students need to know)	**Unwrapped Skills (Students need to be able to do)**	**Bloom's Taxonomy Levels**	**Webb's DOK**
a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.	Develop	Apply	2
a computational model to calculate the change in the energy of one component in a system when the changes in energy are	Create	Create	4

known.			
build, and refine a device that works within given constraints to convert one form of energy into another form of energy.	Design	Create	3
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	Plan	Apply	3
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).	Conduct	Apply	3

Essential Questions:

1. How is energy transformed to obey the law of conservation of energy?
2. How can the specific heat of a substance be used to illustrate the transfer of thermal energy from one substance to another?
3. How does the transfer of thermal energy affect the state of matter in terms of potential and kinetic energy?

Enduring Understanding/Big Ideas:

1. The law of conservation of energy states that energy cannot be created or destroyed; therefore, it must be transformed from one type to another. For example, potential energy can be converted into kinetic energy.
2. Specific heat is a physical property that can be used to calculate the thermal energy of a substance in the equation $Q=mc\Delta T$. If energy is transferred between two substances, the relationship of $Q_1= Q_2$ can be used to determine the properties of m, c, or ΔT of each substance.

3. Thermal energy transfer can change the state of matter of a substance. Heating and cooling curves are a graphical means for illustrating the changes in potential and kinetic energy of the states of matter of a substance.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
Calorie	Law of conservation of energy Energy Thermal energy Heat Joule calorie Specific heat Potential energy Kinetic energy Mechanical energy Chemical energy Renewable energy Heating curve Cooling curve Phase diagram

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Introduction to Energy

Engaging Experience 1

Title: Calorimetry POGIL

Suggested Length of Time: 45-60 minutes

Standards Addressed

Priority:

- 9-12-PS3- 1 Create a computational model to calculate the change in the energy of one component in a system when the changes in energy are known.

Supporting:

- EK 5.B.1 and 5.B.2 LO 5.5 The student is able to use conservation of energy to relate the magnitudes of the energy changes when two nonreacting substances are mixed or brought into contact with one another.

Detailed Description/Instructions: Through the use of a POGIL activity, the student will be able to identify how mass, temperature, heat energy, and the type of substance are related.

Bloom's Levels: Apply

Webb's DOK: 2

Topic 2: Energy of Physical Processes

Engaging Experience 1

Title: Design a Hand Warmer

Suggested Length of Time: 2 days

Standards Addressed

Priority:

- 9-12-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)

Supporting:

- EK 5.B.3 LO 5.6 The student is able to use calculations or estimates to relate energy changes associated with heating/cooling a substance to the heat capacity, relate energy changes associated with a phase transition to the enthalpy of fusion/vaporization, relate energy changes associated with a chemical reaction to the enthalpy of the reaction, and relate energy changes to PΔV work.
- ISTE-EMPOWERED LEARNER.1: Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.

Detailed Description/Instructions: Students will plan and conduct an experiment testing different substances that are dissolved in water and calculate the amount of energy produced.

Bloom's Levels: Create and Apply

Webb's DOK: 3

Topic 3: Energy and Chemical Reactions

Engaging Experience 1

Title: Pogil: Energy and Chemical Reactions

Suggested Length of Time: 1 day

Standards Addressed

Priority:

- 9-12-PS1-5 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.

Supporting:

- EK 5.B.4 LO 5.7 The student is able to design and/or interpret the results of an experiment in which calorimetry is used to determine the change in enthalpy of a chemical process (heating/cooling, phase transition, or chemical reaction) at constant pressure.

Detailed Description/Instructions: Students work through a POGIL on Energy and Chemical Reactions

Bloom's Levels: Apply

Webb's DOK: 2

Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.) Experiment: Enthalpy of chemical reactions lab- Students perform different experiments to combine Enthalpies for another reaction.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Introduction to Energy	Calorimetry POGIL	Through the use of a POGIL activity, the student will be able to identify how mass, temperature, heat energy, and the type of substance are related.	45-60 min
Energy of Physical Processes	Design a Hand Warmer 	Students will plan and conduct an experiment testing different substances that are dissolved in water and calculate the amount of energy produced.	2 days
Energy and Chemical Reactions	POGIL: Energy and Chemical Reactions	Students work through a POGIL on Energy and Chemical Reactions	1 day

Unit 8: Rates of Reaction and Equilibrium

Subject: Accelerated Chemistry
Grade: 9-12
Name of Unit: Rates of Reaction and Equilibrium
Length of Unit: 13-15 days
Overview of Unit: Students will use their knowledge of chemical reactions to study factors that can affect the rate at which the reaction occurs. Using Le Chatelier's Principle, students will study the concept of equilibrium and neutralization reactions between acids and bases.

