Park Hill School District

Building Successful Futures • Each Student • Every Day

High School Topics Chemistry Curriculum

Course Description: This hands-on laboratory course is central to the foundation of all sciences. The course has some emphasis on mathematical applications, real-world scenarios, and problem solving. Topics of study include scientific processes, atom and the periodic table, structure of matter and its properties, chemical reactions, quantitative relationships using the mole, rates of reactions, equilibrium, energy transformation, nuclear energy, and electromagnetic radiation.

Scope and Sequence:

Timeframe	Unit	Instructional Topics
6-7 Days Modified 23-24 days	Introduction to Science Processes	Topic 1: Safety Topic 2: Measurement Topic 3: Experimental Design Topic 4: Graphical Analysis
15-16 Days Modified 28-29 days	Atoms and the Periodic Table	Topic 1: Structure of an Atom Topic 2: History of Atomic Theory Topic 3: Isotopes Topic 4: Periodic Table Trends Topic 5: Lewis dot Structures Topic 6: Types of Bonds Topic 7: Naming Binary Compounds
11-12 Days Modified 15-16 days	Structure of Matter and its Properties	Topic 1: States of Matter Topic 2: Physical and Chemical Properties/ Changes Topic 3: Types of Matter

14-15 Days	Chemical Reactions	Topic 1: Moles Topic 2: Dimensional Analysis Topic 3: Types of Reactions Topic 4: Balancing Equations Topic 5: Stoichiometry
9-10 Days Modified 3 days	Rate of Reactions/ Equilibrium	Topic 1: Collision Theory Topic 2: Factors that Affect Reaction Rate Topic 3: Equilibrium Topic 4: Acids and Bases
10-11 Days Modified 5 days	Energy Transformations	Topic 1: Law of Conservation of Energy Topic 2: Specific Heat Topic 3: Heating and Cooling Curves Topic 4: Renewable Energy Topic 5: Carbon Cycle
10-11 Days Modified 5 days	Nuclear and Electromagnetic Energy	Topic 1: Properties of Waves Topic 2: Electromagnetic Radiation Topic 3: Nuclear Reactions

**This document contains the entire High School Chemistry curriculum that is taught in a regular education setting. Items that are highlighted in yellow have been designated as priority information that should be taught in the High School Topics Chemistry class.*

Unit 1: Introduction to Science Processes

Subject: Chemistry
Grade: 9-12
Name of Unit: Introduction to Science Processes
Length of Unit: 6-7 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:

- ISTE - COMPUTATIONAL THINKER.5: Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.
- 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 is experimental design used as a means to conduct scientific investigations?
3. How are quantitative and qualitative measurements observed and analyzed in scientific experiments?
4. Why is it useful to display data and experimental evidence in charts or graphs?

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. Experiments are used to test hypotheses in scientific investigations. Designing reliable and valid experiments are necessary to collect, analyze, and communicate data and results that focus on scientific concepts.

3. 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.
4. Charts and graphs are a way to visually represent data. These representations can provide an analysis and summary of scientific results.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
Law Line graph Independent variable Dependent variable Metric System/International System of Units (SI) Meter (m) Centimeter (cm) Volume (V) Cubic meter (m^3) Cubic centimeter (cm^3) Liter (L) Milliliter (mL) Mass Kilogram (kg) Gram (g) Celsius (°C) temperature scale Kelvin (K) temperature scale Second (s) Scientific notation Measured numbers Prefix Accuracy Precision	Scientific method Observation Hypothesis Experiments Theory

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Safety

Engaging Experience 1

Title: POGIL Lab Safety

Suggested Length of Time: 30 minutes

Detailed Description/Instructions: This POGIL activity requires students to refer to models and tables to observe patterns and determine lab safety rules.

Bloom's Levels: Apply

Webb's DOK: 2

Topic 2: Measurement

Engaging Experience 1

Title: Rainbow Measurement Lab

Suggested Length of Time: 45 minutes

Detailed Description/Instructions: Students follow a set of instructions to measure different amounts of colored water and combine them in different test tubes. The students then evaluate the amounts in the test tube for accuracy and precision.

Bloom's Levels: Apply

Webb's DOK: 2

Topic 3: Experimental Design

Engaging Experience 1

Title: Experimental Design Activity

Suggested Length of Time: 30 minutes

Detailed Description/Instructions: Students will read a scenario and determine the variables and proper components needed to develop a lab.

Bloom's Levels: Understand

Webb's DOK: 3

Topic 4: Graphical Analysis

Engaging Experience 1

Title: Graphing Activity

Suggested Length of Time: 45 minutes

Supporting:

- ISTE - COMPUTATIONAL THINKER.5: Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.

Detailed Description/Instructions: Students will use data to construct and analyze line graphs.

