



Honors Chemistry Curriculum

Board Approved: 3/20/2025

Course Information

High School Full-year course

Course Description:

In this course, students will use science and engineering practices and cross-cutting concepts to develop a comprehensive understanding of matter and energy in the chemical compounds of our world. The curriculum will delve into the basics of chemistry, including atomic structure, the periodic table, chemical bonding, and stoichiometry. Students will explore the interactions of matter, the structure and properties of substances, chemical reactions, and nuclear processes.

Through hands-on experiments, collaborative projects, and real-world applications, students will gain insight into how chemical principles are fundamental to various fields, from environmental science to engineering. The course will also emphasize critical thinking and problem-solving skills, preparing students to analyze and interpret scientific data effectively. Whether pursuing a career in science or seeking to understand the chemical basis of everyday phenomena, this course provides a solid foundation in the essential principles of chemistry.

The Honors course will emphasize:

- Reading content and completing work outside of class to supplement in-class content and learning.
- Mathematical application and problem-solving.
- Advanced lab work, data analysis, and scientific inquiry.

Transfer Goals:

- Students will approach science as a reliable yet evolving way of knowing and explaining the natural world, recognizing the iterative nature of scientific discovery and the importance of evidence-based reasoning.
- Students will weigh evidence and employ scientific methodologies to ask pertinent questions, conduct thorough investigations, and make informed decisions. They will be adept at using critical thinking and the practices of science and engineering to model and analyze ideas and phenomena effectively.
- Students will leverage their knowledge of chemistry to solve complex problems, integrating concepts of matter, energy, chemical reactions, and nuclear processes. They will utilize their understanding of atomic structure, the periodic table, and chemical bonding in practical and theoretical contexts.
- Students will recognize that chemistry, like all science, is an ongoing human endeavor that continually enhances our understanding of the universe. They will appreciate the historical and contemporary contributions of chemistry to various fields and its significance in addressing global challenges.
- Students will be equipped with the foundational knowledge and skills necessary for success in AP Chemistry or college-level chemistry and related disciplines. They will be prepared to engage with advanced scientific concepts and pursue careers that require a solid understanding of chemical principles.

priority standards indicated in **bold*

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Curriculum Standards: Science Missouri Learning Standards
Curriculum Resource(s): To Be Determined

priority standards indicated in **bold*

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Unit 1: Structure & Properties of Matter

Timeframe: 4 weeks

Unit Description: In this unit, students will explore how macroscopic properties of matter relate to their particles. They will investigate these connections through experiments and data related to states of matter, phase changes, interactions of particles, and kinetic molecular theory. Students will also develop skills in measurement tools and lab procedures.

Enduring Understandings:

- Solids, liquids, and gases have different properties due to particles' motion and their interactions.
- All measurements have uncertainty, and their level of precision must be accounted for in the experiment's design and the data recording.
- The amount of energy transferred during the heating and cooling of matter or changing its state is determined by the interactions among the particles that make up the matter.
- Observable properties of gases can be measured experimentally and explained using an understanding of particle motion.

Essential Questions:

- How are the properties of matter at the macroscopic level related to the particle structure of matter?
- Why must recorded values account for the precision of a measurement?
- What is density, and how does it quantitatively measure the packing of particles that make up matter?
- What is heat, and how is it related to the transfer of energy associated with a change in temperature of matter?
- How are energy transfers classified as endothermic or exothermic?
- Why do substances with stronger attraction among particles generally have higher melting and boiling points than substances with weaker attraction among particles?
- How can the transitions between solid, liquid, and gas be modeled?

Unit 1 Standards

STANDARD CODE	STUDENTS WILL KNOW, BE ABLE TO, AND UNDERSTAND:
9-12.PS1.A2	• I can describe the difference between the energy stored in a sample of a material versus the speed of the particles in a system. • I can describe how changing the temperature of a sample changes the motion of the particles contained in that sample. • I can describe how phase change affects the relative distance between particles in a sample. • I can describe how thermal (kinetic) energy affects the ability of the electrical attraction between particles to keep the particles close together. • I can identify each phase and phase change on a phase diagram and heating curve as energy is added or removed. • I can describe energy flow for both endothermic and exothermic reactions. • I can calculate the amount of energy that is removed or stored in a chemical reaction based on the change in temperature in the system.

