| **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** |
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| 1. Nature and Impact of Science and Engineering |  |  |  |  |  |
| 1. **Nature of Science** |  |  |  |  |  |
| 1. Nature of scientific knowledge |  |  |  |  |  |
| a. Involves a variety of investigation methods |  |  |  |  |  |
| b. Based on experimental evidence that is reproducible |  |  |  |  |  |
| c. How major concepts develop and change over time in light of new evidence |  |  |  |  |  |
| d. Constructing and testing hypotheses |  |  |  |  |  |
| e. Use of particulate representations, models, laws, and theories to explain natural phenomena |  |  |  |  |  |
| f. Development and application of models to explain natural phenomena |  |  |  |  |  |
| g. Involves process skills, including observing, categorizing, comparing, generalizing, inferring, concluding, and communicating |  |  |  |  |  |
| 2. Experimental design, data collection, and analysis |  |  |  |  |  |
| a. Standard units of measurement, dimensional analysis, and unit conversion |  |  |  |  |  |
| b. Scientific notation and use of significant figures |  |  |  |  |  |
| c. Experimental design, including identifying variables, planning data collection, and how it supports testing of the hypothesis |  |  |  |  |  |
| d. Processing, organizing, graphing, and reporting of data |  |  |  |  |  |
| e. Error analysis, including accuracy and precision, mean, and percent error |  |  |  |  |  |
| f. Identifying the sources and effects of error |  |  |  |  |  |
| g. Interpreting and drawing conclusions from data |  |  |  |  |  |
| 3. Laboratory procedures |  |  |  |  |  |
| a. Appropriate preparation, use, storage, and disposal of materials |  |  |  |  |  |
| b. Preparing solutions of varying concentration |  |  |  |  |  |
| c. Appropriate use of laboratory equipment (including selection, calibration, and maintenance) |  |  |  |  |  |
| d. Safety procedures and precautions for the laboratory |  |  |  |  |  |
| **B. Science, Engineering, Technology, Society, and the Environment** |  |  |  |  |  |
| 1. Interdependence of science, engineering, and technology |  |  |  |  |  |
| a. How engineering advances lead to important discoveries in science |  |  |  |  |  |
| b. Science and technology that drive each other forward |  |  |  |  |  |
| 2. Engineering Design |  |  |  |  |  |
| a. Defining problems in terms of criteria for success and constraints or limits |  |  |  |  |  |
| b. Designing solutions, including proposing and evaluating in terms of criteria, constraints, and limitations |  |  |  |  |  |
| c. Optimizing the design, including systematic modification and refinement |  |  |  |  |  |
| 3. Using science and engineering to identify and address negative impacts on the environment and society |  |  |  |  |  |
| a. Acid rain |  |  |  |  |  |
| b. Pollution |  |  |  |  |  |
| c. Greenhouse gases |  |  |  |  |  |
| d. Ozone layer depletion |  |  |  |  |  |
| e. Plastics |  |  |  |  |  |
| f. Waste disposal and recycling |  |  |  |  |  |
| 4. Advantages and disadvantages associated with various types of energy production |  |  |  |  |  |
| a. Energy conservation |  |  |  |  |  |
| b. Recycling of materials |  |  |  |  |  |
| c. Renewable and nonrenewable energy sources |  |  |  |  |  |
| d. Pros and cons of power generation based on various sources (e.g., fossil, nuclear, hydro, wind, solar, and geothermal) |  |  |  |  |  |
| 5. Applications of chemistry and physics and technology in daily life |  |  |  |  |  |
| a. Water purification |  |  |  |  |  |
| b. Plastics, soap, batteries, and other commercial products |  |  |  |  |  |
| c. Mining and industrial processes |  |  |  |  |  |
| d. Communications, telescopes, and medical imaging |  |  |  |  |  |