Bloom's Levels: Analyze

Webb's DOK: 1

Engaging Scenario

Engaging Scenario: In this scenario student groups will be given a mineral ore and will have to design an experiment to determine the amount of the respective metal in the ore can be extracted from an ore if it were the size of the classroom.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Safety	POGIL Lab Safety	This POGIL activity requires students to refer to models and tables to observe patterns and determine lab safety rules.	30 minutes Modified 60 minutes
Measurement	Rainbow Measurement Lab	Students follow a set of instructions to measure different amounts of colored water and combine them in different test tubes. The students then evaluate the amounts in the test tube for accuracy and precision.	45 minutes modified 90 minutes
Experimental Design	Experimental Design Activity	Students will read a scenario and determine the variables and proper components needed to develop a lab.	30 minutes modified 60 minutes
Graphical Analysis	Graphing Activity	Students will use data to construct and analyze line graphs.	45 minutes modified 90 minutes

Unit 2: Atoms and the Periodic Table

Subject: Chemistry
Grade: 9-12
Name of Unit: Atoms and the Periodic Table
Length of Unit: 15-16 days
Overview of Unit: This unit will introduce 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. Students will become familiar with the function of valence electrons and how they are used to form chemical bonds between different types of elements.

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-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:

- 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	3
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

Essential Questions:

1. How has the development of the atomic theory helped with the current understanding of the structure of the atom?
2. How can the arrangement of the periodic table be used to predict physical and chemical properties of an element?
3. How are electrons involved in the formation of chemical bonds?
4. How are chemical compounds named and represented in a chemical formula?

Enduring Understanding/Big Ideas:

1. 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.
2. Elements have several physical and chemical properties including atomic radius, electronegativity, reactivity, and 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.

3. Electrons can be transferred between atoms to form an ionic bond or they can be shared between two atoms to form a covalent bond. Each type of bond can be illustrated using Lewis dot diagrams to show the valence electrons and type of bond.
4. A binary ionic compound is identified from a chemical formula using the name of the metal and nonmetal ending in -ide. A binary covalent compound is identified from a chemical formula using numeric prefixes to identify the number of each element within the compound and ending in -ide.

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 Chemical formula Formula unit Molecules

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Structure of an Atom

Engaging Experience 1

Title: What is an atom? PhET Simulation

Suggested Length of Time: 45-60 min

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 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 use a simulation to determine the structure of the atom, including location and function of the subatomic particles. Students will also determine the charge and magnitude of an ion.

Bloom's Levels: Evaluate

Webb's DOK: 3

Topic 2: History of Atomic Theory

Engaging Experience 1

Title: Thomson and Rutherford PhET Simulation

Suggested Length of Time: 30 minutes

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 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: This online simulation has students manipulate atomic models and replicate Rutherford's gold foil experiment. Students complete a worksheet with various questions to help them evaluate the results of the simulations.

Bloom's Levels: Evaluate

Webb's DOK: 3

Topic 3: Isotopes

Engaging Experience 1

Title: M & M or Bean Isotope Lab

Suggested Length of Time: 45 min

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.

Detailed Description/Instructions: Students will be given a bag of M&M's or beans and will determine the average atomic mass when given the mass for each respective color of M&M or bean. Students will also determine the number of subatomic particles in each isotope of M&M or bean.

Bloom's Levels: Apply

Webb's DOK: 2

Engaging Experience 2

Title: POGIL Isotopes

Suggested Length of Time: 45-60 minutes

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.

Detailed Description/Instructions: This POGIL activity requires students to refer to models and tables to observe patterns and determine naming rules for ionic compounds.

Bloom's Levels: Apply

Webb's DOK: 2

Topic 4: Periodic Table Trends

Engaging Experience 1

Title: Periodic Table Trends Lab

Suggested Length of Time: 90 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.

Detailed Description/Instructions: This lab requires students to uses straws and create a model that illustrates the periodic table trends of electronegativity and atomic radius. Students then evaluate the model to relate electronegativity, atomic radius, and periodic table placement to each other.

Bloom's Levels: Understand

Webb's DOK: 2

Topic 5: Lewis dot Structures

Engaging Experience 1

Title: "Loopy" Dot Diagrams

Suggested Length of Time: 45 min

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.

Detailed Description/Instructions: Students will construct Lewis dot structures for given elements, using a specific color of Fruit Loops for each element. They will then move the Fruit Loops to show what happens to the electrons during the formation of a covalent and ionic bond.

Bloom's Levels: Understand

Webb's DOK: 2

Topic 6: Types of Bonds

Engaging Experience 1

Title: Chemical Bonds Reading Article

Suggested Length of Time: 30 min

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.

Detailed Description/Instructions: Students will go through a reading and 'mark the text' with key terms, summaries, questions. Using a shoulder partner, they will share their understanding and remaining questions on the article. Then the class will discuss the types of bonding together and use the periodic table to predict the bonds formed by elements.

Bloom's Levels: Evaluate

Webb's DOK: 3

Topic 7: Naming Binary Compounds

Engaging Experience 1

Title: POGIL Naming Ionic Compounds

Suggested Length of Time: 45-60 minutes

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. [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.]

Detailed Description/Instructions: This POGIL activity requires students to refer to models and tables to observe patterns and determine naming rules for ionic compounds.

Bloom's Levels: Apply

Webb's DOK: 2

Engaging Experience 2

Title: POGIL Naming Molecular Compounds

Suggested Length of Time: 45-60 minutes

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. [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.]

Detailed Description/Instructions: This POGIL activity requires students to refer to models and tables to observe patterns and determine naming rules for molecular compounds.