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9-12.PS1.A3	• I can evaluate an investigation by assessing the accuracy and precision of the data collected and its limitations. • I can predict how a temperature change will affect the density of a material. • I can predict and calculate how a gas behaves based on changing its pressure, temperature, and volume using the Combined Gas Law.
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Unit 2: Trends and Intermolecular Forces

Timeframe: 4 weeks

Unit Description: In this unit, students will describe and classify matter. Students will relate the bulk properties of matter to its intermolecular and intramolecular forces. Students will explore trends in the periodic table to help explain the properties of the different types and groups of matter. Trends in electrons from the periodic table will be related to the electromagnetic spectrum.

Enduring Understandings:

- The intermolecular forces among particles can explain the macroscopic physical properties of materials.
- The structure and properties of compounds arise from periodic properties.

Essential Questions:

- What defines a pure substance?
- How do the particles in a mixture interact?
- How does each gas in a mixture contribute to the overall pressure of the gas?
- How can intermolecular forces explain trends in the physical properties of substances?
- How does the periodic table serve as an organizational tool for elements?
- How does the electromagnetic spectrum relate to the energy, wavelength, and frequency of different types of electromagnetic radiation?
- How can PES spectra be used to determine the electron configuration of an atom?

Unit 2 Standards

STANDARD CODE	STUDENTS WILL KNOW, BE ABLE TO, AND UNDERSTAND:
9-12.PS1.A.1	• I can properly identify an element or ion's electron configuration based on the PES diagram. • I can explain the trends of electronegativity, atomic radius, and ionization energy using the concepts of coulombic attraction and effective nuclear charge when applicable. • I can identify an element family based on an ionization energy diagram. • I can determine the number of valence electrons of an element based on its position on the periodic table. • I can write the electron configuration for an element based on the number of valence electrons. • I can use the Aufbau Principle, Hund's Rule, and the Pauli Exclusion Principle to diagram an element's electron configuration. • I can predict and explain the trend in reactivity and electronegativity of atoms down a group and across a row in the periodic table based on the attractions of outermost (valence) electrons to the nucleus. • I can predict and explain the relative sizes of atoms both across a row and down a group in the periodic table.
9-12.PS1.A.3	• I can classify matter as an element, compound, or mixture. • I can use Dalton's Law of Partial Pressure to determine the total pressure of a gas system of multiple gases.

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	• I can predict how a gas behaves by changing its pressure, temperature, and volume using gas laws such as the Combined Gas Law and Dalton's Law of Partial Pressures and by collecting gas over water. • I can define the bulk properties of a material and describe how these change based on the relative strength of the compound's intermolecular forces. • I can develop an investigation plan to determine the relative strength of intermolecular forces based on a compound's bulk properties (e.g., melting point and boiling point, volatility, surface tension). • I can name the different intermolecular forces that are present in a compound. • I can describe how London-Dispersion Forces can exist in all atoms because of the momentary unequal distribution of electrons.
9-12.PS4.A.1	• I can describe the change and calculate the value of wavelength, frequency, and energy of a photon of light given one of the values. • I can describe the electromagnetic spectrum and identify the differences in the parts of the spectrum, including visible light. • I can calculate the wavelength of light from an element's ionization energy and vice versa (wavelength to amount of energy required to ionize).

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Unit 3: Bonding

Timeframe: 5 weeks

Unit Description: In this unit, students will explore how the shape and structure of atoms and molecules lead to different types and patterns of bonding. Students will compare types of bonds and model interactions between matter to demonstrate the types and strengths of the different chemical bonds.

Enduring Understandings:

- The microscopic physical properties of materials can be explained by the intermolecular forces among particles.
- The structure and properties of compounds arise from the constituent atoms' periodic properties and bonding patterns.