Priority Standards for unit:

- 9-12-PS1-6 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.]
- 9-12-PS1-7 Refine the design of a chemical system by specifying a change in conditions that would alter the amount 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.]
- BI 2 LO 2.2 The student is able to explain the relative strengths of acids and bases based on molecular structure, interparticle forces, and solution equilibrium.

Supporting Standards for unit:

- BI 2 LO 2.2 The student is able to explain the relative strengths of acids and bases based on molecular structure, interparticle forces, and solution equilibrium.
- EK 3.B.2 LO 3.7 The student is able to identify compounds as Bronsted-Lowry acids, bases, and/or conjugate acid-base pairs, using proton-transfer reactions to justify the identification.
- EK 4.A.1 LO 4.1 The student is able to design and/or interpret the results of an experiment regarding the factors (i.e., temperature, concentration, surface area) that may influence the rate of a reaction.
- EK 5.E.4. LO 5.16 The student can use Le Chatelier's principle to make qualitative predictions for systems in which coupled reactions that share a common intermediate drive formation of a product.
- EK 6.A.1 LO 6.1 The student is able to, given a set of experimental observations regarding physical, chemical, biological, or environmental processes that are reversible,

construct an explanation that connects the observations to the reversibility of the underlying chemical reactions or processes.

- EK 6.A.3 LO 6.3 The student can connect kinetics to equilibrium, such as Le Chatelier's principle, to infer the relative rates of the forward and reverse reactions.
- EK 6.A.4 LO 6.7 The student is able, for a reversible reaction that has a large or small *K*, to determine which chemical species will have very large versus small concentrations at equilibrium.
- EK 6.B.1 LO 6.8 The student is able to use Le Chatelier's principle to predict the direction of the shift resulting from various possible stresses on a system at chemical equilibrium.
- EK 6.B.1 LO 6.9 The student is able to use Le Chatelier's principle to design a set of conditions that will optimize a desired outcome, such as product yield.
- EK 6.B.2 LO 6.10 The student is able to connect Le Chatelier's principle to the comparison of *Q* to *K* by explaining the effects of the stress on *Q* and *K*.
- EK 6.C.1 LO 6.12 The student can reason about the distinction between strong and weak acid solutions with similar values of pH, including the percent ionization of the acids, the concentrations needed to achieve the same pH, and the amount of base needed to reach the equivalence point in a titration.
- EK 6.C.1 LO 6.14 The student can, based on the dependence of K_w on temperature, reason that neutrality requires $[H^+] = [OH^-]$ as opposed to requiring pH = 7, including especially the applications to biological systems.
- EK 6.C.1 LO 6.15 The student can identify a given solution as containing a mixture of strong acids and/or bases and calculate or estimate the pH (and concentrations of all chemical species) in the resulting solution.
- EK 6.C.1 LO 6.16 The student can identify a given solution as being the solution of a monoprotic weak acid or base (including slts in which one ion is a weak acid or base), calculate the pH and concentration of all species in the solution, and/or infer the relative strengths of the weak acids or bases from given equilibrium concentrations.
- 9-12-ETS-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- 9-12-ETS-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.
- 9-12-ETS3-3 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.
- 9-12-ETS-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.

- ISTE-EMPOWERED LEARNER.1: Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.

Unwrapped Concepts (Students need to know)	Unwrapped Skills (Students need to be able to do)	Bloom's Taxonomy Levels	Webb's DOK
scientific principles and evidence	Apply	Apply	3
an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.	Provide	Evaluate	4
the design of a chemical system by specifying a change in conditions that would alter the amount of products at equilibrium.	Refine	Create	2
The relative strengths of acids and bases based on molecular structure	Explain	Understand	2
The relative strengths of acids and bases based on interparticle forces	Explain	Understand	2
The relative strengths of acids and bases based on solution equilibrium	Explain	Understand	2

Essential Questions:

1. How does collision theory explain why temperature, concentration, surface area, and catalysts affect the rate of reaction between substances?
2. How does a system at equilibrium re-establish its equilibrium when a stress acts upon it?
3. How do acid/base reactions relate to equilibrium?
4. Why is it important to understand the magnitude of K (equilibrium constant)?

Enduring Understanding/Big Ideas:

1. The collision theory explains how the increased interaction between substances by temperature change, concentration, surface area, or use of a catalyst will result in a faster reaction rate.