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.) In this scenario, students pick a specific common element to research. Information that students would gather includes the element's atomic structure, isotopes, physical and chemical properties, and examples of compounds that it forms. The project would be presented using digital tools such as Moviemaker, Blogs, Quizlet, etc. The final presentation of research would be presented to the class.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Structure of an Atom	What is an atom? PhET Simulation	Students will use a simulation to determine the structure of the atom, including location and function of the subatomic particles. Students will also determine the charge and magnitude of an ion.	45-60 minutes Modified 90-120 minutes
History of Atomic Theory	Thomson and Rutherford PhET Simulation	This online simulation has students manipulate atomic models and replicate Rutherford's gold foil experiment. Students complete a worksheet with various questions to help them evaluate the results of the simulations.	30 minutes Modified 60 minutes
Isotopes	M & M or Bean Isotope Lab	Students will be given a bag of M&M's or beans and will determine the average atomic mass when given the mass for each respective color of M&M or bean. Students will also determine the number of subatomic particles in each isotope of M&M or bean.	45 minutes
Isotopes	POGIL Isotopes	This POGIL activity requires students to refer to models and tables to observe patterns and determine naming rules for ionic compounds.	45-60 minutes
Periodic Table Trends	Periodic Table Trends Lab	This lab requires students to uses straws and create a model that illustrates the periodic table trends of electronegativity and atomic radius. Students then evaluate the model to relate electronegativity, atomic radius, and periodic table placement to each other.	90 minutes
Lewis Dot Structures	"Loopy" Dot Diagrams	Students will construct Lewis dot structures for given elements, using a specific color of Fruit Loops for each element. They will then move the Fruit Loops to show what happens to the	45 minutes Modified 90 minutes

		electrons during the formation of a covalent and ionic bond.	
Types of Bonds	Chemical Bonds Reading Article	Students will go through a reading and 'mark the text' with key terms, summaries, questions. Using a shoulder partner, they will share their understanding and remaining questions on the article. Then the class will discuss the types of bonding together and use the periodic table to predict the bonds formed by elements.	30 minutes
Naming Binary Compounds	POGIL Naming Ionic Compounds	This POGIL activity requires students to refer to models and tables to observe patterns and determine naming rules for ionic compounds. Modified by using simulations in place of written POGIL	45-60 minutes Modified 90 minutes
Naming Binary Compounds	POGIL Naming Molecular Compounds	This POGIL activity requires students to refer to models and tables to observe patterns and determine naming rules for molecular compounds. Modified by using simulations in place of written POGIL	45-60 minutes Modified 90 minutes

Unit 3: Structure of Matter and its Properties

Subject: Chemistry
Grade: 9-12
Name of Unit: Structure of Matter and its Properties
Length of Unit: 11-12 days
Overview of Unit: This unit focuses on the structure, properties, and classification of matter as it relates to the attractive forces between particles. Students will be introduced to the composition of compounds and bond polarity within a compound. They will also develop an understanding of solutions and how the solubility of a substance is affected by bond polarity and can also change the properties of a substance.

Priority Standards for unit:

- 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).

Supporting Standards for unit:

- 9-12-PS1-4 pply 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.]
- 9-12-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or ice wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]
- 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 LEARNER1: 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**
an investigation to	Plan	Create	2
An investigation to	Conduct	Apply	3
Evidence to	Gather	Understand	2
physical and chemical properties of substances such as melting point, boiling point, vapor pressure, surface tension, and chemical reactivity to	Compare	Understand	2
the relative strength of attractive forces between particles.	Infer	Understand	3

Essential Questions:

1. How do attractive forces determine physical and chemical properties of matter?
2. How does electronegativity determine bond polarity in compounds?
3. How is matter classified based on its composition?
4. How is the formation of a solution based on the attractive forces between two substances?

Enduring Understanding/Big Ideas:

1. Various chemical and physical properties such as states of matter, melting point, boiling point, vapor pressure, surface tension, and reactivity, are based on the level of attraction between atoms and molecules. The attractive forces determine how close the particles (ions, atoms, molecules, formula units) are to one another, thus how strong the attractive force would be.
2. The electronegativity difference between two bonded atoms can help determine the type of bond formed (i.e. polar covalent bond, nonpolar covalent bond, ionic bond).

3. All matter is made of atoms. 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.
4. A solution is formed when a solute is dissolved by a solvent with similar chemical properties in terms of bond polarity. ("like dissolves like")

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
	Physical properties Chemical properties Melting point Boiling point Vapor pressure Surface tension Reactivity Density Physical changes Chemical changes States of matter Solid Liquid Gas Phase diagrams Intermolecular forces Polar covalent bond Nonpolar covalent bond Ionic bond Pure substance Atoms Elements Compounds Molecules Formula units Mixtures Heterogeneous mixtures Homogeneous mixtures Solutions Solute

	Solvent Dissociation Solubility Curve Chromatography Filtration Distillation Evaporation

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: States of Matter

Engaging Experience 1

Title: States of Matter PhET Lab

Suggested Length of Time: 30 minutes

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:

- 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: This online activity requires students to manipulate the temperature of a substance and observe the change in the spacing and motion of the particles of substance. They compare the particles of different states of matter to one another.