Essential Questions:

- How does a Lewis dot structure represent a molecule?
- How does VSEPR theory predict molecular geometry from a Lewis dot structure?
- How does the asymmetric distribution of electrons impact a molecule's polarity?
- How does molecular geometry determine the types of intermolecular forces present?
- What are the differences between nonpolar covalent, polar covalent, and ionic bonding?
- How do the properties of ionic and covalent compounds differ based on their bonding?
- What are ionic solids composed of?
- How can ionic and covalent compounds be represented using particulate models, structural formulas, chemical formulas, and chemical nomenclature?
- How does the sea of electrons model explain the malleability and electrical conductivity of metals?
- Why is resonance important for predicting molecular structure and reactivity?

Unit 3 Standards

STANDARD CODE	STUDENTS WILL KNOW, BE ABLE TO, AND UNDERSTAND:
9-12.PS1.A.1	• I can model the resonance structure of a molecule. • I can calculate the bond lengths of individual bonds within a molecular structure based on given experimental measurements. • I can assign formal charges to individual atoms within a molecule. • I can predict the Lewis dot structure of a molecule using formal charge. • I can explain how structural isomers differ from each other. • I can draw the Lewis dot structure for an atom with the correct number of valence electrons. • I can draw the Lewis dot structure of compounds from the chemical formula. • I can describe a covalent bond as the sharing of electrons between two atoms to fill the octet of each atom. • I can identify the VSEPR shapes from the Lewis dot structure.

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	● I can describe how lone pairs of electrons affect the shapes of molecules. ● I can describe how an atom loses or gains electrons to reach a stable octet of electrons. ● I can predict the number of electrons an atom will lose or gain based on its position on the periodic table and whether it is a metal, nonmetal, or metalloid. ● I can determine the chemical formula for an ionic bond based on the atoms or polyatomic ions reacting together. ● I can predict the relative strength of an ion's attractive force based on the number of electrons lost/gained and the position on the periodic table. ● I can use the IUPAC naming convention to determine the names of covalent and ionic compounds from the formulas and vice versa.
9-12.PS1.A.3	● I can describe the difference between a nonpolar, polar, and ionic bond, specifically the differences in electronegativities and the sharing of electrons. ● I can use the electronegativity differences of bonded elements to determine if a bond is nonpolar, polar, or ionic. ● I can use the shape of covalent molecules to determine if a molecule is symmetrical or unsymmetrical. ● I can determine if a molecule is nonpolar, polar, or ionic based on electronegativity difference and VSEPR shape. ● I can rank the strengths of the different intermolecular forces.
9-12.PS1.A.4	● I can describe how metallic bonding occurs and identify its parts. ● I can explain why electrically conductive materials are made of metals. ● I can model the different types of alloys (substitution and interstitial) and use the model to explain some of their properties.

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Unit 4: The Mole and Dimensional Analysis

Timeframe: 4 weeks

Unit Description: In this unit, students will explore how the mass of atoms is determined, how molar mass is calculated, and how particles are counted in chemistry. Students will use these concepts to convert between relevant mathematical units in chemistry using dimensional analysis. Students will apply these concepts to their understanding of ideal gasses and calculations related to ideal gasses.

Enduring Understandings:

- The mole concept is used to quantitatively relate the number of microscopic particles in a substance to the weight of the macroscopic substance in a laboratory.

Essential Questions:

- How do you calculate empirical and molecular formulas from experimental data?
- How does dimensional analysis help convert units and solve problems?
- How does the concept of the mole and Avogadro's number help in measuring the physical properties of a substance?
- Why are large amounts of particles needed to measure the physical properties of substances?
- How is the molar mass of an element related to the mass of a mole of atoms?
- How can the ideal gas law be used to predict the behavior of gases? Does this prediction change based on what pieces of information you are given?

