ROANOKE VALLEY GOVERNOR'S SCHOOL
ADVANCED PLACEMENT CHEMISTRY
Competencies/Objectives
2007-2008

COMPETENCY 1: Demonstrate awareness, and proper use, of laboratory safety techniques.

ENABLING OBJECTIVES

1-1. Differentiate between safe and unsafe procedures, applications, and methods of disposal of chemicals.
1-2. Chose the appropriate safety equipment for specific laboratory situations.
1-3. Decide which safety and emergency procedures to follow in case of particular accidents including fires and hazardous material spills.
1-4. Demonstrate the proper methods for carrying and moving chemicals and equipment.
1-5. Demonstrate the ability to understand and follow the safety codes on chemical containers.

COMPETENCY 2: Categorize matter and its properties.

ENABLING OBJECTIVES

2-1. Describe the general properties of matter and classify it according to whether it is an element, a compound or a mixture.
2-2. Distinguish between physical and chemical properties of matter.
2-3. Determine chemical and physical properties of substances by carrying out physical and chemical changes.
2-4. Write symbols for 55 common elements.

COMPETENCY 3: Review the rules of chemical nomenclature for writing formulas and naming compounds

ENABLING OBJECTIVES

3-1. Identify basic differences between atoms, molecules, and ions and classify compounds as being ionic or molecular.
3-2. Write the names of ionic and binary covalent compounds from their formulas using older system of prefixes and suffixes and the newer IUPAC system.
3-3. Use the ion-charge method to write formulas for ionic compounds.
3-4. Write the formulas for binary covalent compounds.

COMPETENCY 4: Utilize the Periodic Table to determine properties of an element, or a set of elements.

ENABLING OBJECTIVES

4-1. Describe the events leading to the modern day arrangement of the periodic table.
4-2. Describe the periodic trends of the general characteristics of metals, nonmetals, and metalloids.
4-3. Experimentally determine an activity series of metals.

COMPETENCY 5: Review the categories of chemical reactions and write balanced equations for reactions.

ENABLING OBJECTIVES

5-1. Write and balance chemical equations when given reactants and products.
5-2. Classify those equations that come under the heading of synthesis, decomposition, replacement, and ionic reactions.

5-3. Predict the products of chemical reactions when given the reactants.
5-4. Define oxidation and reduction, and identify any species undergoing oxidation or reduction, and identify the oxidizing and reducing agents.
5-5. Use solubility rules to predict the formation of insoluble products, and the activity series to predict the occurrence of replacement reactions.
5-6. Simplify equations by writing net ionic equations.
5-7. Relate complete and incomplete combustion to oxidation.
5-8. Carry out examples of each kind of reaction, and write balanced equations for each.

COMPETENCY 6: Review the mole concept as related to calculations involving empirical and molecular formulas and to stoichiometry.

ENABLING OBJECTIVES
6-1. Convert numbers of atoms and molecules to masses by using the mole, and vice versa.
6-2. State the masses of atoms or molecules in terms of molar masses.
6-3. Calculate, and prepare solutions of known molarity.
6-4. Distinguish between empirical and molecular formulas.
6-5. Calculate the percentage composition of a compound from its formula, and from experimental data.
6-6. Calculate empirical and molecular formulas from experimental data.
6-7. Calculate mass relationships based on balanced chemical equations.
6-8. Determine the limiting reactant, and the theoretical yield for chemical reactions.
6-9. Experimentally determine the mole ratio for a chemical reaction, and use it to determine the equation for the reaction.

COMPETENCY 7: Predict the spontaneity of reactions.

ENABLING OBJECTIVES
7-1. Define and calculate ΔH and ΔS for a reaction.
7-2. Use the Gibbs-Helmholtz equation to calculate the free energy change for a reaction.
7-3. Experimentally determine $\Delta H_{sol'n}$, and ΔH_{rxn},
7-3. Describe how the signs of ΔH, ΔS, and ΔG relate to the spontaneity of a reaction.
7-4. Predict the spontaneity of reactions and test those predictions experimentally.

COMPETENCY 8: Characterize the electronic structure of the atom.

ENABLING OBJECTIVES

8-1. State and interpret the postulates of the Quantum Theory.
8-2. Relate energy differences, wavelength, and frequencies of EMR.
8-2. Describe the atomic spectrum of hydrogen in terms of the Bohr model, and calculate energy transitions for Lyman and Balmer series.
8-3. Describe the wave nature of electrons according to deBroglie, Planck, and Schrodinger.
8-4. Identify the four quantum numbers and relate each in terms of energy differenes and mathematical interpretation.
8-5. Write electron configurations and use Hund's rule to draw orbital notations for electrons in an atom.
8-6. Experimentally determine the wavelengths and frequencies of line spectrum of selected elements.

COMPETENCY 9: Relate ionic and covalent bonding to the electronic structure of atoms and the ionic and/or molecular compounds they form .