Bloom's Levels: Understand

Webb's DOK: 2

Topic 2: Physical and Chemical Properties/Changes

Engaging Experience 1

Title: Physical and Chemical Properties Lab

Suggested Length of Time: 45-60 min

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:

- 9-12-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Detailed Description/Instructions: Students will identify unknown substances based on their chemical and physical properties by measuring density, surface tension, solubility, boiling point, and reactivity.

Bloom's Levels: Understand

Webb's DOK: 2

Engaging Experience 2

Title: Metals, Nonmetals, and Metalloids Lab

Suggested Length of Time: 30-45 minutes

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.

Detailed Description/Instructions: This lab activity requires students to make and record observations about physical and chemical properties of unknown substances. They then use their data to classify each substance as a metal, nonmetal, or metalloid.

Bloom's Levels: Understand

Webb's DOK: 2

Topic 3: Types of Matter

Engaging Experience 1

Title: Classification of Matter POGIL Activity

Suggested Length of Time: 45 min

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.

Detailed Description/Instructions: Students will use their knowledge of the atom to classify the different types of matter. They will go through the activity learning the differences between compounds and mixtures.

Bloom's Levels: Understand

Webb's DOK: 3

Engaging Experience 2

Title: Separation Challenge

Suggested Length of Time: 45 minutes

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.

Detailed Description/Instructions: Students have to separate the components of a mixture (plastic beads, sand, iron shot, and salt) using their physical properties.

Bloom's Levels: Understand

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.)

In this scenario, students are provided a list of common substances. They are given a sample of one of these as an unknown. Using their knowledge of physical and chemical processes, students conduct a series of tests to record data about their unknown substance. Various equipment and materials are provided for students to use at their discretion. Students would identify their unknown and justify their choice using collected data as evidence.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
States of Matter	States of Matter PhET Lab	This online activity requires students to manipulate the temperature of a substance and observe the change in the spacing and motion of the particles of substance. They compare the particles of different states of matter to one another.	30 minutes Modified 90 minutes
Physical and Chemical Properties/Changes	Physical and Chemical Properties Lab	Students will identify unknown substances based on their chemical and physical properties by measuring density, surface tension, solubility, boiling point, and reactivity.	45-60 minutes
Physical and Chemical Properties/Changes	Metals, Nonmetals, and Metalloids Lab	This lab activity requires students to make and record observations about physical and chemical properties of unknown substances. They then use their data to classify each substance as a metal, nonmetal, or metalloid.	30-45 minutes modified 90 minutes
Types of Matter	Classification of Matter POGIL Activity	Students will use their knowledge of the atom to classify the different types of matter. They will go through the activity learning the differences between compounds and mixtures.	45 minutes
Types of Matter	Separation Challenge	Students have to separate the components of a mixture (plastic beads, sand, iron shot, and salt) using their physical properties. Modified by removing the salt water piece	45 minutes Modified 90 minutes

Unit 4: Chemical Reactions

Subject: Chemistry
Grade: 9-12
Name of Unit: Chemical Reactions
Length of Unit: 14-15 days
Overview of Unit: This unit focuses on the law of conservation of matter as it applies to chemical reactions. Students will mathematically determine the relationship the quantitative relationship between reactants and products and balance chemical equations using the mole ratios. Students will be introduced to the carbon cycle and how the reaction of carbon in nature can play a role in climate change.

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-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:

- 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.

- ISTE-DIGITAL CITIZEN.2: Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.
- ISTE - CREATIVE COMMUNICATOR.6: Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.
- TT.AB.J.13: Students will analyze the harmful impact of bias and injustice on the world, historically and today.

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	develop	Apply	2
that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.	illustrate	Understand	1
symbolic representations and mathematical calculations to	Use	Understand	2
the claim that atoms, and therefore mass, are conserved during a chemical reaction.	support	Understand	3

Essential Questions:

1. How can the concept of the mole be used to make quantitative measurements within chemical reactions?
2. How is energy used and transferred in a chemical reaction?
3. How do chemical reactions obey the law of conservation of mass?

Enduring Understanding/Big Ideas:

1. The mole is a chemical unit of measurement that can be used to convert between particle number and mass of substances.
2. The law of conservation of mass states that matter cannot be created or destroyed. Chemical reactions must be balanced in order to fulfill the law of conservation of mass. Mathematical calculations using mole-mole ratios are used to predict and analyze results of balanced chemical reactions.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
Conversion factor Dimensional analysis Coefficient	Mole Avogadro's number Molar mass Law of conservation of mass Reactant Product Chemical equation Chemical reaction Stoichiometry Mole-mole ratios Percent yield Actual yield Theoretical yield Limiting reactant

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Moles

Engaging Experience 1

Title: How Many Moles? Chalk Activity

Suggested Length of Time: 20 min

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: Students will use a piece of chalk and obtain the mass before using. Then they will predict how many moles of chalk they will use to write their name on the sidewalk/chalkboard. Finally, they will write their names and record the mass of the chalk after using it.

Bloom's Levels: Understand

Webb's DOK: 2

Engaging Experience 2

Title: Calculating Molar Mass

Suggested Length of Time: 90 minutes

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: Students are given one mole of six unknown substances. They have to calculate the molar mass of each unknown and determine what it is from a list of potential known substances. Then, students are given various amounts of six known substances and they have to determine particle count and number of moles using the mass of each substance.