Unit 4 Standards

STANDARD CODE	STUDENTS WILL KNOW, BE ABLE TO, AND UNDERSTAND:
9-12.PS1.B.3	• I can calculate the percent composition of a sample when given the compound's molar mass. • I can calculate the mass of an element from a given sample using Percent Composition. • I can calculate the empirical formula for a substance given the percent of each element it is composed of. • I can convert from an empirical formula to a molecular formula and vice versa. • I can calculate the moles of water in a given hydrate compound through laboratory procedures. • I can calculate the empirical and molecular formula for a carbon-based compound that underwent a combustion reaction. • I can convert units and amounts in chemistry using dimensional analysis. • I can explain the relationship between a substance's mass, the number of particles, and the number of moles. • I can use the mole concept to calculate the mass, number of particles, or the number of moles of a given substance. • I can define molar mass and identify the molar mass of an element. • I can explain the relationships between the macroscopic properties of gas

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	samples. • I can perform calculations using the ideal gas law. • I can create and/or evaluate models based on the ideal gas law. • I can calculate the molar mass of a compound.
9-12.PS1.C.1	• I can calculate the average atomic mass of an element using the isotopes and percent abundances accordingly. • I can solve for the percent abundance of isotopes. • I can explain how protons and neutrons contribute to the mass of an atom. • I can define an isotope and explain the differences between isotopes. • I can calculate the number of protons and neutrons in an isotope based on isotope notation. • I can explain average atomic mass and how it relates to the relative abundance of different isotopes.

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Unit 5: Stoichiometry

Timeframe: 3 weeks

Unit Description: In this unit, students will use the law of conservation of mass and the mole concept to calculate and explain the number of particles present before and after a chemical reaction. Students will apply this skill to the lab setting to predict and evaluate the results of a chemical reaction.

Enduring Understandings:

- The mole concept is used to quantitatively relate the number of particles involved in a reaction to experimental data about the reaction.
- In chemical reactions, bonding between atoms changes, leading to new compounds with different properties.
- In chemical reactions, the amount of mass of the reactants is conserved.

Essential Questions:

- How do we represent chemical reactions?
- Why is it important to balance equations in terms of the conservation of mass?
- How can stoichiometry be used to predict the amounts of reactants and products in a chemical reaction?
- What is the importance of determining the limiting reactant within a reaction?
- How is the balanced chemical reaction used to calculate a reaction's theoretical and percent yield?

Unit 5 Standards

STANDARD CODE	STUDENTS WILL KNOW, BE ABLE TO, AND UNDERSTAND:
9-12.PS1.B.3	• I can perform a stoichiometric calculation when given only the names of the substances (reactants and products) and the amounts of the starting reactants. • I can calculate the excess reactant in a reaction using stoichiometric calculations. • I can balance chemical reactions. • I can explain the relationship between the quantity of reactants consumed and the quantity of products formed in a chemical transformation. • I can perform stoichiometric calculations involving the quantity of reactants and products in a chemical system. • I can identify the limiting reactant in a chemical transformation and use it to calculate theoretical yield. • I can calculate the percent yield and use critical thinking to provide reasonable explanations for the resulting percent yield.
9-12.PS3.A.2	• I can create and evaluate models of chemical transformations. • I can explain that all chemical transformations involve atoms rearranging to form new combinations. • I can express chemical reactions using correct formulaic notation. • I can interpret chemical formula notation to determine what occurred in a chemical reaction.

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Unit 6: Solutions and Precipitation Reactions

Timeframe: 4 weeks

Unit Description: In this unit, students will explore solutions and chemical reactions that occur in solutions. They will model the process of dissolving and compare the solubility of different compounds. Students will describe precipitation reactions and use the concept of molarity to explain the amounts of products and reactants in precipitation reactions.

Enduring Understandings:

- Solubility, electron transfer, and proton transfer are driving forces in chemical reactions.
- All chemical reactions are accompanied by a transfer of energy.
- In chemical reactions, the amount of mass of the reactants is conserved.

Essential Questions:

- How do solubility rules help determine whether a precipitate will form in a reaction?
- Why are spectator ions omitted from net ionic equations?
- Why do precipitation reactions occur when two aqueous solutions are mixed?
- How can precipitation reactions be explained with solubility rules?
- How does molarity quantify the concentration of a solution?

