AP Chemistry

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Text

Chemistry: The Central Science by **Brown, LeMay, Bursten and Murphy**, 11th ed., Pearson – Prentice Hall, 2009. ISBN: 0-13-600617-5

Supplemental Materials used in the AP Chemistry course:

- I. Solutions To Red and Black Exercises by Roxy Wilson, 11th ed., Pearson Prentice Hall, 2009. ISBN: 0-13-600287-0 9 (Red); 0-13-600324-9 (Black).
- II. Chemistry: Explorations in Chemistry Laboratory Manual by Gillespie, Humphreys, Baird, and Robinson, 2nd ed., Simon and Schuster, Inc., 1989. ISBN: 0-205-11940-9.
- III. Chemistry: Experimental Foundations Laboratory Manual by Parry, Merrill, Bassow, and Tellefsen, 3rd ed., Prentice-Hall Inc., 1982. ISBN: 0-13-129270-6.
- IV. Advanced Chemistry with Calculators / LabQuests by Jack Randall, 1st ed., Vernier Software and Technology, 2004. ISBN: 1-929075-36-7.
- V. *AP Chemistry Guided-Inquiry Experiments: Applying the Science Practices* by **Numerous Authors**, 1st ed., The College Board, 2013. www.collegeboard.org/apcentral
- VI. *Chemistry: A Guided Inquiry* by **Richard S. Moog** and **John J. Farrell**, 5th ed., John Wiley and Sons, Inc., 2011. ISBN: 978-0-470-64790-5.
- VII. POGIL: Activities for High School Chemistry edited by Laura Trout, 1st ed., Flinn Scientific, Inc., 2012. ISBN: 978-1-933709-9.

Goals of the course

- Students are prepared to be critical and independent thinkers who are able to function effectively in a scientific and technological society.
- Students will be able to analyze scientific and societal issues using scientific problem solving.
- Students will emerge from this program with an appreciation for the natural world.
- Students will be able to make an acceptable score on the AP Chemistry examination in May.
- In each laboratory experiment, students will physically manipulate equipment and materials in order to make relevant observations and collect data; use the collected data to form conclusions and verify hypotheses; and communicate and compare results and procedures (informally to other experimenters, and also in a formal, written report to the teacher).
- Students will be able to incorporate technology into the study of chemistry. This will involve the use of graphing calculators, probes, and computers for data collection and analysis.
- Students will incorporate the **POGIL** (<u>Process Oriented Guided Inquiry Learning</u>) model of learning in the course. The desired outcome of using the POGIL method is that the learning of certain chemical concepts will be student centered and to convey to students the importance of working in a team with structured roles for each team member.

Guiding principles of the course

The AP Chemistry course curriculum is guided by six **Big Ideas** related to chemistry curriculum and seven Science Practices related to overarching scientific skills developed by the AP Chemistry course. Both the six **Big Ideas** and seven **Science Practices** are listed below.

- **Big Idea 1:** The chemical elements are fundamental building materials of matter, and all matter can be understood in terms of arrangements of atoms. These atoms retain their identity in chemical reactions.
- **Big Idea 2:** Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.
- **Big Idea 3:** Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.
- **Big Idea 4:** Rates of chemical reactions are determined by details of the molecular collisions.
- **Big Idea 5:** The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
- **Big Idea 6:** Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations.
- **Science Practice 1:** The student can use representations and models to communicate scientific phenomena and solve scientific problems.
- Science Practice 2: The student can use mathematics appropriately.
- **Science Practice 3:** The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
- Science Practice 4: The student can plan and implement data collection strategies in relation to a particular scientific question. [Note: Data can be collected from many different sources, e.g., investigations, scientific observations, the findings of others, historic reconstruction, and/or archived data.]
- Science Practice 5: The student can perform data analysis and evaluation of evidence.
- **Science Practice 6:** The student can work with scientific explanations and theories.
- Science Practice 7: The student is able to connect and relate knowledge across various scales, concepts, and representations in and across domains.

