Oakwood City School District Chemistry Science Standards

One goal of science education is to help students become scientifically literate citizens able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science and to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact both themselves and others.

Chemistry is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires three units of science. Each course should include inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.

This course introduces students to key concepts and theories that provide a foundation for further study in other sciences as well as advanced science disciplines. Chemistry comprises a systematic study of the predictive physical interactions of matter and subsequent events that occur in the natural world. The study of matter through the exploration of classification, its structure and its interactions is how this course is organized.

Investigations are used to understand and explain the behavior of matter in a variety of inquiry and design scenarios that incorporate scientific reasoning, analysis, communication skills and real-world applications. An understanding of leading theories and how they have informed current knowledge prepares students with higher order cognitive capabilities of evaluation, prediction and application.

Chemistry Standards

Structures and Properties of Matter

A. Atomic structure
   a. Overview
      i. Evolution of atomic models/theory
      ii. Electron configurations
   b. Objectives
      i. Identify atomic models (e.g., Dalton's, Thomson's, Rutherford's, Bohr's) and the work used to produce each of these models.
      ii. Interpret the classic historical experiments that were used to identify the components of an atom and behavior of electrons.
      iii. Calculate atomic mass given the abundance of various isotopes.
      iv. Determine the atomic number, mass number, number of protons, neutrons and electrons.
      v. Identify the extended and noble gas notation electron configurations for elements in the first three periods.
      vi. Using the periodic table, determine the electron configuration of an atom.
      vii. Construct an orbital diagram or electron configuration to show the probable arrangement of electrons in an atom.
      viii. Determine the average atomic mass of an element based on the percent abundance of its naturally occurring isotopes.
B. Periodic Table
   a. Overview
      i. Properties
      ii. Trends
   b. Objectives
      i. Describe ionization energy and relate it to atomic structure.
      ii. Describe electronegativity and relate it to atomic structure.
      iii. Describe periodic trends in ionic radii and electron affinity and relate them to atomic structure.
      iv. Describe atomic radius and relate to atomic structure.
      v. Describe how shielding effect explains the trend in atomic size. For two atoms, identify the one that is larger, more electronegative, or more easily ionized based on where they are on the periodic table.
C. Chemical bonding
   a. Overview
      i. Ionic

        ii. Polar/covalent
    b. Objectives
        i. Define bond energy and recognize that bond-breaking is an endothermic process and bond-forming is an exothermic process.
        ii. Represent the formation of a bond using electron configurations of individual atoms.
        iii. Explain the tendency of elements to transfer or share electrons based on their location on the periodic table.
        iv. Identify valence electrons as the highest energy electrons in the atom and use the octet rule to predict the most stable ion formed.
        v. Distinguish between ionic and polar/nonpolar covalent bonds based on their electronegativity values.
        vi. Write equations for covalent bond formation between two atoms using Lewis structures.
        vii. Explain the difference between a single, double and triple bond in terms of electrons shared.
        viii. Compare the bond energies and lengths for single, double and triple bonds conceptually (no numbers).
        ix. Compare electrons in a metallic bond and in a covalent bond.
        x. Construct models or diagrams (e.g., Lewis dot structures, ball and stick models) of common compounds and molecules (e.g., NaCl, SiO_2, O_2, H_2, CO_2) and distinguish between ionically and covalently bonded compounds.
        xi. Distinguish between bond polarity and molecular polarity.

D. Representing compounds
    a. Overview
        i. Formula writing
        ii. Nomenclature
        iii. Models and shapes (Lewis structures, ball and stick, molecular geometries)
    b. Objectives
        i. Given elements from the periodic table and/or polyatomic ions, predict the formula of a compound. Write a formula from the name of an acid.
        ii. Given the formula of an ionic compound or a binary covalent compound, determine the compound’s name.
        iii. Name an acid based on its chemical formula.
        iv. Construct simple Lewis structures of compounds made up of hydrogen, carbon, nitrogen, oxygen, phosphorus, sulfur and the halogens.
        v. Predict the three-dimensional shapes of simple Lewis structures using valence shell electron pair repulsion (VSEPR) theory.
        vi. Construct three-dimensional ball and stick models to determine the shapes of simple covalent compounds.

E. Quantifying matter
    a. Overview
    b. Objectives

- i. Measure the volume of an irregular solid using SI units.
- ii. Provide your answer using correct significant figures and unit. Distinguish accuracy from precision.
- iii. Carry out laboratory measurements with a variety of equipment (e.g., graduated cylinders, beakers, balances) and report measurements to the correct number of significant figures.
- iv. Compare the accuracy of each measuring device.
- v. Apply the rules for determining significant digits when performing mathematical operations.

F. Intermolecular forces of attraction
- a. Overview
  - i. Types and strengths
  - ii. Implications for properties of substances
    1. Melting and boiling point
    2. Solubility
    3. Vapor pressure
- b. Objectives
  - i. Describe intermolecular forces for molecular compounds.
    1. H-bond as attraction between molecules when H is bonded to O, N, or F.
    2. Dipole-dipole attractions between polar molecules.
    3. London dispersion forces (electrons of one molecule attracted to nucleus of another molecule)
    4. Relative strengths (H>dipole>London/van der Waals)
  - ii. Explain why intermolecular forces are weaker than ionic, covalent or metallic bonds.
  - iii. Identify the intermolecular forces that exist in a given compound
  - iv. Explain why greater solubility occurs when dissolving a substance in a solvent with similar intermolecular forces ("like dissolves like")

Interactions of Matter

A. Chemical reactions
- a. Overview
  - i. Types of reactions
  - ii. Kinetics
  - iii. Energy
  - iv. Equilibrium
  - v. Acids/bases
- b. Objectives
  - i. Classify a chemical reaction as synthesis, decomposition, single replacement, double replacement or organic combustion.

ii. Identify which substance is oxidized and which substance is reduced in an oxidation/reduction reaction.
iii. Identify the ways the rate of a chemical reaction can be affected (e.g., concentrations of reactions, surface area, changing temperature or pressure of gaseous substances, using a catalyst).
iv. Calculate the thermal energy change (q), the change of temperature (ΔT), initial or final temperature and mass of a material using specific heat.
v. Track the flow of energy and explain why a reaction is an exothermic or endothermic process.
vi. Perform calculations relating pH to hydronium ion concentration. Identify acids based on the formation of the hydronium ion in water.
vii. Identify bases by their dissociation in water to form the hydroxide ion.

B. Gas laws
   a. Overview
      i. Pressure, volume and temperature
      ii. Ideal gas law
   b. Objectives
      i. Explain both the quantitative and qualitative relationships between pressure, volume and temperature.
      ii. Construct models representing the relationship of pressure, volume and temperature related to collisions and energy of particles.
      iii. Apply gas laws to common scenarios (e.g. hot air balloons, tire blowouts)
      iv. Use the kinetic molecular theory to explain the motion of gas particles and how they are affected by changes in pressure, temperature and/or volume.

C. Stoichiometry
   a. Overview
      i. Molecular calculations
      ii. Solutions
      iii. Limiting reagents
   b. Objectives
      i. Convert between mass, moles, volume and number of representative particles using Avogadro's number, molar mass and density using dimensional analysis.
      ii. Quantitatively define concentrations in a solution.
      iii. Explain the effect of solute concentration on colligative properties.
      iv. Calculate the reactants needed to produce an exact amount of a product and visa-versa
      v. Compare limiting to excess reagents in a chemical reaction.