Unit 6 Standards

STANDARD CODE	STUDENTS WILL KNOW, BE ABLE TO, AND UNDERSTAND:
9-12.PS1.A.3	• I will know and apply the solubility rules for a precipitate reaction to predict the products. • I can perform calculations relating to the molarity of solutions. • I can use the solubility curve to determine the level of saturation.
9-12.PS1.B.3	• I can explain why some chemical reactions form precipitates based on their chemical properties and solubility rules. • I can predict which product of a chemical reaction will be a precipitate based on solubility rules.
9-12.PS3.A.2	• I can construct a chemical reaction symbolically with balanced molecular, complete ionic, and net ionic equations. • I can use models to explain how temperature and pressure affect the solubility of different substances. • I can construct and interpret solubility curves to determine the solubility of a substance at various temperatures. • I can determine if a substance is soluble and how much will dissolve in a given amount of solvent at a specific temperature. • I can collect and record data on the solubility of substances. • I can include a rationale for the choice of substances to compare and a description of the composition of those substances at the atomic-molecular level.

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Unit 7: Redox Reactions

Timeframe: 2 weeks

Unit Description: In this unit, students will analyze how electron transfer can drive chemical reactions in redox reactions. They will classify types of redox reactions and predict the products of single replacement reactions using data from investigations about the activity series of elements. Students will model redox reactions using chemical formulas and pictorial representations.

Enduring Understandings:

- All chemical reactions are accompanied by a transfer of energy due to the movement of electrons.
- In chemical reactions, the amount of mass of the reactants is conserved.

Essential Questions:

- How does the balancing process differ between acidic and basic conditions?
- How are electrons transferred between reactants in oxidation-reduction (redox) reactions?
- What role does the activity series play in predicting the occurrence of redox reactions?

Unit 7 Standards

STANDARD CODE	STUDENTS WILL KNOW, BE ABLE TO, AND UNDERSTAND:
9-12.PS1.A.1	• I can identify the oxidation numbers of atoms, monatomic ions, and individual atoms within a compound.
9-12.PS1.A.3	• I can predict the product of a redox reaction. • I can identify single replacement reactions. • I can predict the product of single replacement reactions. • I can write balanced chemical equations for single replacement reactions. • I can use the activity series to determine if a single replacement reaction will occur. • I can use the activity series to determine the relative reactivity of metals and non-metals.
9-12 PS1.B.3	• I can balance a redox reaction (standard method) by assigning oxidation numbers, creating half-reactions, and tracking the electron transfer.
9-12.PS3.A.2	• I can identify and classify different redox reactions, such as combination, decomposition, displacement, and combustion reactions. • I can explain the process of oxidation and reduction in terms of electron transfer. • I can determine the oxidizing and reducing agents in a redox reaction. • I can construct and interpret redox reaction diagrams to visualize electron flow. • I can predict the spontaneity of redox reactions using standard reduction potentials.

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Unit 8: Acid-Base Reactions

Timeframe: 3 weeks

Unit Description: In this unit, students will compare strong and weak acids and bases by using models and comparing their dissociations. Students will calculate pH and pOH and predict the products of reactions between strong acids and bases. Students will develop lab skills by completing titrations.

Enduring Understandings:

- All chemical reactions are accompanied by a transfer of energy.
- In chemical reactions, the amount of mass of the reactants is conserved.
- The properties of acids and bases drive proton transfer during chemical reactions.

Essential Questions:

- What is the significance of the equivalence point in a titration, and how is it determined experimentally?
- How are acids and bases classified as strong or weak?
- What does the pH of a solution measure?
- How can titrations be used to determine the concentration of an unknown solution?
- How do titration curves help understand the reaction between an acid and a base?