Throughout this document, the chapters will be related to the **Big Idea(s)** that they cover. Also, the labs listed in this document will be related to the **Science Practices** that they cover.

Fall Semester

Review topics and Stoichiometry Chapters 2-3 – Big Ideas #1 and #3 addressed in this unit

- I. Measurement topics
- II. Atomic theory
- III. Symbols and formulas
- IV. Periodic table
- V. Ionic and covalent bonds
- VI. Nomenclature
- VII. Isotopes, Percent Abundance, Average Atomic Mass
- VIII. Reactions
- IX. Stoichiometry
 - A. Percent composition
 - B. Empirical formulas Molecular formulas
 - C. Combustion Analysis
 - D. Mole relationships percent (%) yield
 - E. Limiting reagents

The student will:

- 1. Define terms such as matter, energy, element, compound, mixture, solution, exothermic, endothermic.
- 2. Work comfortably with the metric system. Work problems using dimensional analysis.
- 3. Be able to determine the number of protons, electrons, and neutron in an isotope of an atom or ion.
- 4. Apply significant figures in problem solving and laboratory work.
- 5. Apply knowledge of significant figures to laboratory work.
- 6. Know the proper form of a formal lab report.
- 7. Name the polyatomic ions, given the formula, and vice versa.
- 8. Use a solubility table to determine relative solubility of ionic compounds.
- 9. Name inorganic compounds, including acids, using the Stock system.
- 10. Write formulas for the names of inorganic compounds.
- 11. Work problems involving mole concepts, molarity, percent composition, empirical formulas, and molecular formulas.
- 12. Balance equations given both reactants and products
- 13. Solve stoichiometric problems involving percent yield, and limiting reagents.
- 14. Solve for the average atomic mass of an element.

Laboratory Investigation

• <u>Lab Activity #1</u> - Experiment 1: Determination of a Chemical Formula (Copper Iodide) (The source of this lab was an instructor at a 2008 AP Chemistry course) *This lab addresses Science Practices: 1, 2, 4, 5

Non-Lab Activity for Big Idea #3

 Guided Inquiry Activity #31 – Empirical Formula: Can a Molecule Be Identified by Its Percent Composition (Chemistry: A Guided Inquiry – Supplemental Material VI) *Students will use models and questions from the activity to derive the idea of an empirical formula and its uses (and limitations) for substance identification.

Types of Chemical Reactions and Solution Stoichiometry

Chapter 4 and Section 2 of Chapter 20 – Big Idea #3 is addressed in this unit.

I. Reaction types

A. Acid base reactions

- 1. Concepts of
 - a) Lowry-Brønsted
- B. Precipitation reactions
- C. Oxidation reduction reactions
 - 1. Oxidation number
 - 2. Electron transport
 - 3. Electrochemistry
- II. Stoichiometry
- III. Net ionic equations
- IV. Balancing equations including redox
- V. Mass-volume relationships with emphasis on the mole

The student will:

- 1. Apply the periodic law to chemical reactivity in predicting reaction products.
- 2. Discuss aqueous solutions: strong and weak electrolytes.
- 3. Discuss the activity series of the elements.
- 4. Distinguish between metals and nonmetals.
- 5. Classify compounds as to acids, bases, salts, and covalent molecules.
- 6. Use the properties of metals and nonmetals to predict reaction products.
- 7. Write chemical equations for synthesis, decomposition, single replacement, redox, combustion, and acid-base reactions.
- 8. Use the Activity series of elements to predict single replacement reactions
- 9. Use the Periodic Table to predict common oxidation states.
- 10. Assign oxidation numbers to elements in a compound.
- 11. Balance redox reactions in both acidic and basic solutions.
- 12. Predict mole ratios of a chemical reaction by the method of extrapolation