2. Le Chatelier's Principle describes how the change in amounts or concentrations of products, reactants, and catalysts within a chemical reaction can shift the equilibrium of the reaction in a certain direction.
3. The pH scale displays the acidity and basicity of chemical substances. When an acid and a base react with one another, water and a salt are produced which neutralizes the pH thus giving the name to the reaction, a neutralization reaction. An imbalance of H^+ and OH^- ions within a neutralization reaction will result in the production of an acid or a base.
4. The equilibrium constant allows you to determine which side of the reaction is 'favored' or how close to completion the reaction has gone.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
	Collision theory Concentration Dilution Catalyst Surface area Activation energy Chemical equilibrium Le Chatelier's Principle Rate of reaction Reversible reaction Acids Bases Amphoteric Neutral pH pH scale Neutralization reaction Indicator Salt Strong acid Weak acid Strong base Weak base K expression Kp Kc

	Basic rate law Initial rate method Polyprotic dissociation pOH + pH Bronsted-Lowry acids & bases

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Kinetics

Engaging Experience 1

Title: Rate of the Decomposition of Calcium Carbonate Lab (Flinn)

Suggested Length of Time: 1 day

Standards Addressed

Priority:

- 9-12-PS1-6 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.]

Supporting:

- EK 4.A.1 LO 4.1 The student is able to design and/or interpret the results of an experiment regarding the factors (i.e., temperature, concentration, surface area) that may influence the rate of a reaction.
- ISTE-EMPOWERED LEARNER.1: Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.

Detailed Description/Instructions: Students will collect a volume of gas during a period of time to determine the rate of the decomposition reaction of calcium carbonate.

Bloom's Levels: Evaluate

Webb's DOK: 4

Topic 2: Equilibrium

Engaging Experience 1

Title: Equilibrium Activity with straws

Suggested Length of Time: 1 day

Standards Addressed

Priority:

- 9-12-PS1-7 Refine the design of a chemical system by specifying a change in conditions that would alter the amount 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

Supporting:

- EK 6.A.1 LO 6.1 The student is able to, given a set of experimental observations regarding physical, chemical, biological, or environmental processes that are reversible, construct an explanation that connects the observations to the reversibility of the underlying chemical reactions or processes.

Detailed Description/Instructions: Activity involving how products and reactants achieve equilibrium in different scenarios.

Bloom's Levels: Create

Webb's DOK: 2

Topic 3: Acids and Bases

Engaging Experience 1

Title: Determine the pH of Common Household Substances

Suggested Length of Time: 1 day

Standards Addressed

Priority:

- BI 2 LO 2.2 The student is able to explain the relative strengths of acids and bases based on molecular structure, interparticle forces, and solution equilibrium.

Supporting:

- ISTE-EMPOWERED LEARNER.1: Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.

Detailed Description/Instructions: Students will be determining the pH of various household items.

Bloom's Levels: Evaluate

Webb's DOK: 3

Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.)

Students will be performing the Le Chatelier's Principle Lab (Flinn) to identify the shift in an equilibrium reaction by altering a number of different variables.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Kinetics	Rate of the Decomposition of Calcium Carbonate Lab	Students will collect a volume of gas during a period of time to determine the rate of the decomposition reaction of calcium carbonate.	1 day
Equilibrium	Equilibrium Activity with Straws	Activity involving how products and reactants achieve equilibrium in different scenarios.	1 day
Acids and Bases	Determine the pH of Common Household Substances	Students will be determining the pH of various household items.	1 day

Unit of Study Terminology

Appendices: All Appendices and supporting material can be found in this course's shell course in the District's Learning Management System.

Assessment Leveling Guide: A tool to use when writing assessments in order to maintain the appropriate level of rigor that matches the standard.

Big Ideas/Enduring Understandings: Foundational understandings teachers want students to be able to discover and state in their own words by the end of the unit of study. These are answers to the essential questions.

Engaging Experience: Each topic is broken into a list of engaging experiences for students. These experiences are aligned to priority and supporting standards, thus stating what students should be able to do. An example of an engaging experience is provided in the description, but a teacher has the autonomy to substitute one of their own that aligns to the level of rigor stated in the standards.

Engaging Scenario: This is a culminating activity in which students are given a role, situation, challenge, audience, and a product or performance is specified. Each unit contains an example of an engaging scenario, but a teacher has the ability to substitute with the same intent in mind.

Essential Questions: Engaging, open-ended questions that teachers can use to engage students in the learning.

Priority Standards: What every student should know and be able to do. These were chosen because of their necessity for success in the next course, the state assessment, and life.

Supporting Standards: Additional standards that support the learning within the unit.

Topic: These are the main teaching points for the unit. Units can have anywhere from one topic to many, depending on the depth of the unit.

Unit of Study: Series of learning experiences/related assessments based on designated priority standards and related supporting standards.

Unit Vocabulary: Words students will encounter within the unit that are essential to understanding. Academic Cross-Curricular words (also called Tier 2 words) are those that can be found in multiple content areas, not just this one. Content/Domain Specific vocabulary words are those found specifically within the content.

Symbols:


This symbol depicts an experience that can be used to assess a student's 21st Century Skills using the rubric provided by the district.


This symbol depicts an experience that integrates professional skills, the development of professional communication, and/or the use of professional mentorships in authentic classroom learning activities.