Bloom's Levels: Apply

Webb's DOK: 2

Topic 2: Dimensional Analysis

Engaging Experience 1

Title: Conversion Stations

Suggested Length of Time: 45 minutes

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: Students rotate through different stations that require them to take measurements and convert into different units of measurement.

Bloom's Levels: Apply

Webb's DOK: 2

Engaging Experience 2

Title: POGIL Unit Dimensional Analysis

Suggested Length of Time: 45 minutes

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: This POGIL activity requires students to refer to models and tables to observe patterns and determine how to convert units of measurement using dimensional analysis.

Bloom's Levels: Apply

Webb's DOK: 2

Topic 3: Types of Reactions

Engaging Experience 1

Title: Coffee Creamer Lab

Suggested Length of Time: 30 min

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.

Detailed Description/Instructions: Students will observe the change in energy while creating ice cream. They will analyze where the energy is located and how it is transferred in order to create ice cream out of creamer.

Bloom's Levels: Understand

Webb's DOK: 1

Engaging Experience 2

Title: Endothermic and Exothermic Inquiry Lab

Suggested Length of Time: 60 minutes

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:

- ISTE-DIGITAL CITIZEN.2: Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.
- ISTE - CREATIVE COMMUNICATOR.6: Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.

Detailed Description/Instructions: In this inquiry activity, students use calcium chloride, baking soda, phenol red, and water in different combinations to determine which chemicals create an endothermic or exothermic reaction.

Bloom's Levels: Understand

Webb's DOK: 1

Topic 4: Balancing Equations

Engaging Experience 1

Title: Balancing Chemical Equations PhET Simulation

Suggested Length of Time: 30-45 min

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.

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 use the simulation to develop an understanding of how mass is conserved in a chemical reaction. Through this, they will then learn how the chemical equation is balanced using coefficients within the equation.

Bloom's Levels: Understand

Webb's DOK: 2

Topic 5: Stoichiometry

Engaging Experience 1

Title: S'mores Activity or LEGO Activity

Suggested Length of Time: ~30 min

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: Students will use the concept of stoichiometry and the mole to determine the correct ratio of parts to complete s'mores or a LEGO car. They will also develop an understanding of limiting and excess reactants with different scenarios of s'more ingredients or LEGO car parts that are available.

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.)

In this scenario, students conduct a chemical reaction between vinegar and baking soda and analyze the results of the reaction. In order to conduct the analysis, students record the mass of the initial and final amounts of both reactants and products. Then, using dimensional analysis and mole-mole ratios from the balanced equation, students calculate the percent yield for the chemical reaction and evaluate their results.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Moles	How Many Moles? Chalk Activity	Students will use a piece of chalk and obtain the mass before using. Then they will predict how many moles of chalk they will use to write their name on the sidewalk/chalkboard. Finally, they will write their names and record the mass of the chalk after using it.	20 minutes
Moles	Calculating Molar Mass	Students are given one mole of six unknown substances. They have to calculate the molar mass of each unknown and determine what it is from a list of potential known substances. Then, students are given various amounts of six known substances and they have to determine particle count and number of moles using the mass of each substance.	90 minutes
Dimensional Analysis	Conversion Stations	Students rotate through different stations that require them to take measurements and convert into different units of measurement.	45 minutes
Dimensional Analysis	POGIL Unit Dimensional Analysis	This POGIL activity requires students to refer to models and tables to observe patterns and determine how to convert units of measurement using dimensional analysis.	45 minutes
Balancing Equations	Balancing Chemical Equations PhET Simulation	Students will use the simulation to develop an understanding of how mass is conserved in a chemical reaction. Through this, they will then learn how the chemical equation is balanced using coefficients within the equation.	30-45 minutes
Stoichiometry	S'mores Activity or LEGO Activity	Students will use the concept of stoichiometry and the mole to determine the correct ratio of parts to complete s'mores or a LEGO car. They will also develop an understanding of limiting and excess reactants with different scenarios of s'more ingredients or LEGO car parts that are available.	30 minutes

Unit 5: Rate of Reactions/ Equilibrium

Subject: Chemistry
Grade: 9-12
Name of Unit: Rate of Reactions/ Equilibrium
Length of Unit: 9-10 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.]

Supporting Standards for unit:

- 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.]
- 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
scientific principles and evidence to	Apply	Apply	3
an explanation about the effects	provide	Analyze	3

of changing the temperature or concentration of the reaction particles on the rate at which a reaction occurs.			

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 Le Chatelier's Principle apply to equilibrium in chemical reactions?
3. How do acid/base reactions relate to equilibrium?

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.

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

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Collision Theory

Engaging Experience 1

Title: Collision Theory Gizmo

Suggested Length of Time: 30 minutes

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.

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 use an online simulation to manipulate temperature, concentration, surface area, and catalyst conditions and evaluate how these factors impact the rate of reaction.

Bloom's Levels: Analyze

Webb's DOK: 3

Topic 2: Factors that Affect Reaction Rate

Engaging Experience 1

Title: Alka-Seltzer Rocket Lab

Suggested Length of Time: 60-90 minutes

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.

Supporting:

- ISTE - INNOVATIVE DESIGNER.4: Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions.
- ISTE - CREATIVE COMMUNICATOR.6: Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.