Laboratory Investigations

- <u>Lab Activity #2</u> Experiment 5: Acids and Bases: Standardization of a Solution of a Base and the Identification of an Unknown Acid (Explorations in Chemistry Supplemental Material II) *This lab addresses Science Practices: 1, 2, 3, 4, 5, 6, 7
- <u>Lab Activity #3</u> Investigation 8: How Can We Determine the Actual Percentage of H₂O₂ in a Drugstore Bottle of Hydrogen Peroxide (Chemistry: Guided-InquiryExperiments Supplemental Material V) *This lab addresses Science Practices: 1, 2, 3, 4, 5, 6, 7 AND is <u>Inquiry Lab #1</u> for the course.
- <u>Lab Activity #4</u> Reactions of Aqueous Solutions Lab Molecular, Ionic, Net Ionic Reactions and Solubility (**The source of this lab was an instructor at a 2008 AP Chemistry course**) *This lab addresses Science Practices: 1, 3, 4, 5, 7

Thermochemistry

Chapter 5 – Big Ideas #3 and #5 are addressed in this unit.

- I. Thermal energy, heat, and temperature
- II. Calorimetry
- III. Enthalpy changes
- IV. Hess's Law

The student will:

- 1. Learn the meaning of the following thermodynamic terms: enthalpy, ΔH , exothermic, endothermic, system, surroundings, universe, heat of formation, heat of reaction, calorimetry, heat, calorie, joule, standard molar enthalpy of formation, molar heat of combustion.
- 2. Solve calorimetry problems involving $q = sm\Delta T$.
- 3. Use Hess's Law to solve for heat of reaction.
- 4. Use stoichiometric principles to solve heat problems.

Laboratory Investigations

- Lab Activity #5 Experiment 13: Determining the Enthalpy of a Chemical Reaction (Hess's Law) (Advanced Chemistry with LabQuest – Supplemental Material IV) *This lab addresses Science Practices: 1, 2, 3, 4, 5, 6, 7
- Lab Activity #6 Experiment 9: Determining the Mole Ratios in a Chemical Reaction (Advanced Chemistry with LabQuest Supplemental Material IV) *This lab addresses Science Practices: 1, 2, 3, 4, 5, 6, 7
- Lab Activity #7 Experiment 16: Conductimetric Titration and Gravimetric Determination of a Precipitate (Advanced Chemistry with LabQuest – Supplemental Material IV) *This lab addresses Science Practices: 1, 2, 3, 4, 5, 6, 7

Atomic and nuclear structure Chapters 6 and 7 – Big Idea #1 addressed in this unit.

- I. Electronic Structure
 - A. Evidence for the atomic theory
 - B. Atomic number and mass number
 - C. Electron energy levels: atomic spectra, atomic orbitals
 - D. Data analysis and comprehension of Photoelectron Spectroscopy (PES)
 - E. Periodic relationships

- 1. Name the major subatomic particles in an atom.
- 2. Discuss the Bohr model of the atom, and compare it to the quantum mechanical model of the atom.
- 3. Illustrate the Coulombic forces between the nucleus and valence electrons and how the forces can vary.
- 5. Work problems involving energies of electron transitions.
- 6. Define and discuss the following terms or concepts: Heisenberg uncertainty principle, Pauli exclusion principle, wave-particle duality of matter, Wave function of electrons (Y), radial probability density, orbitals, Aufbau process, and Hund's rule.
- 7. Draw and name the s, p, and d orbitals.

- 8. Determine electron configurations from Photoelectric Spectroscopy data.
- 9. Understand the basis for the periodic law, and apply it to periodic trends such as atomic radii, ionization energy, density, melting point, oxidation states, and electronegativity.
- 10. Relate para-magnetism and di-magnetism to atomic structure.

Non-Lab Activities for Big Idea #1

- Guided Inquiry Activity #8 Photoelectron Sprectroscopy: What is Photoelectric Spectroscopy? (Chemistry: A Guided Inquiry – Supplemental Material VI)
- Guided Inquiry Activity #9 The Shell Model (III): How Many Peaks Are There in a Photoelectron Spectrum? (Chemistry: A Guided Inquiry – Supplemental Material VI)
- Guided Inquiry Activity #10 Electron Configurations: How Are Electrons Arranged? (Chemistry: A Guided Inquiry – Supplemental Material VI)

*Students will use models and questions from the POGIL activities listed above to develop the concepts of Photoelectron Spectroscopy (PES), data interpretation, and the relation of PES to conventional electron configurations.

