Course Description

The Chemistry Cherokee Teaching & Learning Standards are designed to continue student investigations of the physical sciences that began in grades K-8 and provide students the necessary skills to be proficient in chemistry. These standards include more abstract concepts such as the structure of atoms, structure and properties of matter, the conservation and interaction of energy and matter, and the use of Kinetic Molecular Theory to model atomic and molecular motion in chemical and physical processes. Students investigate chemistry concepts through experiences in laboratories and field work using the process of inquiry. Chemistry students use the periodic table to help with the identification of elements with particular properties, recognize patterns that lead to explain chemical reactivity and bond formation. They use the IUPAC nomenclature in order to predict chemical names for ionic (binary and ternary), acidic, and inorganic covalent compounds, and conduct experiments to manipulate factors that affect chemical reactions.

Science standards integrate the three dimensions of **Science and Engineering Practices (SEPs)**, **Crosscutting Concepts (CCCs)**, and **Disciplinary Core Ideas (DCIs)** to provide a comprehensive framework that emphasizes active engagement, interdisciplinary connections, and core scientific principles. Together, they show how science standards engage *students* in obtaining, evaluating, and communicating information.

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Science and Engineering Practices are fundamental approaches that scientists and engineers use to investigate the natural world and solve practical problems. **Crosscutting Concepts** in science are overarching themes that bridge various disciplines, helping students and researchers see connections and deepen their understanding of the natural world. **Disciplinary Core Ideas** are fundamental concepts that students need to understand to develop a deep knowledge of science across various disciplines.

Semester 1 (August – December)

Unit 0: Thinking Like a Scientist (2 weeks)

This introductory unit focuses on developing essential scientific thinking skills. Students will engage in activities designed to refine their ability to design and conduct investigations, apply scientific theories, critically evaluate scientific literature, and actively participate in scientific discussions. These standards represent scientific thinking skills that should continue to be incorporated throughout the entire course.

Overarching Standard for Unit 0

TLS9-12: **Refine scientific inquiry skills by designing and conducting investigations, applying scientific theories, critically evaluating scientific literature, and contributing to scientific discussions.**

Supporting Standards for Student Mastery in Unit 0

TLS9-12.a: Use specialized scientific terms and concepts to analyze and explain scientific phenomena.

TLS9-12.b: Design and conduct independent experiments with multiple variables.

TLS9-12.c: Utilize advanced tools and statistical methods for data analysis.

TLS9-12.d: Communicate complex findings through reports and presentations.

Unit 1: Modern Atomic Theory (2 weeks)

In this unit, students will learn about the modern atomic theory and periodic law to understand the characteristics of atoms and elements. They will evaluate the merits and limitations of various atomic models and construct arguments to support the idea that the proton defines an element's identity. This unit provides a foundational understanding of atomic structure and its implications in chemistry.

Overarching Standard for Unit 1

C1: Obtain, evaluate, and communicate information about the use of the modern atomic theory and periodic law to explain the characteristics of atoms and elements.

C1.a: Evaluate merits and limitations of different models of the atom in relation to relative size, charge, and position of protons, neutrons, and electrons in the atom.

Supporting Standards for Student Mastery in Unit 1

C1.b: Construct an argument to support the claim that the proton (and not the neutron or electron) defines the element's identity.

C1.c: Construct an explanation based on scientific evidence of the production of elements heavier than hydrogen by nuclear fusion.

C1.d: Construct an explanation that relates the relative abundance of isotopes of a particular element to the atomic mass of the element.

Unit 2: Electrons & The Periodic Table (4 weeks)

In this unit, students will explore the relationship between electron configurations and the periodic properties of elements. Using the periodic table as a model, students will predict the relative properties of elements based on patterns. They will construct explanations for electron movement to identify elements and understand the importance of molecular-level structure in the functioning of designed materials. This unit provides a comprehensive understanding of how electron configurations influence the properties and behaviors of elements.

Overarching Standard for Unit 2

C1: Obtain, evaluate, and communicate information about the use of the modern atomic theory and periodic law to explain the characteristics of atoms and elements.

C1.f: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms (i.e. including atomic radii, ionization energy, and electronegativity).

C1.g: Develop and use models, including electron configuration of atoms and ions, to predict an element's chemical properties.

Supporting Standards for Student Mastery in Unit 2

C1.e: Construct an explanation of light emission and the movement of electrons to identify elements.

C2.c: Construct an explanation about the importance of molecular-level structure in the functioning of designed materials. (*Clarification statement*: 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.)