ENABLING OBJECTIVES

9-1. Describe the formation of cations and anions, and relate it to ionization energies and electronegativities, and position on the periodic table.
9-2. Relate ΔH of ionic compounds to their lattice energies.
9-3. Write Lewis structures to show the covalent bonding in molecules and polyatomic ions.
9-4. Determine polarity of covalent bonds form electronegativities.
9-5. Compare bond lengths of covalent bonds.
9-6. Use bond energies to calculate ΔH for the formation of molecular compounds.

COMPETENCY 10: Determine the shape of molecules and describe the distribution of the valence electrons according to atomic orbital theory.

10-1. USE VSEPR model to predict the geometric shape of simple molecules and polyatomic ions.
10-2. Construct models of molecules and polyatomic ions to illustrate their predicted geometric shapes.
10-3. Predict the polarity of molecules by using the VSEPR model for molecules containing polar covalent bonds.
10-4. Describe covalent bonding in terms of atomic orbitals: sp, sp^2, sp^3 hybrid orbitals, sigma and pi bonds, and expanded octets.
10-5. Experimentally relate solubilities of solutes to their polarities.

COMPETENCY 11: Describe gases in terms of the kinetic theory of gases, apply the gas laws and the Ideal Gas Equation to problems, and compare real gases to ideal gases.

ENABLING OBJECTIVES
11-1. Define pressure and relate to kinetic theory.
11-2. Describe the effect of temperature on pressure and volume of gases.
11-3. Apply the mole-volume relationship of gases to gas-phase reactions.
11-4. Describe the relationship between pressure and volume of gases (Boyle's Law).
11-5. Combine Boyle's, Charles, and Avogadro's laws of gases into the ideal gas law.
11-6. Describe diffusion of gases and relate to Graham's Law.
11-7. Describe mixtures of gases in terms of Dalton's Law of Partial Pressure.
11-8. Relate the density of gases to molar volume and molar mass.
11-9. Describe the operation of mercury barometers.
11-10. Relate the motion of molecules to the Boltzman distribution and temperature.
11-11. Compare the behavior of real gases to the ideal and relate to the van der Waals equation.
11-12. Experimentally determine the molar mass of a gas.

COMPETENCY 12: Characterize the properties of chemical systems that reach equilibrium in the gaseous phase.

ENABLING OBJECTIVES
12-1. Write the expression for K_c from the balanced equation for a reaction involving gases.

12-2. Calculate K_c from equilibrium concentrations of all species, or from original concentrations of all species and the equilibrium concentration of one species.
12-3. Predict the direction a chemical system will move to reach equilibrium when the value of K_c is known.
12-4. Predict the equilibrium concentration of one species when given those of all other species when the value of K_c is known.
12-5. Predict the equilibrium concentrations of all species when given their original concentrations and when the value of K_c is known.
12-6. Using LeChatelier's Principle, predict the effect of a change in the number of moles, volume, or temperature upon the position of an equilibrium.
12-7. Experimentally determine K_c for an equilibrium system.
12-8. Relate the standard free energy change for a reaction to the equilibrium constant.

COMPETENCY 13: Describe the properties of acids and bases.

ENABLING OBJECTIVES
13-1. Relate the acidic and basic properties of aqueous solutions to the dissociation of water.
13-2. Carry out calculations involving pH and pOH.
13-3. Compare strong and weak acids.
13-4. Compare strong and weak bases.
13-5. Predict the acidity or basicity of salt solutions (cations and anions).
13-6. Write the equations for reactions for reactions between strong acids-strong bases, strong acids-weak bases, and weak acids-strong bases.
13-7. Carry out acid-base titrations and write equations for the reactions.
13-8. Compare Arrhenius, Bronsted-Lowry, and Lewis theories of acids.

COMPETENCY 14: Apply properties of systems at equilibrium to dissociation of acids/bases.

ENABLING OBJECTIVES
14-1. Write the equilibrium expression for dissociation of weak acids and calculate K_a.
14-2. Calculate [H+] in solutions of weak acids when given K_a.
14-3. Calculate [H+] in buffered solutions.
14-4. Write the equilibrium expression for the dissociation of weak bases and calculate K_b.
14-5. Calculate [OH-] in solutions of weak bases when given K_a.
14-6. Relate K_a and K_b.
14-7. Experimentally determine K_a for a weak acid.

COMPETENCY 15: Describe the properties of solutions and carry out calculations related to these properties.

ENABLING OBJECTIVES
15-1. Compare unsaturated, saturated, and supersaturated solutions to equilibrium conditions.
15-2. Distinguish between electrolytes and non-electrolytes.
15-3. Carry out calculations involving solution concentrations in mole fractions, molality, and/or molarity.
15-4. Describe the factors that affect the solubility of a solute in a particular solvent.
15-5. Determine the concentration of an unknown solution by using the Spec 20 and Beer's Law
15-6. Describe the colligative properties of solutions.
15-7. Experimentally determine the molar mass of an unknown solute by freezing point depression and boiling point elevation.

