AVHS – Chemistry Standards

Atomic and Molecular Structure

1. The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. As a basis for understanding this concept:
    a. *Students know* how to relate the position of an element in the periodic table to its atomic number and atomic mass.
    b. *Students know* how to use the periodic table to identify metals, semimetals, nonmetals, and halogens.
    c. *Students know* how to use the periodic table to identify alkali metals, alkaline earth metals and transition metals, trends in ionization energy, electronegativity, and the relative sizes of ions and atoms.
    d. *Students know* how to use the periodic table to determine the number of electrons available for bonding.
    e. *Students know* the nucleus of the atom is much smaller than the atom yet contains most of its mass.

Chemical Bonds

2. Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules. As a basis for understanding this concept:
    a. *Students know* atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.
    b. *Students know* chemical bonds between atoms in molecules such as H_2 , CH_4 , NH_3 , H_2CCH_2 , N_2 , Cl_2 , and many large biological molecules are covalent.
    c. *Students know* salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.
    d. *Students know*the atoms and molecules in liquids move in a random pattern relative to one another because the intermolecular forces are too weak to hold the atoms or molecules in a solid form.
    e. *Students know* how to draw Lewis dot structures.

Conservation of Matter and Stoichiometry

3. The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants. As a basis for understanding this concept:
    a. *Students know* how to describe chemical reactions by writing balanced equations.
    b. *Students know* the quantity one mole is set by defining one mole of carbon 12 atoms to have a mass of exactly 12 grams.
    c. *Students know* one mole equals 6.02×10^{23}particles (atoms or molecules).
    d. *Students know* how to determine the molar mass of a molecule from its chemical formula and a table of atomic masses and how to convert the mass of a molecular substance to moles, number of particles, or volume of gas at standard temperature and pressure.
    e. *Students know* how to calculate the masses of reactants and products in a chemical reaction from the mass of one of the reactants or products and the relevant atomic masses.

Gases and Their Properties

4. The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gases. As a basis for understanding this concept:
    a. *Students know* the random motion of molecules and their collisions with a surface create the observable pressure on that surface.
    b. *Students know* the random motion of molecules explains the diffusion of gases.
    c. *Students know* how to apply the gas laws to relations between the pressure, temperature, and volume of any amount of an ideal gas or any mixture of ideal gases.
    d. *Students know* the values and meanings of standard temperature and pressure (STP).
    e. *Students know* how to convert between the Celsius and Kelvin temperature scales.
    f. *Students know* there is no temperature lower than 0 Kelvin.

Acids and Bases

5. Acids, bases, and salts are three classes of compounds that form ions in water solutions. As a basis for understanding this concept:
    a. *Students know* the observable properties of acids, bases, and salt solutions.
    b. *Students know* acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.
    c. *Students know* strong acids and bases fully dissociate and weak acids and bases partially dissociate.
    d. *Students know* how to use the pH scale to characterize acid and base solutions.

Solutions

6. Solutions are homogeneous mixtures of two or more substances. As a basis for understanding this concept:
    a. *Students know* the definitions of solute and solvent.
    b. *Students know* how to describe the dissolving process at the molecular level by using the concept of random molecular motion.
    c. *Students know* temperature, pressure, and surface area affect the dissolving process.
    d. *Students know* how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition.

Chemical Thermodynamics

7. Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept:
    a. *Students know* how to describe temperature and heat flow in terms of the motion of molecules (or atoms).
    b. *Students know* chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.
    c. *Students know* energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts.
    d. *Students know* how to solve problems involving heat flow and temperature changes, using known values of specific heat and latent heat of phase change.

Reaction Rates

8. Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules. As a basis for understanding this concept:
    a. *Students know* the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.
    b. *Students know* how reaction rates depend on such factors as concentration, temperature, and pressure.
    c. *Students know* the role a catalyst plays in increasing the reaction rate.

Chemical Equilibrium

9. Chemical equilibrium is a dynamic process at the molecular level. As a basis for understanding this concept:
    a. *Students know* how to use Le Chatelier's principle to predict the effect of changes in concentration, temperature, and pressure.
    b. *Students know* equilibrium is established when forward and reverse reaction rates are equal.

Organic Chemistry and Biochemistry

10. The bonding characteristics of carbon allow the formation of many different organic molecules of varied sizes, shapes, and chemical properties and provide the biochemical basis of life. As a basis for understanding this concept:
    a. *Students know* large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits.
    b. *Students know* the bonding characteristics of carbon that result in the formation of a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.
    c. *Students know* amino acids are the building blocks of proteins.

Nuclear Processes

11. Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept:
    a. *Students know* protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.
    b. *Students know* the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions. The change in mass (calculated by $E = mc^2$) is small but significant in nuclear reactions.
    c. *Students know* some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.
    d. *Students know* the three most common forms of radioactive decay (alpha, beta, and gamma) and know how the nucleus changes in each type of decay.
    e. *Students know* alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.