Unit 3: Chemical Bonding & Nomenclature (5 weeks)

In this unit, students will investigate fundamental concepts of chemical bonding and the systematic naming of compounds. They will develop and use models to evaluate different bonding configurations, gaining a deep understanding of how atoms combine to form compounds. Students will also investigate patterns in IUPAC nomenclature to accurately predict and name chemical compounds. By the end of this unit, students will be proficient in using bonding models to determine chemical formulas and understand the principles behind chemical naming conventions, enhancing their ability to communicate chemical information effectively.

Overarching Standard for Unit 3

C2: Obtain, evaluate, and communicate information about the chemical and physical properties of matter resulting from the ability of atoms to form bonds.

C2.d: Develop and use models to evaluate bonding configurations from nonpolar covalent to ionic bonding. (*Clarification statement*: VSEPR theory is not addressed in this element.)

Supporting Standards for Student Mastery in Unit 3

C2.e: Ask questions about chemical names to identify patterns in IUPAC nomenclature in order to predict chemical names for ionic (binary and ternary), acidic, and inorganic covalent compounds.

C2.f: Develop and use bonding models to predict chemical formulas including ionic (binary and ternary), acidic, and inorganic covalent compounds.

Unit 4: Chemical Reactions (5 weeks)

In this unit, students will explore the principles and mechanisms of chemical reactions by learning to apply the Law of Conservation of Matter. They will use mathematics and computational thinking to balance various types of chemical reactions and investigate indicators of chemical reactions to confirm the formation of new chemicals. Students will also plan and carry out investigations to enhance their understanding of reaction dynamics and the factors influencing them.

Overarching Standard for Unit 4

C3: Obtain, evaluate, and communicate information about how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.

C3.a: Use mathematics and computational thinking to balance chemical reactions (i.e., synthesis, decomposition, single replacement, double replacement, and combustion) and construct an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

Supporting Standards for Student Mastery in Unit 4

C3.b: Plan and carry out an investigation to determine that a new chemical has been formed by identifying indicators of a chemical reaction (e.g., precipitate formation, gas evolution, color change, water production, and changes in energy to the system).

C4.a: Plan and carry out an investigation to provide evidence of the effects of changing concentration, temperature, and pressure on chemical reactions.
(Clarification statement: Pressure should not be tested experimentally.)

C4.b: Construct an argument using collision theory and transition state theory to explain the role of activation energy in chemical reactions.
(Clarification statement: Reaction coordinate diagrams could be used to visualize graphically changes in energy (direction flow and quantity) during the progress of a chemical reaction.)

C4.c: Construct an explanation of the effects of a catalyst on chemical reactions and apply it to everyday examples.

Semester 2 (January – May)

Unit 5: The Mole & Stoichiometry (6 weeks)

In this unit, students will study the foundational concepts of the mole and stoichiometry in chemistry. They will understand chemical composition in compounds and reactions, utilizing mathematics and computational thinking to grasp the significance of the mole and Avogadro's number. Students will learn how to solve reaction stoichiometry problems using mole ratios and mathematical thinking. Additionally, they will plan and conduct investigations to deepen their understanding of how reactants and products interact in chemical reactions.

Overarching Standard for Unit 5

C3: Obtain, evaluate, and communicate information about the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.

C3.c: Use mathematics and computational thinking to apply concepts of the mole and Avogadro's number to conceptualize and calculate
- percent composition
- empirical/molecular formulas
- mass, moles, and molecules relationships
- molar volumes of gases

C3.d: Use mathematics and computational thinking to identify and solve different types of reaction stoichiometry problems (i.e., mass to moles, mass to mass, moles to moles, and percent yield) using significant figures.
(*Clarification statement*: For elements c and d emphasis is on use of mole ratios to compare quantities of reactants or products and on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.)

Supporting Standards for Student Mastery in Unit 5

C3.e: Plan and carry out an investigation to demonstrate the conceptual principle of limiting reactants.

Unit 6: Gases & IMFs (4 weeks)

In this unit, students will investigate the properties of gases and intermolecular forces (IMFs) by studying how forces affect the motion of objects. They will dive into the Kinetic Molecular Theory to model atomic and molecular motion in various chemical and physical processes. Investigations will help students gather evidence to compare physical and chemical properties, infer the strength of intermolecular and intramolecular forces, and construct explanations of phase changes using heating curves as evidence.

