

Test Content Categories	Required Course Numbers											
I. Basic Principles of Matter and Energy; Thermodynamics (14%)												
A. Matter and Energy												
1. Organization of matter a. pure substances (elements and compounds) b. mixtures (homogeneous, heterogeneous, solutions, suspensions) c. states of matter (solid, liquid, gas, plasma)												
2. Particulate structure of matter a. atoms, ions, molecules												
3. Differences between chemical and physical properties and chemical and physical changes a. chemical versus physical properties b. chemical versus physical changes c. intensive versus extensive properties												
4. Conservation of energy and the conservation of matter in chemical processes a. law of conservation of energy b. law of conservation of matter												
5. Different forms of energy a. kinetic and potential b. chemical, electrical, electromagnetic, nuclear, and thermal energy c. conversions between different forms of energy within chemical systems												

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B. Thermodynamics in Chemistry											
1. Temperature, thermal energy, and heat capacity, including temperature scales, units of energy, and calculations involving these concepts a. temperature and temperature scales b. thermal energy and units of energy c. heat transfer d. heat capacity and specific heat e. calorimetry calculations											
2. Concepts and calculations involving phase transitions between the various states of matter a. phase transitions and diagrams b. heats of vaporization, fusion, and sublimation c. heating curves											
3. Kinetic molecular theory and ideal gas laws a. assumptions of the kinetic molecular theory b. ideal gases and the ideal gas laws (e.g., applications, calculations) c. real gas behavior											
4. Energetics of chemical reactions a. exothermic and endothermic reactions b. bond energy; Hess's law											

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5. How the laws of thermodynamics relate to chemical reactions and phase changes a. laws of thermodynamics b. spontaneous/reversible processes c. change in enthalpy, entropy, and Gibbs energy in chemical/physical processes											
II. Atomic and Nuclear Structure (12%)											
1. Current model of atomic structure a. description of atomic model (e.g., subatomic particles, orbitals, quantum numbers) b. experimental basis (e.g., cathode ray tube, gold foil experiment, spectral lines) c. isotopes (mass number, average atomic mass)											
2. Electron configuration of the elements based on the periodic table a. Aufbau principle, Hund's rule, Pauli exclusion principle b. correlation between electron configuration and periodic table c. relationship between electron configuration and chemical and physical properties											
3. Radioactivity a. characteristics of alpha particles, beta particles, and											

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gamma radiation b. radioactive decay processes; half life c. fission, fusion, and other nuclear reactions d. balancing nuclear reactions and identifying products of nuclear reactions											
4. How the electronic absorption and emission spectra of elements are related to electron energy levels a. electronic energy transitions in atoms (e.g., ground state, excited states, emission/absorption of energy) b. energy of electronic absorption/emission spectral lines in various regions of the electromagnetic spectrum c. relationship between energy, frequency, and wavelength											
III. Nomenclature; Chemical Composition; Bonding and Structure (15%) A. Nomenclature and Chemical Composition											
1. Systematic names and chemical formulas of simple inorganic compounds a. binary compounds b. acids, bases, and salts c. hydrates											
2. Names of common organic compounds based on their functional groups a. alkanes, alkenes, and alkynes b. alcohols, ethers, ketones, aldehydes, amines											

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3. Mole concept and how it applies to chemical composition a. Avogadro's number, molar mass, and mole conversions b. calculation of empirical and molecular formulas c. percent composition											
B. Bonding and Structure											
1. Common properties of bonds a. relative bond lengths b. relative bond strengths											
2. Bond types a. ionic bonding b. covalent bonding (polar, nonpolar, hybridization) c. metallic bonding											
3. Structural formulas and molecular geometry (shape) a. Lewis structures including formal charges b. resonance structures c. molecular geometry (shape and approximate bond angles)											
4. Identify polar and nonpolar molecules a. analysis of bonding in the molecule b. symmetry of molecular structure											

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5. Intermolecular interactions a. hydrogen bonding b. London forces (instantaneous induced dipole-dipole) c. dipole-dipole d. dipole-induced dipole											
6. How bonding and structure correlate with physical properties a. boiling points and melting points b. solubility c. equilibrium vapor pressure											
IV. Chemical Reactions; Periodicity (20%) A. Periodicity											
1. Basis of the periodic table and general layout a. arranged in groups and periods b. atomic number and mass c. symbols of the elements d. metals, nonmetals, metalloids e. transition elements											
2. Periodic trends in physical and chemical properties of the elements a. atomic/ionic radius b. ionization energy c. electron affinity											

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d. electronegativity e. physical properties (e.g., boiling/melting points, conductivity) f. chemical reactivity											
B. Chemical Reactions and Basic Principles											
1. Balancing chemical equations a. simple chemical equations b. chemical equations involving oxidation-reduction											
2. Stoichiometric calculations a. simple calculations based on balanced chemical equations involving moles, mass, and volume b. limiting reagent calculations and percent yield											
3. Identify, write, and predict products of simple reaction types a. combustion, neutralization b. decomposition, dehydration c. single and double replacement d. oxidation-reduction											
4. Chemical kinetics a. rate laws, rate constants, and reaction order b. activation energy and reaction mechanisms including catalysts c. factors affecting reaction rate such as concentration, surface area, and temperature											
5. Chemical reaction equilibrium											