Detailed Description/Instructions: In this guided inquiry lab, students design an experiment to investigate how changing water temperature, amount of Alka-Seltzer, and surface area of Alka-Seltzer affects the rate of reaction.

Bloom's Levels: Apply

Webb's DOK: 3

Topic 3: Equilibrium

Engaging Experience 1

Title: Blue Bottle and Traffic Light Demonstrations

Suggested Length of Time: 30 minutes

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.

Supporting:

- 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.
- ISTE-DIGITAL CITIZEN.2: Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.
- ISTE - CREATIVE COMMUNICATOR.6: Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.

Detailed Description/Instructions: This demonstration illustrates equilibrium involving redox reactions. It can be used as a springboard for an online discussion on what is occurring with the chemical reactions and why color changes, and their reversal, are occurring.

Bloom's Levels: Evaluate

Webb's DOK: 4

Topic 4: Acids and Bases

Engaging Experience 1

Title: pH Lab

Suggested Length of Time: 45 minutes

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.

Supporting:

- 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.]

Detailed Description/Instructions: Students use known pH value buffer solutions and different indicators to create a reference chart. They then have an unknown buffer solution for which they have to identify its pH based on their indicator charts.

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.) In this scenario, students investigate how ion concentration affects the pH value of acid/base solutions. Students are provided different acid/base indicators and solutions of varying H+ and OH- concentrations (1M, 0.8M, 0.6 M, 0.4 M, and 0.2 M) that are unknown to them. They have to combine the solutions to determine which pairings will produce a solution in equilibrium at neutral pH. In doing so they should be able to identify the concentration of each unknown solution.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Collision Theory	Collision Theory Gizmo	Students use an online simulation to manipulate temperature, concentration, surface area, and catalyst conditions and evaluate how these factors impact the rate of reaction.	30 min
Factors that Affect Reaction Rate	Alka-Seltzer Rocket Lab	In this guided inquiry lab, students design an experiment to investigate how changing water temperature, amount of Alka-Seltzer, and surface area of Alka-Seltzer affects the rate of reaction.	60-90 min
Equilibrium	Blue Bottle and Traffic Light Demonstrations	This demonstration illustrates equilibrium involving redox reactions. It can be used as a springboard for an online discussion on what is occurring with the chemical reactions and why color changes, and their reversal, are occurring.	30 min
Acids and Bases	pH Lab	Students use known pH value buffer solutions and different indicators to create a reference chart. They then have an unknown buffer solution for which they have to identify its pH based on their indicator charts. Modified by using pH strips to chart.	45 min Modified 90 minutes

Unit 6: Energy Transformation

Subject: Chemistry
Grade: 9-12
Name of Unit: Energy Transformation
Length of Unit: 10-11 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 be able to apply this knowledge to the concept of specific heat and how energy can be transformed from one substance to another, thus conserving energy. Renewable energy sources will be discussed, and students will gain an understanding of human energy consumption in the United States.

Priority Standards for unit:

- 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.]
- 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-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.

Supporting Standards for unit:

- 9-12-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]
- 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-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-DIGITAL CITIZEN.2: Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.
- ISTE - CREATIVE COMMUNICATOR.6: Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.
- TT.AB.J.13: Students will analyze the harmful impact of bias and injustice on the world, historically and today.

Unwrapped Concepts (Students need to know)	**Unwrapped Skills (Students need to be able to do)**	**Bloom's Taxonomy Levels**	**Webb's DOK**
an investigation	Plan	Create	2
an investigation	Conduct	apply	3
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)	Provide	analyze	3
A computational model to calculate the change in the energy of one component in a system when the changes in energy are known	Create	Create	4
A major global challenge to specify qualitative criteria and constraints for solutions that account for societal needs and wants	Analyze	Analyze	3

A major global challenge to specify quantitative criteria and constraints for solutions that account for societal needs and wants	Analyze	Analyze	3
A solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering	Design	Create	3
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 impacts	Evaluate	Analyze	4
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 cultural impacts	Evaluate	Analyze	4
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 environmental impacts	Evaluate	Analyze	4

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?
4. What are the different types of renewable energy and how can they be used for human consumption?

5. How is carbon cycled among the atmosphere, hydrosphere, geosphere, and biosphere?

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. Chemical reactions involve energy changes in substances. Endothermic reactions absorb energy, and exothermic reactions release energy.
3. 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.
4. 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.
5. Renewable energy sources include biomass, solar, wind, water, geothermal, and nuclear. These energy sources can be used to generate heat or electricity for human purposes.
6. Carbon cycles through the atmosphere, hydrosphere, geosphere, and biosphere through chemical reactions that involve carbon compounds, specifically carbon dioxide. Examples of reactions include photosynthesis, respiration, and the formation of carbonic acid.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
Calorie	Law of conservation of energy Energy Endothermic Exothermic Second Law of Thermodynamics Thermal energy Heat Joule calorie Specific heat Potential energy Kinetic energy Mechanical energy Chemical energy Renewable energy

	Heating curve Cooling curve Biomass energy Wind energy Solar energy Geothermal energy Nuclear energy Carbon cycle Photosynthesis Respiration Greenhouse gases Global warming Carbon sinks Atmosphere Biosphere Geosphere Hydrosphere

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Law of Conservation of Energy

Engaging Experience 1

Title: Hot/Cold Water Tornado Demo

Suggested Length of Time: 20 min

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:

- ISTE-DIGITAL CITIZEN.2: Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.
- ISTE - CREATIVE COMMUNICATOR.6: Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.