| e. Biological applications |  |  |  |  |  |
| II. Principles and Models of Matter and Energy |  |  |  |  |  |
| **A. Atomic and Nuclear Structure and Processes** |  |  |  |  |  |
| 1. Current model of atomic structure |  |  |  |  |  |
| a. Description of basic model, including number and location of protons, neutrons, and electrons |  |  |  |  |  |
| b. Atomic number, atomic mass, and isotopes |  |  |  |  |  |
| c. Correlation between the electron configuration of elements and their position on the periodic table |  |  |  |  |  |
| d. Development and experimental basis of current model |  |  |  |  |  |
| 2. Radioactivity |  |  |  |  |  |
| a. Basic characteristics of alpha particles, beta particles, and gamma radiation |  |  |  |  |  |
| b. Radioactive decay (e.g., half-life) |  |  |  |  |  |
| c. Identifying fission and fusion reactions |  |  |  |  |  |
| d. Identifying products of nuclear reactions |  |  |  |  |  |
| **B. Relationships Between Energy and Matter** |  |  |  |  |  |
| 1. Organization of matter |  |  |  |  |  |
| a. Pure substances (elements and compounds) |  |  |  |  |  |
| b. Mixtures (homogeneous, heterogeneous, solutions, suspensions) |  |  |  |  |  |
| c. States of matter (solid, liquid, gas, and plasma) |  |  |  |  |  |
| d. Atoms, ions, and molecules |  |  |  |  |  |
| 2. Difference between chemical and physical properties and changes |  |  |  |  |  |
| a. Chemical versus physical properties or changes |  |  |  |  |  |
| b. Conservation of matter in chemical and physical processes |  |  |  |  |  |
| 3. Conservation of energy in chemical and physical processes |  |  |  |  |  |
| a. Kinetic and potential energy concepts and particulate models |  |  |  |  |  |
| b. Forms of energy, including chemical, electrical, thermal, electromagnetic, and nuclear |  |  |  |  |  |
| c. Conversion between different forms of energy |  |  |  |  |  |
| d. Energy required to break bonds and energy released when bonds form |  |  |  |  |  |
| e. Exothermic and endothermic processes |  |  |  |  |  |
| 4. Temperature, thermal energy, and specific heat capacity, including computational thinking |  |  |  |  |  |
| a. Temperature scales (Kelvin, Celsius, and Fahrenheit) |  |  |  |  |  |
| b. Heat transfer (conduction, convection, and radiation) |  |  |  |  |  |
| c. Specific heat capacity |  |  |  |  |  |
| 5. Energy concepts involving phase transitions, including particulate models |  |  |  |  |  |
| a. Phase diagrams |  |  |  |  |  |
| b. Heats of vaporization, fusion, and sublimation |  |  |  |  |  |
| c. Heating curves |  |  |  |  |  |
| 6. Kinetic molecular theory, including particulate and mathematical models |  |  |  |  |  |
| a. Assumptions and applications of the kinetic molecular theory |  |  |  |  |  |
| b. Ideal gas behavior (e.g., relationships between temperature, pressure, and volume) |  |  |  |  |  |
| III. Chemistry |  |  |  |  |  |
| **A. Chemical Composition, Bonding, and Structure** |  |  |  |  |  |
| 1. Mole concept and application to chemical systems |  |  |  |  |  |
| a. Avogadro’s number, molar mass, and mole conversions |  |  |  |  |  |
| b. Percent composition |  |  |  |  |  |
| 2. Names and chemical formulas for simple inorganic compounds |  |  |  |  |  |
| a. Interpreting chemical formulas |  |  |  |  |  |
| b. Naming compounds based on formula |  |  |  |  |  |
| c. Writing formulas based on name of compound |  |  |  |  |  |
| 3. Properties and models of bonding |  |  |  |  |  |
| a. Ionic bonding |  |  |  |  |  |
| b. Covalent bonding (polar and nonpolar) |  |  |  |  |  |
| c. Metallic bonding |  |  |  |  |  |
| d. Relative bond strengths and bond lengths of single, double, and triple bonds |  |  |  |  |  |
| e. Electron dot and Lewis structures |  |  |  |  |  |
