| **Test Content Categories** | **How well do I know the content?  (scale 1–5)** | **What resources do I have/need for this content?** | **Where can I find the resources I need?** | **Dates I will study this content** | **Date completed** |
| --- | --- | --- | --- | --- | --- |
| **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 |  |  |  |  |  |
| **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 |  |  |  |  |  |
| 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 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 |  |  |  |  |  |
| 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 |  |  |  |  |  |
| 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 |  |  |  |  |  |
| 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 |  |  |  |  |  |
| 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 |  |  |  |  |  |
| **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, slightly soluble compounds) |  |  |  |  |  |
| b. ksp 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 p​H and p​O​H |  |  |  |  |  |
| a. p​H scale |  |  |  |  |  |
| b. calculation of p​H and p​O​H |  |  |  |  |  |
| c. calculation of [H​+] and [O​H​−] |  |  |  |  |  |
| 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 |  |  |  |  |  |
| 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 |  |  |  |  |  |
| 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 |  |  |  |  |  |
| 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 |  |  |  |  |  |
| 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 |  |  |  |  |  |
| b. laboratory safety rules for students |  |  |  |  |  |
| c. appropriate apparel and conduct in the laboratory, such as wearing goggles |  |  |  |  |  |
| d. emergency procedures |  |  |  |  |  |