GOAL 4: CONCEPTS OF CHEMISTRY

The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live.

1. <u>Expectation</u>: The student will explain that atoms have structure and this structure serves as the basis for the properties of elements and the bonds that they form.

(1) The student will analyze the structure of the atom and describe the characteristics of the particles found there.

Assessment limits

- subatomic particles (protons, neutrons, & electrons –not to include quantum mechanical details of electron configurations)
- nucleus & electron cloud (definition; no orbitals included)
- atomic number, mass number, and isotopes (definitions; calculate numbers of protons, neutrons, and electrons; notations)
- atomic mass (qualitative concept of weighted average only; atomic mass unit)
- neutral atom
- historical development and/or experimental evidence for the existence and structure of the atom (Democritus, Dalton, Thomson, Rutherford, Bohr, electron cloud model)

(2) The student will demonstrate that the arrangement and number of electrons and the properties of elements repeat in a periodic manner illustrated by their arrangement in the periodic table.

Assessment limits

- groups/families and periods/series (groups 1-18; Alkali Metals, Alkaline Earth Metals, Transition Metals, Halogens, Noble Gases; Periods 1-7; Lanthanide Series, Actinide Series)

For the following assessment limits, use only elements in groups 1,2, & 13-18.

- how trends behave (valence electrons; atomic radius; ionization energy; relative chemical reactivity; metallic/nonmetallic properties)

(3) The student will explain how atoms interact with other atoms through the transfer and sharing of electrons in the formation of chemical bonds.

Assessment limits

- formation of ions (relate charge of ions to number of electrons gained or lost as determined by valence electrons / location of elements on Periodic Table; cation; anion)
- bond (definition)
- formation of ionic bond (definition; metal-nonmetal; based on valence electrons / location of elements on the Periodic Table)
- formation of covalent bond (definition; nonmetal-nonmetal; based on valence electrons / location of elements on the Periodic Table; formation of single, double, and triple bonds)
- bond polarity (concept only, no electronegativity calculations; common examples)
- metallic bond (definition)
- bond energy (compare ionic and covalent)
- metallic, ionic, and molecular substances (melting point, boiling point, electrical conductivity)

2. <u>Expectation</u>: The student will explain how the properties of compounds are related to the arrangement and type of atoms they contain.

(1) The student will explain how the properties of a molecule are determined by the atoms it contains and their arrangement.

Assessment limits

- polar and nonpolar molecules ("like dissolves like" and why; not to include prediction of polarity from shape)
- shapes of molecules (limited to linear, bent/angular, tetrahedral)
- water (definition and explanation of shape and polarity of molecule, observed changes in density as phases change, use as a "universal" solvent; conceptual understanding of hydrogen bonding, high surface tension, high specific heat)

(2) The student will explain why organic compounds are so numerous and diverse.

Assessment limits

- inorganic and organic compounds (define in terms of carbon content; do not include CO, CO_2, or carbonates as organic compounds; definition of hydrocarbons)
- ability of carbon to form chains and make rings (recognize, but not produce structural formulas)

(3) The student will describe the properties of solutions and explain how they form.

Assessment limits

- solute, solvent, and solubility
- suspensions and colloids
- alloys and gaseous solutions
- concentration (relative: dilute, concentrated, unsaturated, saturated, supersaturated; molarity – conceptual only; interpretation of solubility curves)
- dissociation/ionization (basic description; factors that influence rate: surface area of solute, temperature, agitation)
- electrolytes (definition in terms of composition and properties)

(4) The student will differentiate among acids, bases, and salts based on their properties.

Assessment limits

- Arrhenius definition (H^+ and OH^-)
- ability of water to act as either an acid or a base
- neutralization (definition)
- salts (definition)
- indicators (phenolphthalein)
- function of buffers (conceptual only)

3. <u>Expectation</u>: The student will apply the basic concepts of thermodynamics (thermochemistry) to phases of matter and phase and chemical changes.

(1) The student will explain that thermal energy in a material consists of the ordered and disordered motions of its colliding particles.

Assessment limits

- thermal energy (differentiate between thermal energy and temperature)
- phase changes
- heating / cooling (temperature vs. time) curve (interpret the different parts of the curve in terms of motion / kinetic energy and organization of the particles; changes in particle motion and organization between phase changes; identify melting/freezing and boiling point; not to include potential energy or calculations of Q)

(2) The student will describe observed changes in pressure, volume, or temperature of a sample in terms of macroscopic changes and the behavior of particles.

Assessment Limits

- constant temperature (effect of pressure or volume change to sample of solid, liquid, or gas)
- constant volume (effect of pressure or temperature change to sample of solid, liquid, or gas)
- constant pressure (effect of temperature or volume change to sample of solid, liquid, or gas)

(3) The student will explain why the interactions among particles involve a change in the energy system.

