



CHEMISTRY

Test Framework

	Content Domain	Range of Competencies	Approximate Percentage of Test Score
I.	Nature of Science	0001–0003	18%
II.	Matter and Atomic Structure	0004–0006	18%
III.	Energy and Chemical Bonding	0007–0010	23%
IV.	Chemical Reactions	0011–0014	23%
V.	Stoichiometry and Solutions	0015–0017	18%

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I. NATURE OF SCIENCE

0001 Understand principles and procedures of scientific inquiry.

- ▶ Demonstrate knowledge of the principles and procedures for designing and carrying out scientific investigations.
- ▶ Recognize methods and criteria for collecting, organizing, analyzing, and numerically and graphically presenting scientific data.
- ▶ Recognize the evidential basis of scientific claims.
- ▶ Demonstrate knowledge of the safety procedures and hazards associated with chemical investigations and the materials, equipment, and measurement standards used in chemistry.
- ▶ Apply basic mathematical procedures and concepts of uncertainty in reporting data and solving problems in chemistry.

0002 Understand the history and nature of science.

- ▶ Demonstrate knowledge of the historical development of major scientific ideas.
- ▶ Demonstrate knowledge of major contemporary theories, laws, models, and concepts in physics, biology, and Earth and space science.
- ▶ Demonstrate knowledge of unifying themes, principles, and relationships that connect the different branches of the sciences and the uses and limitations of models.
- ▶ Demonstrate knowledge of the nature of science and its characteristics as a system of inquiry.

0003 Understand the relationships among science, technology, engineering, mathematics, and society.

- ▶ Analyze the interrelationships among chemistry, technology, engineering, mathematics, and society.
- ▶ Evaluate scientific research and the coverage of science in the media.
- ▶ Analyze social, economic, and ethical issues associated with technological and scientific developments.

II. MATTER AND ATOMIC STRUCTURE

0004 Understand the properties of matter.

- ▶ Analyze the characteristics of elements, compounds, and mixtures.
- ▶ Apply methods used to determine the chemical and physical properties of unknown substances.
- ▶ Analyze physical, chemical, and nuclear changes in matter.
- ▶ Demonstrate knowledge of the characteristics of radioactive materials.

0005 Understand atomic theory and the periodic table.

- ▶ Analyze various historical and contemporary models of atomic structure and the supporting evidence for these models.
- ▶ Demonstrate knowledge of the properties of and interactions between electrons, protons, and neutrons; and the relationships among energy levels, photons, and atomic spectra.
- ▶ Demonstrate the ability to analyze electron configurations, orbital notations (or diagrams), and Lewis (or electron) dot symbols.
- ▶ Demonstrate knowledge of the organization of the periodic table and its usefulness in predicting the physical and chemical properties and relative reactivity of given elements.

0006 Understand the kinetic molecular theory, the nature of phase changes, and the gas laws.

- ▶ Demonstrate knowledge of the basic principles of the kinetic molecular theory and the distinguishing characteristics of the four states of matter.
- ▶ Analyze heating and cooling curves and phase diagrams.
- ▶ Demonstrate knowledge of the relationships among volume, temperature, and pressure in gases.
- ▶ Solve problems involving the gas laws.

III. ENERGY AND CHEMICAL BONDING

0007 Understand the principles of thermodynamics and calorimetry.

- ▶ Analyze the three laws of thermodynamics and their applications to chemical and biochemical systems.
- ▶ Predict the spontaneity of given chemical reactions.
- ▶ Differentiate among forms of energy and between heat and temperature.
- ▶ Analyze the results of calorimetry experiments.

0008 Understand energy relationships in chemical bonding, chemical reactions, and physical processes.

- ▶ Analyze energy changes due to the formation or breaking of chemical bonds.
- ▶ Analyze energy changes during chemical reactions, including the analysis of enthalpy diagrams.
- ▶ Analyze energy changes involved in phase transitions, dissolving solutes in solvents, and diluting solutions.

0009 Understand the nomenclature and structure of inorganic and organic compounds.

- ▶ Apply the International Union of Pure and Applied Chemistry (IUPAC) rules of nomenclature.
- ▶ Analyze the characteristics of inorganic structures, including ionic solids, network solids, and metallic solids.
- ▶ Predict the geometry of molecules and polyatomic ions.
- ▶ Analyze the chemical composition and basic structure of organic compounds.
- ▶ Recognize the characteristics of structural, geometric, and optical isomers.

0010 Understand chemical bonding and intermolecular forces and their effect on the properties of substances.

- ▶ Compare the characteristics of types of chemical bonds.
- ▶ Analyze chemical bonding in terms of electron behavior and the factors that affect bond strength.
- ▶ Analyze the characteristics of various types of intermolecular forces and the forces between molecules of a given structure.
- ▶ Relate the properties of substances to their atomic bonds and intermolecular forces.

IV. CHEMICAL REACTIONS

0011 Understand the nature of chemical reactions.

- ▶ Analyze different types of chemical reactions.
- ▶ Predict the outcomes of chemical reactions.
- ▶ Demonstrate knowledge of collision theory and factors that influence reaction rates.
- ▶ Analyze rate problems and experimental rate data.

0012 Understand the principles of chemical equilibrium.

- ▶ Demonstrate knowledge of the concept of chemical equilibrium and the factors that influence chemical equilibrium.
- ▶ Apply Le Châtelier's principle to chemical systems.
- ▶ Solve problems involving equilibrium constants.

0013 Understand acid-base chemistry.

- ▶ Analyze acids and bases according to how they behave and how they are defined.
- ▶ Determine the hydronium ion concentration, hydroxide ion concentration, pH, and pOH for acid, base, and salt solutions.
- ▶ Demonstrate knowledge of the relationship between molecular structure and acid strength and the relative strengths of acids and bases.
- ▶ Analyze buffer solutions qualitatively and quantitatively.
- ▶ Demonstrate knowledge of the principles and applications of acid-base titrations.

0014 Understand oxidation-reduction reactions and electrochemistry.

- ▶ Demonstrate knowledge of oxidation, reduction, oxidation numbers, and the balancing of oxidation-reduction equations.
- ▶ Analyze the components and operating principles of electrochemical cells and electrolytic cells.
- ▶ Solve problems involving electrochemical cells.
- ▶ Demonstrate knowledge of the applications of electrochemistry.

V. STOICHIOMETRY AND SOLUTIONS

0015 Understand the mole concept.

- ▶ Demonstrate knowledge of the mole concept and its use in chemical calculations.
- ▶ Solve problems involving molar mass, percent-composition, and empirical and molecular formulas.

0016 Understand stoichiometry.

- ▶ Demonstrate the ability to interpret chemical notation, balance chemical equations, and recognize net ionic equations.
- ▶ Solve stoichiometric problems involving moles, mass, volume, and energy, including limiting reactant and percent yield.

0017 Understand the properties of solutions and colloidal suspensions.

- ▶ Demonstrate knowledge of different types of solutions, colloids, and suspensions.
- ▶ Solve problems involving concentrations of solutions.
- ▶ Analyze factors that affect solubility and solubility curves.
- ▶ Analyze the colligative properties of solutions.