Unit 8 Standards

STANDARD CODE	STUDENTS WILL KNOW, BE ABLE TO, AND UNDERSTAND:
9-12.PS1.A.3	• I can compare weak and strong acids based on how much they dissociate and the relative pH values they produce in solution. • I can identify an acid and a base using different definitions and descriptions (Arrhenius, Bronsted-Lowry). • I can explain the relationship between the hydrogen ion concentration and the pH of a solution. • I can explain how the titration process works and perform a simple titration in a lab setting.
9-12.PS1.B.3	• I can perform calculations from titration to solve for a given unknown acid (monoprotic) or base. • I can calculate the pH and pOH of a solution given ion concentrations.
9-12.PS3.A.2	• I can write the net ionic reaction from a neutralization reaction. • I can predict the products of a reaction between a strong acid and a strong base. • I can model the chemical transformation when a strong acid and base react.

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Unit 9: Thermochemistry

Timeframe: 3 weeks

Unit Description: In this unit, students will continue their study of energy by analyzing energy transformations that occur during chemical reactions. They will analyze energies contained in chemical bonds and use these energies to calculate and explore changes in energy during chemical reactions.

Enduring Understandings:

- All chemical reactions are accompanied by a transfer of energy.
- In chemical reactions, the amount of mass of the reactants is conserved.

Essential Questions:

- How do you calculate the molar heat of a reaction from experimental data?
- How does a temperature change during a reaction indicate energy transfer?
- How can calorimetry be used to quantify energy changes in a chemical reaction?
- How do the bonds in reactants and products determine the overall energy change in a reaction?

Unit 9 Standards

STANDARD CODE	STUDENTS WILL KNOW, BE ABLE TO, AND UNDERSTAND:
9-12.PS1.A.5	• I can calculate the molar heat of a substance when it has reacted in a calorimeter. • I can explain the difference between endothermic and exothermic reactions based on energy transfer. • I can interpret energy diagrams to distinguish between endothermic and exothermic reactions. • I can define bond energy and explain its role in chemical reactions. • I can perform calorimetry experiments to measure the heat absorbed or released in chemical reactions. • I can analyze and interpret calorimetry data to determine the bond energy change of reactions. • I can use models to represent the energy changes in thermodynamic reactions. • I can explain how energy is conserved in thermodynamic processes. • I can evaluate the impact of temperature, pressure, and concentration on the spontaneity of a reaction using thermodynamic models.

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Unit 10: Chemical Kinetics

Timeframe: 2 weeks

Unit Description: In this unit, students will explore the factors that impact the rates of chemical reactions. They will model their findings. Students will also learn about chemical reactions that involve the nucleus and compare nuclear reactions to the other types of chemical reactions in terms of energy scale and what is transformed through the process.

Enduring Understandings:

- All chemical reactions are accompanied by a transfer of energy.
- Chemical reactions occur at varying rates related to factors influencing the frequency and success of collisions between reactants.

Essential Questions:

- How can the rate of a chemical reaction be measured?
- What does rate measurement reveal about the transformation of reactants and products?

Unit 10 Standards

STANDARD CODE	STUDENTS WILL KNOW, BE ABLE TO, AND UNDERSTAND:
9-12.PS1.B.1	• I can explain the impact of temperature on the rate of chemical reactions. • I can describe the impact of concentration and pressure on the speed of a reaction. • I can analyze how surface area influences the rate at which reactions occur. • I can explain the role of catalysts in increasing the rate of a chemical reaction. • I can interpret and apply the rate law to determine the rate law to determine the relationship between reactant concentrations and reaction rate. • I can explain the significance of activation energy in reaction rate models and how it influences reaction rates.
9-12.PS1.C.1	• I can name an isotope given the number of protons and neutrons in the nucleus and vice versa. • I can determine the products of a nuclear reaction, including fission, fusion, and decay, and describe the emitted particles. • I can, given a chemical reaction with known reactant amounts, use mathematical representations to calculate the limiting reactant with percent yield. • I can develop a model to demonstrate different nuclear processes: fission, fusion, and nuclear decay. • I can explain why the scale of energy release in a nuclear process is much larger than the scale of energy change in a chemical process.

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