Detailed Description/Instructions: This demo has hot water in one 2-liter bottle with red food coloring and cold water in one 2-liter bottle with blue food coloring. Then the bottles are placed on top of one another with the hot water on top and the lids of the bottles fused together. Ask the students what is happening with the water, ask them why it is not mixing? (Do not tell them which water is hot or cold.) Then flip the bottles and see the food coloring mix and it becomes purple. Again, ask the students what is happening. Discuss the transfer of energy and conservation of energy.

Bloom's Levels: Analyze

Webb's DOK: 3

Topic 2: Specific Heat

Engaging Experience 1

Title: Calorimetry Lab with Unknown Metals

Suggested Length of Time: 60-75 min

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).

Detailed Description/Instructions: Students will set up a calorimeter and study the specific heat of the metal to determine its identity. They will also measure the density of the metal and use this as a value to compare their results to and determine which process is more accurate.

Bloom's Levels: Apply

Webb's DOK: 3

Topic 3: Heating and Cooling Curves

Engaging Experience 1

Title: Phase Changes POGIL Activity

Suggested Length of Time: 45 min

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.

Detailed Description/Instructions: The students will go through the introduction activity witnessing how the energy is transferring in and out of a system during phase changes. Then they will study the line graph that is formed when energy is added or removed from a substance over time to see how the various phase changes occur at specific temperatures.

Bloom's Levels: Understand

Webb's DOK: 2

Topic 4: Renewable Energy

Engaging Experience 1

Title: Renew-A-Bean Activity

Suggested Length of Time: 45-60 min

Standards Addressed

Priority:

- 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.

Supporting:

- TT.AB.J.13: Students will analyze the harmful impact of bias and injustice on the world, historically and today.

Detailed Description/Instructions: Students will use beans to show the ratio of renewable resources and nonrenewable resources used by Americans. Throughout the activity they will 'use' their resources based on specific conditions of resource consumption. Students will be able to see how the resources are depleted and how quickly they are depleted depending on each scenario.

Bloom's Levels: Analyze

Webb's DOK: 3

Topic 5: Carbon Cycle

Engaging Experience 1

Title: Carbon Cycle Interactive Game

Suggested Length of Time: 60 min

Standards Addressed

Supporting:

- 9-12-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]
- 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.
- 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.
- TT.AB.J.13: Students will analyze the harmful impact of bias and injustice on the world, historically and today.

Detailed Description/Instructions: The students will go through a simulation as a carbon atom with the goal of completing the carbon cycle and answering questions along the way. Students will have a better understanding of how carbon travels through the atmosphere, geosphere, and biosphere and its effect on the environment.

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.)

In this scenario, students design and construct a Rube Goldberg machine that converts chemical energy into mechanical energy to complete a series of tasks. Students are given a list of tasks from which to choose. They research chemical reactions that can supply the energy needed to start the machine and come up with ways to complete their chosen tasks.

OR

In this scenario, students research a form of renewable energy (biomass, solar, wind, water, and geothermal), how it is transformed, what its efficiency is, and how it relates to human consumption. Then, students use their findings to produce an end product that illustrates their understanding of this energy source. Examples of end products include such items as a newspaper, magazine, game, or a song/rap.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Law of Conservation of Energy	Hot/Cold Water Tornado Demo	This demo has hot water in one 2-liter bottle with red food coloring and cold water in one 2-liter bottle with blue food coloring. Then the bottles are placed on top of one another with the hot water on top and the lids of the bottles fused together. Ask the students what is happening with the water, ask them why it is not mixing? (Do not tell them which water is hot or cold.) Then flip the bottles and see the food coloring mix and it becomes purple. Again, ask the students what is happening. Discuss the transfer of energy and conservation of energy.	20 min Modified 40 minutes
Types of Reactions	Coffee Creamer Lab	Students will observe the change in energy while creating ice cream. They will analyze where the energy is located and how it is transferred in order to create ice cream out of creamer.	30 minutes
Types of Reactions	Endothermic and Exothermic Inquiry Lab	In this inquiry activity, students use calcium chloride, baking soda, phenol red, and water in different combinations to determine which chemicals create an endothermic or exothermic reaction.	60 minutes
Specific Heat	Calorimetry Lab with Unknown Metals	Students will set up a calorimeter and study the specific heat of the metal to determine its identity. They will also measure the density of the metal and use this as a value to compare their	60-75 min

		results to and determine which process is more accurate.	
Heating and Cooling Curves	Phase Changes POGIL Activity	The students will go through the introduction activity witnessing how the energy is transferring in and out of a system during phase changes. Then they will study the line graph that is formed when energy is added or removed from a substance over time to see how the various phase changes occur at specific temperatures.	45 min
Renewable Energy	Renew-A-Bean Activity	Students will use beans to show the ratio of renewable resources and nonrenewable resources used by Americans. Throughout the activity they will 'use' their resources based on specific conditions of resource consumption. Students will be able to see how the resources are depleted and how quickly they are depleted depending on each scenario.	45-60 min
Carbon Cycle	Carbon Cycle Interactive Game	The students will go through a simulation as a carbon atom with the goal of completing the carbon cycle and answering questions along the way. Students will have a better understanding of how carbon travels through the atmosphere, geosphere, and biosphere and its effect on the environment.	60 minutes