| f. Molecular structure models (shape, bond angles, and polarity) |  |  |  |  |  |
| g. Intermolecular forces (e.g., hydrogen bonding, dipole- dipole) |  |  |  |  |  |
| 4. How bonding, structure, and intermolecular interactions are related to physical properties of pure substances |  |  |  |  |  |
| a. Boiling points and melting points |  |  |  |  |  |
| b. Solubility |  |  |  |  |  |
| **B. Chemical Reactions and Periodicity** |  |  |  |  |  |
| 1. The periodic table as a model |  |  |  |  |  |
| a. Arranged in groups and periods |  |  |  |  |  |
| b. Symbols of the element, atomic number, and atomic mass |  |  |  |  |  |
| c. Location of metals, nonmetals, metalloids, and transition elements |  |  |  |  |  |
| 2. Trends in physical and chemical properties of the elements based on their position on the periodic table |  |  |  |  |  |
| a. Atomic and ionic radius |  |  |  |  |  |
| b. Ionization energy |  |  |  |  |  |
| c. Electronegativity |  |  |  |  |  |
| d. Physical properties |  |  |  |  |  |
| e. Chemical properties and reactivity |  |  |  |  |  |
| 3. Chemical reaction equations |  |  |  |  |  |
| a. Identifying single-replacement, double-replacement, neutralization, precipitation, combustion, synthesis, decomposition, and oxidation-reduction reactions |  |  |  |  |  |
| b. Predicting products of simple reaction types |  |  |  |  |  |
| c. Balancing equations |  |  |  |  |  |
| d. Stoichiometric relationships based on balanced equations |  |  |  |  |  |
| 4. Chemical reaction kinetics |  |  |  |  |  |
| a. Catalysts |  |  |  |  |  |
| b. Factors affecting reaction rate, including concentration, surface area, temperature, and pressure |  |  |  |  |  |
| **C. Solutions and Acid-Base Chemistry** |  |  |  |  |  |
| 1. Analysis of types of solutions |  |  |  |  |  |
| a. Dilute, concentrated, unsaturated, saturated, and supersaturated |  |  |  |  |  |
| b. Concentration terms (molarity and percent by mass or volume) |  |  |  |  |  |
| 2. Solutions and solubility |  |  |  |  |  |
| a. Factors affecting rate of dissolving (temperature, pressure, surface area, and stirring) |  |  |  |  |  |
| b. Interpreting solubility curves (temperature dependence) |  |  |  |  |  |
| c. Electrolytes, nonelectrolytes, and electrical conductivity of solutions |  |  |  |  |  |
| 3. Models of acids and bases and their properties |  |  |  |  |  |
| a. Identifying common acids and bases |  |  |  |  |  |
| b. Strong and weak acids and bases (degree of dissociation in aqueous solution) |  |  |  |  |  |
| c. Relationship between acidity and pH or |  |  |  |  |  |
| d. Applications of buffers |  |  |  |  |  |
| 4. Concepts involving acid-base neutralization |  |  |  |  |  |
| a. Neutralization |  |  |  |  |  |
| b. Use of acid-base indicators |  |  |  |  |  |
| c. Titrations |  |  |  |  |  |
| IV. Physics |  |  |  |  |  |
| **A. Mechanics** |  |  |  |  |  |
| 1. Description of motion in one and two dimensions |  |  |  |  |  |
| a. Scalar quantities (distance, mass, speed, time, and energy) |  |  |  |  |  |
| b. Vector quantities (displacement, velocity, acceleration, force, and momentum) |  |  |  |  |  |
| c. Linear motion |  |  |  |  |  |
| d. Two-dimensional motion, including circular motion and projectile motion |  |  |  |  |  |
| 2. Newton’s laws of motion |  |  |  |  |  |
| a. First law (mass and inertia) |  |  |  |  |  |
| b. Second law (net force, mass, and acceleration) |  |  |  |  |  |
| c. Third law (action-reaction pairs) |  |  |  |  |  |
| 3. Weight, mass, density, and buoyancy |  |  |  |  |  |
| a. Distinguish between weight and mass |  |  |  |  |  |
| b. Newton’s law of universal gravitation |  |  |  |  |  |
| c. Acceleration due to gravity |  |  |  |  |  |
| d. Fluid properties (Archimedes’ principle and density) |  |  |  |  |  |
