CHEMISTRY I: COURSE OVERVIEW

The academic standards establish the practices and core content for all Chemistry I courses in Tennessee high schools. The core ideas within the framework and standards are not meant to represent an equal division of material and concepts.

The major disciplinary core ideas utilized for Chemistry I include:

Physical Science (PSCI)
Physical Sciences (PS)
Matter and Its Interactions • Structure and properties of matter • Chemical reactions • Nuclear process
Motion and Stability: Forces and Interactions • Forces and motion • Types of interactions • Stability and instability in physical systems
Energy • Definitions of energy • Conservation of energy and energy transfer • Relationship between energy and forces • Energy in chemical processes and everyday life
Waves and Their Applications in Technologies for Information Transfer • Wave properties • Electromagnetic radiation

Students should explore these chemistry concepts and the seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and, stability and change) through laboratory techniques, manipulation of chemical quantities, and problem-solving practices. Within the Chemistry I standards, scientific and engineering practices are embedded as a means to learn about specific topics identified for the course. Engaging in these practices with current applications will help students become scientifically literate and astute consumers of scientific information.

Teachers, schools, and districts should use these standards to make decisions concerning the structure and content for Chemistry I classes in Tennessee schools. All chemistry courses must allow students to engage in problem solving, decision making, critical thinking, and applied learning. Chemistry courses are also laboratory based and require a minimum of 30% hands-on investigation. Chemistry laboratories will need to be stocked with the materials and equipment necessary to complete scientific investigations.

Although science is a body of content knowledge consisting of theories that explain data, science is also a set of practices that use analysis and argumentation to establish, extend, and refine knowledge. The science and engineering practices are used as a means to learn science by doing science, thus combining content knowledge with skill. These practices are not intended to be a sequence of steps nor are they intended to be taught as a separate, introductory unit for the course. By combining content knowledge with skill, students discover how scientific knowledge is acquired and applied to solve problems or advance scientific knowledge further. In addition, there are seven crosscutting concepts that are fundamental to the nature of science and thus stretch across all science disciplines. The Chemistry I standards have been constructed by explicitly integrating practices and crosscutting concepts, iteratively and in combination, within each core idea to provide students with a well-rounded education in science.

The academic standards for Chemistry I should be the basis for the development of classroom and course-level assessments.

CHEMISTRY I: ACADEMIC STANDARDS

CHEM1.PS1: Matter and Its Interactions

1) Understand and be prepared to use values specific to chemical processes: the mole, molar mass, molarity, and percent composition.

2) Demonstrate that atoms, and therefore mass, are conserved during a chemical reaction by balancing chemical equations.

3) Perform stoichiometric calculations involving the following relationships: mole-mole; mass-mass; mole-mass; mole-particle; and mass-particle. Show a qualitative understanding of the phenomenon of percent yield, limiting, and excess reagents in a chemical reaction through pictorial and conceptual examples. (states of matter liquid and solid; excluding volume of gasses)

4) Use the reactants in a chemical reaction to predict the products and identify reaction classes (synthesis, decomposition, combustion, single replacement, double replacement).

5) Conduct investigations to explore and characterize the behavior of gases (pressure, volume, temperature), develop models to represent this behavior, and construct arguments to explain this behavior. Evaluate the relationship (qualitatively and quantitatively) at STP between pressure and volume (Boyle's law), temperature and volume (Charles's law), temperature and pressure (Gay-Lussac law), and moles and volume (Avogadro's law), and evaluate and explain these relationships with respect to kinetic-molecular theory. Be able to understand, establish, and predict the relationships between volume, temperature, and pressure using combined gas law both qualitatively and quantitatively.

6) Use the ideal gas law, $PV = nRT$, to algebraically evaluate the relationship among the number of moles, volume, pressure, and temperature for ideal gases.

7) Analyze solutions to identify solutes and solvents, quantitatively analyze concentrations (molarity, percent composition, and ppm), and perform separation methods such as evaporation, distillation, and/or chromatography and show conceptual understanding of distillation. Construct an argument to justify the use of certain separation methods under different conditions.

8) Identify acids and bases as a special class of compounds with a specific set of properties.

9) Draw models (qualitative models such as pictures or diagrams) to demonstrate understanding of radioactive stability and decay. Understand and differentiate between fission and fusion reactions. Use models (graphs or tables) to explain the concept of half-life and its use in determining the age of materials (such as radiometric dating).

10) Compare alpha, beta, and gamma radiation in terms of mass, charge, and penetrating power. Identify examples of applications of different radiation types in everyday life (such as its applications in cancer treatment).

11) Develop and compare historical models of the atom (from Democritus to quantum model) and construct arguments to show how scientific knowledge evolves over time, based on experimental evidence, critique, and alternative interpretations.

12) Explain the origin and organization of the Periodic Table. Predict chemical and physical properties of main group elements (reactivity, number of subatomic particles, ion charge, ionization energy, atomic radius, and electronegativity) based on location on the periodic table. Construct an argument to describe how the quantum mechanical model of the atom (e.g., patterns of valence and inner electrons) defines periodic properties. Use the periodic table to draw Lewis dot structures and show understanding of orbital notations through drawing and interpreting graphical representations (i.e., arrows representing electrons in an orbital).

13) Use the periodic table and electronegativity differences of elements to predict the types of bonds that are formed between atoms during chemical reactions and write the names of chemical compounds, including polyatomic ions using the IUPAC criteria.

14) Use Lewis dot structures and electronegativity differences to predict the polarities of simple molecules (linear, bent, trigonal planar, trigonal pyramidal, tetrahedral). Construct an argument to explain how electronegativity affects the polarity of basic chemical molecules.

15) Investigate, describe, and mathematically determine the effect of solute concentration on vapor pressure using the solute's van 't Hoff factor on freezing point depression and boiling point elevation.

CHEM1.PS2: Motion and Stability: Forces and Interactions

1) Draw, identify, and contrast graphical representations of chemical bonds (ionic, covalent, and metallic) based on chemical formulas. Construct and communicate explanations to show that atoms combine by transferring or sharing electrons.

2) Understand that intermolecular forces created by the unequal distribution of charge result in varying degrees of attraction between molecules. Compare and contrast the intermolecular forces (hydrogen bonding, dipole-dipole bonding, and London dispersion forces) within different types of simple substances (only those following the octet rule) and predict and explain their effect on chemical and physical properties of those substances using models or graphical representations.

3) Construct a model to explain the process by which solutes dissolve in solvents, and develop an argument to describe how intermolecular forces affect the solubility of different chemical compounds.

4) Conduct an investigation to determine how temperature, surface area, and stirring affect the rate of solubility. Construct an argument to explain the relationships observed in experimental data using collision theory.

CHEM1.PS3: Energy

1) Contrast the concepts of temperature and heat in macroscopic and microscopic terms. Understand that thermal energy is a form of energy and temperature is a measure of average kinetic energy of a group of particles.

2) Draw and interpret heating and cooling curves and phase diagrams. Analyze the energy changes involved in calorimetry by using the law of conservation of energy quantitatively (use of $q = mc\Delta T$) and qualitatively.

3) Distinguish between endothermic and exothermic reactions by constructing potential energy diagrams and explain the differences between the two using chemical terms (e.g. activation energy). Recognize when energy is absorbed or given off depending on the bonds formed and bonds broken.

4) Analyze energy changes to explain and defend the law of conservation of energy.

CHEM1.PS4: Waves and Their Applications in Technologies for Information Transfer

1) Using a model, explain why elements emit and absorb characteristic frequencies of light and how this information is used.