Bonding and Molecular Structure

Chapters 8 and 9 – Big Idea #2 is addressed in this unit.

- I. Binding forces
 - A. ionic
 - B. covalent
 - C. metallic
 - D. hydrogen bonding
 - E. Van der Waals
- II. Relationships to states, structure, and properties of matter
- III. Polarity of bonds, Electronegativities
- IV. Molecular models
 - A. Lewis structures
 - B. Valence bond: Hybridization of orbitals, resonance, sigma and pi bonds
- V. VSEPR
 - A. Geometry of molecules and ions
 - B. Structural, geometric, optical, and conformational isomerism of:
 - 1. Organic molecules
 - 2. Coordination complexes
- VI. Polarity of molecules
- VII. Relation of molecular structure to physical properties

- 1. Draw Lewis structures for the common atoms, ions, and molecules.
- 2. Use periodic trends of electronegativity to predict bond type.
- 3. Distinguish between polar and nonpolar molecules.
- 4. Use electronegativity values and bonding concepts to determine oxidation states on atoms.
- 5. Draw resonance structures.
- 6. Name compounds and write chemical formulas.
- 7. Use the VSEPR model to predict molecular geometry.
- 8. Relate VSEPR to hybridization.

Laboratory Investigation

• Lab Activity #8 - VSEPR Lab – Dry lab, molecular model building (The source of this lab was an instructor at a 2008 AP Chemistry course) *This lab addresses Science Practices: 1, 3, 5, 6, 7

Non-Lab Activity for Big Idea #2

• Guided Inquiry Activity #25 – Metals: What Makes a Metal Metallic (Chemistry: A Guided Inquiry – Supplemental Material VI) *Students will use models and questions from the activity to understand the nature of metallic bonding and how the bonding contributes to physical properties of metals.

Gases

Chapters 10 – Big Ideas #2 and #3 are addressed in this unit.

- I. Gas Laws
 - A. Ideal gases
 - B. Boyle's law
 - C. Charles' law
 - D. Dalton's law of partial pressure
 - E. Graham's law
 - F. Van der Waal's equation of state
- II. Kinetic-Molecular theory
 - A. Avogadro's hypothesis and the mole concept
 - B. Kinetic energy of molecules
 - C. Deviations from ideality

The student will:

- 1. State and discuss the major tenants of the kinetic-molecular theory.
- 2. Apply the kinetic-molecular theory to gases.
- 3. Discuss intermolecular forces and relate them to topics such as non ideal behavior of gases.
- 4. Discuss the methods and units for measuring pressure; convert between units.
- 5. Work problems using: Charles's law, Boyle's law, Gay-Lussac's law, Avogadro's Law, Dalton's law, the ideal gas law, and Van der Waal's equation.
- 6. Extrapolate absolute zero from temperature and pressure data of a gas.
- 7. Determine the molar mass of a gas based upon the ideal gas law.

Laboratory Investigation

- <u>Lab Activity #8</u> Experiment 10: Molar Mass of Butane Gas (Advanced Chemistry with LabQuest – Supplemental Material IV) *This lab addresses Science Practices: 1, 2, 3, 5, 6, 7
- Class Participatory Demonstration: Diffusion of HCl_(g) and NH_{3(g)}: Rate of Diffusion Dependence on Molecular Weight. (Molecular weight determination)

Intermolecular Forces, Liquids, and Solids Chapter 11 – Big Idea #2 is addressed in this unit.