| 4. Analysis of motion and forces and applications |  |  |  |  |  |
| a. Friction |  |  |  |  |  |
| b. Center of mass |  |  |  |  |  |
| c. Impulse and linear momentum |  |  |  |  |  |
| d. Conservation of momentum and collisions (elastic and inelastic) |  |  |  |  |  |
| e. Uniform circular motion |  |  |  |  |  |
| f. Projectile motion |  |  |  |  |  |
| g. Periodic motion (Hooke’s law, pendulums, and springs) |  |  |  |  |  |
| 5. Energy and work |  |  |  |  |  |
| a. Mechanical energy (kinetic and potential) |  |  |  |  |  |
| b. Conservation of energy |  |  |  |  |  |
| c. Concept of work and power |  |  |  |  |  |
| d. Force and distance relationships in simple machines |  |  |  |  |  |
| **B. Electricity, Magnetism, and Waves** |  |  |  |  |  |
| 1. Electrostatics |  |  |  |  |  |
| a. Static electric charge (attractive and repulsive forces) |  |  |  |  |  |
| b. Methods of charge separation (friction, conduction, induction, and polarization) |  |  |  |  |  |
| c. Coulomb’s law and electric fields |  |  |  |  |  |
| d. Electric potential and potential difference (voltage) |  |  |  |  |  |
| e. Conductors and insulators |  |  |  |  |  |
| 2. Properties and relationships involving electric current |  |  |  |  |  |
| a. Current, resistance, potential difference (voltage) |  |  |  |  |  |
| b. Ohm’s law |  |  |  |  |  |
| c. Relationship between power, electric current, and potential difference |  |  |  |  |  |
| d. Electrical energy in daily life (kilowatt-hour) |  |  |  |  |  |
| e. Difference between direct current and alternating current |  |  |  |  |  |
| f. Sources of potential difference (batteries, generators, photocells) |  |  |  |  |  |
| g. Analysis of simple series and parallel circuits |  |  |  |  |  |
| 3. Magnetic fields, forces, and materials |  |  |  |  |  |
| a. Magnetic forces (attractive and repulsive) and fields |  |  |  |  |  |
| b. Magnets (bar magnets and poles, permanent magnets, and electromagnets) |  |  |  |  |  |
| c. Relationships between electricity and magnetism and applications (motors and generators) |  |  |  |  |  |
| 4. Types of waves and their characteristics |  |  |  |  |  |
| a. Transverse and longitudinal |  |  |  |  |  |
| b. Relationships between amplitude, wavelength, frequency, period, and speed of propagation, and energy (mechanical and electromagnetic) |  |  |  |  |  |
| c. Superposition, standing waves, and resonance |  |  |  |  |  |
| 5. Electromagnetic waves and the electromagnetic spectrum |  |  |  |  |  |
| a. Model and properties of light (electric and magnetic fields, speed of light, energy, and photons) |  |  |  |  |  |
| b. Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, x-rays, and gamma rays) |  |  |  |  |  |
| c. The visible spectrum |  |  |  |  |  |
| 6. Light wave phenomena |  |  |  |  |  |
| a. Reflection, refraction, and total internal reflection |  |  |  |  |  |
| b. Diffraction, interference, and polarization |  |  |  |  |  |
| c. Scattering, absorption, dispersion, and transmission |  |  |  |  |  |
| 7. Sound |  |  |  |  |  |
| a. Compression waves |  |  |  |  |  |
| b. Echoes |  |  |  |  |  |
| c. Speed of sound (sonic boom and sound barrier) |  |  |  |  |  |
| d. Pitch (frequency) and loudness (intensity) |  |  |  |  |  |
| e. Applications of resonance (e.g., musical instruments, harmonics) |  |  |  |  |  |
| f. Applications of Doppler effect involving sound |  |  |  |  |  |
| 8. Geometric optics |  |  |  |  |  |
| a. Mirrors (plane, convex, and concave) |  |  |  |  |  |
| b. Lenses (converging and diverging) |  |  |  |  |  |
| c. Using diagrams to characterize image formation (e.g., distance, size, orientation, and real versus virtual) |  |  |  |  |  |
| d. Simple instruments (e.g., magnifying glass, prisms) |  |  |  |  |  |