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a. equilibrium constants b. Le Châtelier's principle											
6. Oxidation-reduction reactions and how to determine oxidation states a. oxidation states b. identify oxidation-reduction reactions and half reactions c. standard reduction potentials d. electrochemical reactivity series e. electrochemical cells											
C. Biochemistry and Organic Chemistry											
1. Important biochemical compounds a. carbohydrates, including simple sugars b. lipids c. proteins and amino acids d. DNA and RNA e. products of photosynthesis and respiration											
2. Common organic compounds (i.e., identify functional groups) a. alcohols b. ketones and aldehydes c. alkanes, alkenes, and alkynes d. ethers e. carboxylic acids f. amines g. benzene											

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V. Solutions and Solubility; Acid-Base Chemistry (15%)											
A. Solutions and Solubility											
1. Solution terminology and calculations											
a. dilute, concentrated											
b. saturated, unsaturated, supersaturated											
c. solvent, solute											
d. concentration units (e.g., molarity, molality, mole fraction, parts per million (ppm), parts per billion (ppb), percent by mass or volume)											
e. preparation of solutions of varying concentrations											
2. Factors affecting solubility and dissolution rate											
a. dissolution rate (i.e., temperature, pressure, surface area, agitation)											
b. solubility and solubility curves (temperature and pressure dependent)											
3. Solution phenomena based on colligative properties											
a. freezing point depression											
b. boiling point elevation											
c. vapor pressure effects											
d. osmotic pressure											
4. Common applications of equilibrium in ionic solutions											
a. solubility of ionic compounds (e.g., solubility rules,											

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slightly soluble compounds) b. K_p calculations including percent dissociation and precipitation c. common ion effect d. electrolytes, nonelectrolytes, and electrical conductivity											
B. Acid-Base Chemistry											
1. Define and identify acids and bases and know their properties a. Arrhenius acids and bases b. Brønsted-Lowry acids and bases c. Lewis acids and bases d. neutralization and equivalence point											
2. The pH scale and calculations involving pH and pOH a. pH scale b. calculation of pH and pOH c. calculation of $[H_+]$ and $[OH^-]$ d. knows the meaning of K_w											
3. Concepts and calculations involving acid-base titrations a. use and selection of indicators (e.g., phenolphthalein, litmus paper) b. endpoint determination c. calculations based on titrations											
4. Equilibrium relationships in acid-base chemistry											

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a. strong/weak acids and bases, including common examples b. monoprotic and polyprotic acids c. K_a , K_b , and percent dissociation d. hydrolysis (acidic and basic salts) e. buffer solutions											
VI. Scientific Inquiry and Social Perspectives of Science (12%)											
A. History and Nature of Scientific Inquiry											
1. Processes involved in scientific inquiry a. formulating problems b. forming and testing hypotheses c. development of theories, models, and laws (postulates, assumptions) d. process skills including observing, concluding, comparing, inferring, categorizing, and generalizing											
2. Experimental design a. testing hypotheses b. significance of controls c. use and identification of variables d. data collection planning											

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3. Nature of scientific knowledge a. subject to change b. consistent with experimental evidence c. reproducibility d. unifying concepts and processes (e.g., systems, models, constancy and change, equilibrium, form and function)											
4. Major historical developments in chemistry and the contributions of major historical figures a. how current chemical principles and models developed over time b. major developments in chemistry (e.g., atomic model, ideal gas behavior) including major historical figures											
B. Science, Technology, Society, and the Environment											
1. Impact of chemistry and technology on society and the environment a. pharmaceuticals b. acid rain c. medical imaging d. air and water pollution e. greenhouse gases f. ozone layer depletion g. waste disposal and recycling											

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h. nanotechnology											
2. Applications of chemistry in daily life a. plastics, soap, batteries, fuel cells, and other consumer products b. water purification c. chemical properties of household products											
3. Advantages and disadvantages associated with various types of energy production a. renewable and nonrenewable energy resources b. conservation and recycling c. pros and cons of power generation based on various sources such as fossil and nuclear fuel, hydropower, wind power, solar power, and geothermal power											
VII. Scientific Procedures and Techniques (12%)											
1. Collect, evaluate, manipulate, interpret, and report data a. significant figures in collected data and calculations b. organization and presentation of data c. knows how to interpret and draw conclusions from data presented in tables, graphs, and charts (e.g., trends in data, relationships between variables, predictions and conclusions based on data)											
2. Units of measurement, notation systems, conversions, and mathematics used in chemistry											

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a. standard units of measurement b. unit conversion c. scientific notation d. measurement equipment											
3. Basic error analysis a. determining mean b. accuracy and precision c. identifying sources and effects of error d. percent error											
4. Appropriate preparation, use, storage, and disposal of materials in the laboratory a. appropriate use and storage b. safe disposal c. preparation for classroom use d. safe procedures and safety precautions											
5. Appropriate use, maintenance, and calibration of laboratory equipment a. appropriate use and storage b. maintenance and calibration c. preparation for classroom use d. safety procedures and precautions when using equipment											
6. Safety procedures and precautions for the high school chemistry laboratory a. location and use of standard safety equipment such as eyewash and shower											

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b. laboratory safety rules for students c. appropriate apparel and conduct in the laboratory, such as wearing goggles d. emergency procedures											