- I. Liquids and solids
 - A. Liquids and solids from the K-M viewpoint
 - B. Phase diagrams of one-component systems
 - C. Changes of state
 - D. Structure of solids including lattice energies / Coulombic forces

The student will:

- 1. State and discuss the major tenants of the kinetic-molecular theory.
- 2. Apply the kinetic-molecular theory to liquids and solids, as well as gases.
- 3. Discuss intermolecular forces and relate them to physical properties such as boiling point.
- 4. Interpret heating curves as to melting point, boiling point, and specific heat.
- 5. Calculate energy values associated with changes of temperature and state of matter.
- 6. Discuss the phenomena of boiling, and are able to relate it to pressure.
- 7. Distinguish between substitutional and interstitial alloys and discuss how each kind is used in industry.

Laboratory Investigation

 <u>Lab Activity #9</u> - Investigation 5: Sticky Question: How Do You Separate Molecules That Are Attracted to One Another (Chemistry: Guided-Inquiry Experiments – Supplemental Material V) *This lab addresses Science Practices: 1, 3, 4, 5, 6, 7 AND is <u>Inquiry Lab #2</u> for the course.

End of Fall Semester

Spring Semester

Solutions and Colloids Chapter 13 - Big Idea #2 is addressed in this unit.

I. Types of solutions II. Factors affecting solubility III. Concentration issues IV. Raoult's law and colligative properties V. Nonideality

- 1. Define solution vocabulary.
- 2. Discuss the effect that physical conditions have on solubility.
- 3. Discuss the process of heat of solution and how lattice energy and heat of hydration are used to determine ΔH_{soln} .
- 4. Use the concepts of intermolecular forces in discussing the dissolving process.
- 5. Separate compounds into electrolytes and nonelectrolytes.
- 6. Solve problems involving molarity and mole fraction.
- 7. Correctly use Beer's law to determine concentration of a solution.
- 8. Apply how colligative properties are involved with depression of freezing point, elevation of boiling point, lowering of vapor pressure, and increasing of osmotic pressure.
- 9. Distinguish between an ideal and a non-ideal solution; apply the van't Hoff factor

Laboratory Investigations

- <u>Lab Activity #10</u> Experiment 17: Determining the Concentration of a Solution: Beer's Law (Advanced Chemistry with LabQuest – Supplemental Material IV) *This lab addresses Science Practices: 1, 3, 4, 5, 6, 7
- Lab Activity #11 Investigation 2: How Can Color Be Used to Determine the Mass Percent of Copper in Brass? (Chemistry: Guided-Inquiry Experiments – Supplemental Material V) *This lab addresses Science Practices: 1, 3, 4, 5, 6, 7 AND is Inquiry Lab #3 for the course.

Chemical Kinetics

Chapter 14 - Big Idea #4 is addressed in this unit.

- I. Rate of reaction
- II. Order of the reaction
- III. Factors that change the rate of the reaction
 - A. Temperature
 - B. Concentration
 - C. Nature of substance
 - D. Catalysts
- IV. Relationship between the rate-determining step and the reaction mechanism

The student will:

- 1. List the factors that influence the rate of a chemical reaction.
- 2. Use experimental data to determine the rate law, determine the order of the reaction, and to define proper units for the constant.
- 3. Compare and contrast zero, first, and second order reactions in terms of the plot needed to give a straight line, the relationship of the rate constant to the slope of the straight line, and the half-life of the reaction. Use of a correlation constant (r^2) will be used to determine the order of integrated rate laws.
- 4. Use experimental data to postulate a reaction mechanism.
- 5. Interpret how changing the conditions of the reaction (i.e., temperature, pressure, concentration, and addition of a catalyst) affects both the rate and the rate constant of the reaction.
- 6. Discuss the role of a catalyst in the rate and mechanism of a reaction; distinguish between a homogeneous and a heterogeneous catalyst.
- 7. Model graphically the activation energy of a reaction and explain how the addition of a catalyst can lower the activation energy of a chemical reaction.

Laboratory Investigations

<u>Lab Activity #12</u> - Investigation 11: What is the Rate Law of the Fading of Crystal Violet Using Beer's Law? (Chemistry: Guided-Inquiry Experiments – Supplemental Material V) *This lab addresses Science Practices: 1, 3, 4, 5, 6, 7 AND is <u>Inquiry Lab #4</u> for the course.