COMPETENCY 16: Identify and characterize the factors that affect reaction rate.

ENABLING OBJECTIVES

16-1. Determine the order of a reaction when given the initial rate as a function of concentration of a reaction.
16-2. Calculate, for a first order reaction, the concentration of a reactant after a given time.
16-3. Calculate, for a first order reaction, the time required for the concentration to drop by a given amount when given the rate constant.
16-4. When given either the half-life or the rate constant for a first order reaction, calculate the other given the original concentration and the rate constant.
16-5. Experimentally determine the order of a reaction.
16-6. Relate ozone depletion to CFCs and chlorine photochemistry.
16-7. Compare homogeneous with heterogeneous catalysts, and their affects on reaction rates.

COMPETENCY 17: Describe oxidation-reduction reactions.

ENABLING OBJECTIVES

17-1. Balance redox reactions by half-reaction method.
17-2. Experimentally carry out a redox titration.
17-3. Relate corrosion to oxidation-reduction and how it may be prevented.

COMPETENCY 18: Describe the principles of electrochemical reactions.

ENABLING OBJECTIVES

18-1. Compare voltaic with electrolytic cells.
18-2. Use the Nernst equation to calculate voltages of cells and half-cells.
18-3. Use standard reduction voltages to calculate voltages of cells or electrodes.
18-4. Experimentally determine cell/half-cell voltages of voltaic cells.
18-5. Experimentally determine the products of electrolytic cells.

COMPETENCY 19: Describe the basic principles of spectroscopy and correlate the basics of spectroscopy to the operation of specific analytical instruments.

ENABLING OBJECTIVES

19-1. Describe the characteristics common to all spectroscopy.
19-2. Differentiate between the various kinds of spectroscopy and the types of analysis for which they are best suited.
19-3. Obtain a spectral curve for a solution by using the Ultraviolet-Visible Spectrophotometer (UV-VIS).
19.4. Determine the concentration of an unknown solution by using the Spec 20 and Beer's Law.
19.5. Determine the presence or absence of certain kinds of covalent bonds in compounds using the Fourier Transformed Infrared Spectrophotometer (FTIR).
19.6. Determine any detectable amounts of select metals in water or paint samples using the Atomic Absorption Spectrophotometer (AAS)

COMPETENCY 20: Describe the basic principles of chromatography and apply various chromatographic methods to the analysis of mixtures.

ENABLING OBJECTIVES

20-1. Describe the characteristics common to all chromatography.

20-2. Differentiate between the various kinds of chromatography and the types of separation/analysis for which they are suited.
20-3. Use column chromatography to separate colors in foods.
20-4. Use Thin-Layer chromatography to determine the identity of an unknown herbicide.
20-5. Use Gas Chromatography to determine the components in gasoline.

COMPETENCY 21: Differentiate between alaphatic and aromatic hydrocarbons and how they are named.

ENABLING OBJECTIVES
23-1. Apply IUPAC rules to the naming of alaphatic and aromatic hydrocarbons.
23-2. Draw Lewis structures of these compounds based on their names.

COMPETENCY 22: Differentiate between structural, functional and geometric isomers.

ENABLING OBJECTIVES
24-1. Apply IUPAC rules to the naming of structural, functional, geometric isomers.
24-2. Draw Lewis structures to illustrate the various kinds of isomers as well as the possible isomers of selected compounds.

COMPETENCY 23: Identify the functional groups, such as COOH, C=O, and OH, that produce substituted hydrocarbons.

ENABLING OBJECTIVES
25-1. Apply IUPAC rules to the naming of organic compounds that contain functional groups.
25-2. Draw Lewis structures to show the different classes of compounds, such as carboxylic acids, aldehydes and alcohols, that result from the presence of functional groups.
25-3. Experimentally determine the presence of selected functional groups.

COMPETENCY 24: Write the names and formulas of substituted hydrocarbons using IUPAC rules of nomenclature.

ENABLING OBJECTIVES
26-1. Determine the parent hydrocarbon, the presence of multiple bonds, and the identity of any functional groups and write the appropriate IUPAC name from looking at a structural formula.
26-2. Draw appropriate structural formulas from the IUPAC names of organic compounds that may contain multiple bonds and/or various functional groups.

COMPETENCY 25. Evaluate the impact of science and technology on society.

ENABLING OBJECTIVES
27-1. Select a current, technological issue and take a position on it.
27-2. Carry out a literature search on the issue.
27-3. Debate the opposite position on the issue
27-4. Interview experts in the field of the issue.
27-5. Carry out a survey of two different groups to determine their knowledge/opinions of the issue.
27-6. Summarize current position on the issue.