

CHEMISTRY – ESSENTIAL STANDARDS & BENCHMARKS

Essential Standard: ATOMIC STRUCTURE AND BONDING

STUDENTS WILL UNDERSTAND THAT THE PROPERTIES OF MATTER AND THEIR INTERACTIONS ARE A CONSEQUENCE OF THE STRUCTURE OF MATTER, INCLUDING NUCLEAR PROCESSES .

First Semester Benchmarks:

- *Students know* how to relate the position of an element in the periodic table to its atomic number and atomic mass.
- *Students know* how to use the periodic table to identify metals, semimetals, nonmetals, and halogens.
- *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.
- *Students know* how to use the periodic table to determine the number of electrons available for bonding.
- *Students know* the nucleus of the atom is much smaller than the atom yet contains most of its mass.
- *Students know* protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.
- *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.
- *Students know* some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.
- *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.
- *Students know* alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.
- *Students know* atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.
- *Students know* chemical bonds between atoms in molecules such as H₂, CH₄, NH₃, H₂CCH₂, N₂, Cl₂, and many large biological molecules are covalent.
- *Students know* salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.
- *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.
- *Students know* how to draw Lewis dot structures.

Second Semester Benchmarks:

➤ NONE

Essential Standard: CONSERVATION OF MATTER/STOICHIOMETRY

STUDENTS WILL DEMONSTRATE THE QUALITATIVE AND QUANTITATIVE RELATIONSHIPS OF MATTER IN CHEMICAL PROCESSES.

First Semester Benchmarks:

- *Students know* how to describe chemical reactions by writing balanced equations.
- *Students know* the quantity *one mole* is set by defining one mole of carbon 12 atoms to have a mass of exactly 12 grams.
- *Students know* one mole equals 6.02×10^{23} particles (atoms or molecules).
- *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.
- *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.

Second Semester Benchmarks:

NONE

Essential Standard: STATES OF MATTER

STUDENTS WILL UNDERSTAND THE PROPERTIES AND BEHAVIOR OF SOLIDS, LIQUIDS, GASES AND MIXTURES (4, 5, 6).

First Semester Benchmarks:

NONE

Second Semester Benchmarks:

- *Students know* the random motion of molecules and their collisions with a surface create the observable pressure on that surface.
- *Students know* the random motion of molecules explains the diffusion of gases.
- *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.
- *Students know* the values and meanings of standard temperature and pressure (STP).
- *Students know* how to convert between the Celsius and Kelvin temperature scales.
- *Students know* there is no temperature lower than 0 Kelvin.
- *Students know* the definitions of *solute* and *solvent*.
- *Students know* how to describe the dissolving process at the molecular level by using the concept of random molecular motion.
- *Students know* temperature, pressure, and surface area affect the dissolving process.
- *Students know* how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition.
- *Students know* the observable properties of acids, bases, and salt solutions.
- *Students know* acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.

- *Students know* strong acids and bases fully dissociate and weak acids and bases partially dissociate.
- *Students know* how to use the pH scale to characterize acid and base solutions.

ESSENTIAL STANDARD: KINETICS AND THERMODYNAMICS

STUDENTS WILL DESCRIBE THE DYNAMICS OF CHEMICAL PROCESSES, INCLUDING ENERGY CHANGE, REACTION RATES AND EQUILIBRIUM.

First Semester Benchmarks

NONE

Second Semester Benchmarks

- *Students know* how to describe temperature and heat flow in terms of the motion of molecules (or atoms).
- *Students know* chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.
- *Students know* energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts.
- *Students know* how to solve problems involving heat flow and temperature changes, using known values of specific heat and latent heat of phase change.
- *Students know* the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.
- *Students know* how reaction rates depend on such factors as concentration, temperature, and pressure.
- *Students know* the role a catalyst plays in increasing the reaction rate.
- *Students know* how to use LeChatelier's principle to predict the effect of changes in concentration, temperature, and pressure.
- *Students know* equilibrium is established when forward and reverse reaction rates are equal.

ESSENTIAL STANDARD: ORGANIC AND BIOCHEMISTRY

STUDENTS WILL UNDERSTAND THE BONDING CHARACTERISTICS AND CHEMICAL PROPERTIES OF ORGANIC AND BIOMOLECULES.

First Semester Benchmarks

NONE

Second Semester Benchmarks

- *Students know* large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits.
- *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.
- *Students know* amino acids are the building blocks of proteins.