Non-Lab Activity for Big Idea #4

• M & M Activity – Rate Order Modeling (This Activity was written by Corey Brueckner based upon similar activities observed.) *Students will use M&M's to model the conversion of a product to a reactant in a chemical reaction. The students will analyze the data collected from the activity. Graphing calculators and basic statistical analysis will be utilized to determine the appropriate mathematical function for a first order chemical reaction.

Equilibrium

Chapter 15 - Big Idea #6 is addressed in this unit.

I. Concept of dynamic equilibrium including Le Chatelier's principle II. Equilibrium constants and the law of mass action

The student will:

- 1. Describe the meaning of physical and chemical equilibrium, and give real life examples of each.
- 2. Write the law of mass action for any system at equilibrium.
- 3. Understand the meaning of equilibrium constant and reaction quotient (Q).
- 4. Interpret the position of equilibrium from the size of the equilibrium constant.
- 5. Use Le Chatelier's principle to predict the direction a system in equilibrium will shift in order to re-establish equilibrium.
- 6. Know that temperature, pressure, and concentration will shift the position of equilibrium.
- 7. Understand that a catalyst will not have an effect of the equilibrium constant.

Laboratory Investigations

• <u>Lab Activity #13</u> - Experiment 10: The Determination of an Equilibrium Constant (Advanced Chemistry with LabQuests – Supplemental Material IV) *This lab addresses Science Practices: 1, 3, 4, 5, 6, 7.

Non-Lab Activity for Big Idea #6

• POGIL Activity – Equilibrium: At what point is a reversible reaction "completed"? (**POGIL: Activities for High School Chemistry – Supplemental Material VII**) *Students will manipulate data from the activity in tables to conclude that the change of the forward reaction eventually equals the change of the reverse reaction and dynamic equilibrium is eventually reached.

Acids and Bases Chapter 16 - Big Idea #6 is addressed in this unit.

- I. Lowry-Brønsted theory
 - A. Properties of acids and bases
 - B. Acid base neutralization
 - C. Amphiprotic species
 - D. Relative strengths of acids and bases
 - E. Polyprotic acids

- 1. Distinguish between the various modern theories of acids and bases.
- 2. Name and write formulas for normal salts, hydrogen salts, hydroxy salts, oxysalts, and acids.
- 3. Write balanced equations involving acids, bases, and salts. 3. Know and use the water constant, Kw.
- 4. Define pH, pOH, pK, Ka, Kb, ionization constant, percent ionization, Ksp.
- 5. Convert from $\{H_3O+\}$ or $\{OH-\}$ to pH or pOH.
- 6. Perform a titration and solve for the appropriate concentration.

- 7. Use a pH meter to determine a titration curve and (a) the equivalence point from a strong acid / strong base titration data set using a graphing calculator;
 (b) the Ka (or Kb) from a weak acid / strong base titration data set using a graphing calculator;
 (c) determine the basic shape of a polyprotic acid /base titration curve.
- 8. Pick a suitable indicator for a titration.
- 9. Use the ICE method to determine pH values of weak acids or pOH values of weak bases. (Law of Mass Action)
- 10. Use the concept of conjugate acid-base pairs to predict reaction products.
- 11. Define and give examples of amphiprotic species.
- 12. List the six strong acids.
- 13. Recognize Lewis acid-base reactions.
- 14. Determine the strength of an acid based upon structure and electronegativity
- 15. Discuss the acid-base properties of oxides and how it applies to the formation of acid rain.

Non-Lab Activity for Big Idea #6

Virtual Titration (This activity was written by Corey Brueckner and uses the website http://www.chemcollective.org/vlab/vlab.php for data generation.) *Students will generate pH and volume of titrant used data virtually from the website listed above. Students will then be required to construct a variety of graphs from the data collected. The graphs will be used during the unit to demonstrate equivalence point determination (strong and weak acids), Ka determination, and the general shape of the graph for the titration of a polyprotic acid.