Assessment limits

- exothermic change (bond formation; dissociation; thermal energy released; no predictions/calculations of ΔH)
- endothermic change (bond breaking; dissociation; thermal energy absorbed; no predictions/calculations of ΔH)

4. <u>Expectation</u>: The student will explain how and why substances are represented by formulas.

(1) The student will illustrate that substances can be represented by formulas.

Assessment limits

- subscripts (determine the numbers of atoms represented by a given formula; describe the function of subscripts in a chemical formula)
- use symbols to represent elements and polyatomic ions (limited to NH_4^{+1}, OH^{-1}, NO_3^{-1}, NO_2^{-1}, ClO_3^{-1}, ClO_2^{-1}, HCO_3^{-1}, CO_3^{-2}, SO_4^{-2}, SO_3^{-2}, PO_4^{-3}, PO_3^{-3}; including diatomics – H_2, O_2, N_2, Cl_2, Br_2, I_2, F_2; given periodic table and ion chart)
- acids (binary naming system; ternary/oxyacid naming system limited to polyatomic ions given above)
- write formulas for compounds (given Periodic Table, ion chart of polyatomic ions and transition metals, and compound name; Stock System/Roman Numerals for ionic compounds; prefixes (up through hexa) for molecular compounds; no hydrates)
- name compounds (given formula, Periodic Table, and ion chart of polyatomic ions and transition metals; Stock System/Roman Numerals for ionic compounds; prefixes (up through hexa) for molecular compounds; no hydrates)

(2) The student will show that chemical reactions can be represented by symbolic or word equations that specify all reactants and products involved.

Assessment limits

For the following assessment limits, students are not expected to predict products or use phase symbols.

- convert word equations to symbolic equations
- convert symbolic equations to word equations

(3) The student will use mole relationships.

Assessment limits

- mole and Avogadro's Number (definitions)
- relationship between moles and mass
- relationship between moles and particles
- formula mass (calculate the formula mass of a compound given the periodic table; no hydrates)
- mass percent composition (calculate the mass percent composition of a compound given the formula, formula mass, and periodic table; no hydrates)

5. <u>Expectation</u>: The student will explain that matter undergoes transformations, resulting in products that are different from the reactants.

(1) The student will describe the general types of chemical reactions.

Assessment limits

- synthesis and decomposition (definition; identify type given balanced formula equation or written description)
- combustion (definition; identify type given balanced formula equation or written description)
- single displacement (definition; identify type given balanced formula equation or written description; apply activity series to determine if reaction will occur)
- double displacement (definition; identify type given balanced formula equation or written description; apply solubility rules to predict if a precipitate will form)

(2) The student will balance simple equations (not to include redox reactions).

Assessment limits

- Law of Conservation of Mass (apply to reactions to account for the same number of atoms of each type appearing in both the reactants and products)
- coefficients (define; use to balance symbolic equations; explain meaning in symbolic equations; differentiate between the use and meaning of coefficients and subscripts)

(3) The student will demonstrate that adjusting quantities of reactants may affect the amounts of products formed.

Assessment limits

- use of coefficients in a balanced equation to predict amounts of reactants and products (at the molecular/mole level – no mass-mass calculations)
- changing the amount of reactant(s) may change the amount of product(s) formed (no calculations)

(4) The student will recognize that chemical reactions occur at different speeds.

Assessment limits

- reaction rate (in order for atoms to react they must collide with sufficient energy; reaction rate increases as frequency of molecular collisions increases)
- effects of surface area, temperature, and concentration on the frequency and energy of molecular collisions (no calculations or specific concentration units)
- catalysts (definition; conceptual understanding of behavior)

CONCEPTS TO BE TAUGHT BY EIGHTH GRADE:

(1) physical and chemical properties
(2) density – concept and calculations
(3) physical and chemical changes
(4) states of matter
(5) elements and compounds
(6) heterogeneous and homogeneous mixtures
(7) evidence of a chemical reaction
(8) identifying reactants and products of a chemical reaction given a symbolic equation, a word equation, or a description of the reaction.
(9) Law of Conservation of Mass
(10) Law of Conservation of Energy
(11) properties of acids and bases
(12) pH scale

CONCEPTS TO BE TAUGHT BUT NOT ASSESSED AT THE STATE LEVEL:

(1) emission spectra
(2) particle-mole, mass-mole, and mass-mass calculations
(3) molarity calculations
(4) organic compounds -- fuels, plastics, biologicals, etc.
variety of materials due to the ability of Carbon to form long chains (plastics/polymers, fuels, biological compounds)
(5) historical development of the periodic table
(6) specific heat
(7) why periodic trends follow observed patterns
(8) Bronsted-Lowery definition of acids and bases
(9) enthalpy and entropy
(10) activation energy and associated graphs