Unit 7: Nuclear and Electromagnetic Energy

Subject: Chemistry
Grade: 9-12
Name of Unit: Nuclear and Electromagnetic Energy
Length of Unit: 10-11 days
Overview of Unit: This unit focuses on the energy released through various forms of nuclear reactions such as fusion, fission, and radioactive decay. Students will develop an understanding of how electromagnetic radiation (light) interacts with matter through various wavelengths, frequencies, and energies.

Priority Standards for unit:

- 9-12-PS1 -9 Use symbolic representations to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.]
- 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.]

Supporting Standards for unit:

- 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.]
- 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**
Use symbolic representations to	use	Understand	2
the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.	illustrate	Understand	1
Mathematical representations to support a claim regarding relationships among the frequency traveling in various media	Use	Apply	3
Mathematical representations to support a claim regarding relationships among the wavelength traveling in various media	Use	Apply	3
Mathematical representations to support a claim regarding relationships among the speed of waves traveling in various media	Use	Apply	3

Essential Questions:

1. How are wave properties of frequency, wavelength, and speed mathematically related?
2. How do the properties of electromagnetic radiation affect its interactions with matter?
3. How is energy release related to fission, fusion, and radioactive decay of an atom's nucleus?

Enduring Understanding/Big Ideas:

1. All forms of light travel at the same speed (speed of light (c) = 2.998 x 10^8 m/s) but vary in wavelength (λ) and frequency (ν). Based on the mathematical equation, $c = \lambda \nu$, the frequency and wavelength of wave can be determined.

2. Each type of electromagnetic radiation (light) as displayed on the electromagnetic spectrum has a specific wavelength, frequency, and energy. Based on the type of light, the interaction with matter can differ because of the energy difference, thus producing the photoelectric effect.
3. The nucleus of an atom changes during fusion, fission, and radioactive decay (alpha decay, beta decay, gamma decay) thus releasing various amounts of energy.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
	Electromagnetic radiation Electromagnetic spectrum Speed of light (c) Frequency (ν) Wavelength (λ) Photoelectric effect Photons Energy level Nuclear equations Alpha particle Beta particle Chain reaction Decay curve Fission Fusion Gamma ray Half-life Radiation Radioisotope Radioactive decay

Resources for Vocabulary Development: Textbook, Online resources

Topic 1: Properties of Waves

Engaging Experience 1

Title: The Electromagnetic Spectrum POGIL Activity

Suggested Length of Time: 30-45 min

Standards Addressed

Priority:

- 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.

Supporting:

- 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.

Detailed Description/Instructions: Students will use the relationship between wavelength and frequency to discover multiple types of electromagnetic radiation. Students will be introduced to the electromagnetic spectrum and see how the waves of each type differ from one another and result in a different amount of energy released.

Bloom's Levels: Understand

Webb's DOK: 3

Topic 2: Electromagnetic Radiation

Engaging Experience 1

Title: Flame Test Lab

Suggested Length of Time: 45 minutes

Standards Addressed

Priority:

- 9-12-PS1 -9 Use symbolic representations 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.

Supporting:

- 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.

Detailed Description/Instructions: Students conduct flame test labs on known salt solutions with different metals. They use the colors produced to identify unknown salt solutions. They also explain how the colors produced by the metals applies to fireworks.

Bloom's Levels: Apply

Webb's DOK: 3

Topic 3: Nuclear Reactions

Engaging Experience 1

Title: Nuclear Fission PhET Simulation

Suggested Length of Time: 45-60 min

Standards Addressed

Priority:

- 9-12-PS1 -9 Use symbolic representations 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.

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 use the simulation to see how the nucleus of the atom is changed when it undergoes fission. Students will also be able to see what a chain reaction would look like in the presence of multiple nuclei.

Bloom's Levels: Understand

Webb's DOK: 1

Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.) In this scenario, students will research, design, and construct a solar oven to make a s'more. The students justify their design using their understanding of electromagnetic radiation. They will also connect how the nuclear reactions of the sun are the ultimate source of energy that fuels their solar oven.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Properties of Waves	The Electromagnetic Spectrum POGIL Activity	Students will use the relationship between wavelength and frequency to discover multiple types of electromagnetic radiation. Students will be introduced to the electromagnetic spectrum and see how the waves of each type differ from one another and result in a different amount of energy released.	30-45 min Modified 90 minutes
Electromagnetic Radiation	Flame Test Lab	Students conduct flame test labs on known salt solutions with different metals. They use the colors produced to identify unknown salt solutions. They also explain how the colors produced by the metals applies to fireworks.	45 min
Nuclear Reactions	Nuclear Fission PhET Simulation	Students will use the simulation to see how the nucleus of the atom is changed when it undergoes fission. Students will also be able to see what a chain reaction would look like in the presence of multiple nuclei.	45-60 min

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.