Overarching Standard for Unit 6

C2: Obtain, evaluate, and communicate information about how forces affect the motion of objects.

C2.b: Construct an argument by applying principles of inter- and intra- molecular forces to identify substances based on chemical and physical properties.

C5: Obtain, evaluate, and communicate information about the Kinetic Molecular Theory to model atomic and molecular motion in chemical and physical processes.

C5.c: Develop and use models to quantitatively, conceptually, and graphically represent the relationships between pressure, volume, temperature, and number of moles of a gas.

Supporting Standards for Student Mastery in Unit 6

C2.a: Plan and carry out an investigation to gather evidence to compare the physical and chemical properties at the macroscopic scale to infer the strength of intermolecular and intramolecular forces.

C5.b: Construct an explanation using a heating curve as evidence of the effects of energy and intermolecular forces on phase changes.

Unit 7: Solutions and Acids & Bases (5 weeks)

In this unit, students will explore the properties and behaviors of solutions, as well as the nature of acids and bases. They will learn how to prepare and properly label solutions of specified molar concentrations and how to evaluate acids and bases, gaining a conceptual understanding of pH as it relates to acidic and basic conditions. Students will plan and carry out investigations to understand the effects of various factors on chemical reactions and develop models to illustrate processes. Finally, students will explore acid-base neutralization, deepening their understanding of solution chemistry and acid-base interactions.

Overarching Standard for Unit 7

C6: Obtain, evaluate, and communicate information about electrical and magnetic force interactions.

C6.d: Communicate scientific and technical information on how to prepare and properly label solutions of specified molar concentration.

C6.f: Use mathematics and computational thinking to compare, contrast, and evaluate the nature of acids and bases in terms of percent dissociation, hydronium ion concentration, and pH.

(*Clarification statement*: Understanding of the mathematical relationship between negative logarithm of the hydrogen concentration and pH is not expected in this element. Only a conceptual understanding of pH as related to acid/basic conditions is needed.)

Supporting Standards for Student Mastery in Unit 7

C2.e: Ask questions about chemical names to identify patterns in IUPAC nomenclature in order to predict chemical names for ionic (binary and ternary), acidic, and inorganic covalent compounds.

C2.f: Develop and use bonding models to predict chemical formulas including ionic (binary and ternary), acidic, and inorganic covalent compounds.

C4.a: Plan and carry out an investigation to provide evidence of the effects of changing concentration, temperature, and pressure on chemical reactions.

(*Clarification statement*: Pressure should not be tested experimentally.)

C4.d: Refine the design of a chemical system by altering the conditions that would change forward and reverse reaction rates and the amount of products at equilibrium.
(*Clarification statement*: Emphasis is on the application of LeChatelier's principle.)

C6.a: Develop a model to illustrate the process of dissolving in terms of solvation versus dissociation.

C6.b: Plan and carry out an investigation to evaluate the factors that affect the rate at which a solute dissolves in a specific solvent.

C6.c: Use mathematics and computational thinking to evaluate commercial products in terms of their concentrations (i.e., molarity and percent by mass).

C6.e: Develop and use a model to explain the effects of a solute on boiling point and freezing point.

C6.g: Ask questions to evaluate merits and limitations of the Arrhenius and Bronsted-Lowry models of acid and bases.

C6.h: Plan and carry out an investigation to explore acid-base neutralization.

Unit 8: Thermodynamics (3 weeks)

In this unit, students will explore the principles of thermodynamics and their applications in chemical and physical processes. They will obtain, evaluate, and communicate information about the Kinetic Molecular Theory to model atomic and molecular motion. Students will plan and carry out investigations to calculate the amount of heat absorbed or released during various chemical and physical processes, addressing concepts such as enthalpy, heat change, and Hess's Law. They will develop models to illustrate how energy release or absorption depends on changes in total bond energy. This unit will deepen students' understanding of energy transformations and the laws governing them, providing a solid foundation in thermodynamics.

Overarching Standard for Unit 8

C5: Obtain, evaluate, and communicate information about the Kinetic Molecular Theory to model atomic and molecular motion in chemical and physical processes.

C5.a: Plan and carry out an investigation to calculate the amount of heat absorbed or released by chemical or physical processes. (*Clarification statement*: Calculation of the enthalpy, heat change, and Hess's Law are addressed in this element.)

Supporting Standards for Student Mastery in Unit 8

C2.g: Develop a model to illustrate the release or absorption of energy (endothermic or exothermic) from a chemical reaction system depends upon the changes in total bond energy.