Additional Aspects of Aqueous Equilibria Chapter 17 - Big Idea #6 is addressed in this unit.

- I. The Common-Ion Effect
- II. Weak acids and bases
 - A. pH
 - B. pOH
 - C. Buffer systems
 - D. Hydrolysis
- **III. Solubility Product**
 - A. Factors involving dissolution
 - B. Molar solubility

- 1. Identify weak electrolytes.
- 2. Write a law of mass action for any reaction in equilibrium.
- 4. Make a buffer for a particular pH. Decide on the most appropriate weak acid to use and the correct ratio of conjugate base to weak acid.
- 6. Recognize salts that undergo hydrolysis and write a reaction for the ion with water.
- 7. Given the concentration and amount of weak acids or bases and an appropriate titrant, calculate data to produce a titration curve.
- 8. Write solubility product expressions for slightly soluble compounds.

9. Solve problems involving: (a) solubility product constants from solubility; (b) molar solubility from Ksp; (c) concentrations of substances necessary to produce a precipitate; (d) concentrations of ions involved in simultaneous equilibrium.

Laboratory Investigations

- <u>Lab Activity #14</u> Investigation 16: The Preparation and Testing of an Effective Buffer: How Do Compounds Influence a Buffer's pH and Capacity (Chemistry: Guided-Inquiry Experiments – Supplemental Material IV) *This lab addresses Science Practices: 1, 3, 4, 5, 6, 7 AND is <u>Inquiry Lab #5</u> for the course.
- <u>Lab Activity #15</u> Experiment 23: Determining the Ksp of Calcium Hydroxide (Advanced Chemistry with LabQuest Supplemental Material IV) *This lab addresses Science Practices: 1, 3, 4, 5, 6, 7.

Non-Lab Activity for Big Idea #6

• Virtual Build a Buffer Activity (This activity was written by Corey Brueckner and uses the website <u>http://www.chemcollective.org/vlab/vlab.php</u> for data generation.) *Students will determine the volumes needed of weak acids and the appropriate conjugate base (both of a particular molarity) to make a specific volume of a buffer of a particular pH. Once the students have completed the calculations on paper, they will then use the website shown above to virtually make the solution. The website measures the pH of the buffer solution made, so feedback for success (or not so successful) is instantaneous.

Non-Lab Activity for Big Idea #6

• The Science Behind the Home Remedy to Shrink or Eliminate Kidney Stones (This presentation (Power Point) was created by Corey Brueckner.) *A home remedy to shrink or eliminate kidney stones is touted by numerous websites on the Internet. The type of kidney stone used as an example in the presentation is calcium oxalate. The most common combination of ingestible substances discussed is a puree of asparagus and large amounts of Coca Cola consumed. The asparagus acts as a diuretic, which draws water into the kidneys. The dilution of ions in the kidneys causes a shift in the equilibrium reaction, causing the stone to dissolve into ions. The students will be asked to justify the shrinking of the kidney stone based upon LeChatelier's principle. The Coca Cola introduces acids, thus the situation can be used to demonstrate through LeChatelier's principle how acids increase the solubility of low Ksp substances. Once again, students will be asked to justify the shift in the dissolution equilibrium by adding hydrogen ions via the Coca Cola. This activity is intended to meet the requirement for Societal or Technological Impact of Chemistry.

Non-Lab Activity for Big Idea #6

• The Leaching of Heavy Metals From Mining Waste (Tailings) in the Rocky Mountain Region (This activity was created by Corey Brueckner in conjunction with the PBS NOVA presentation "Poison in the Rockies". (Season 17, Episode 11, 1992)) *The mining industry has a long history in the Rocky Mountain region. The PBS NOVA presentation "Poison in the Rockies" documents this and the environmental legacy left by abandoned mines leaching toxic heavy metals into the soil and waterways of the Rocky Mountains. After watching the episode, students will be asked to calculate lead ion concentrations from Ksp data given about common lead containing ores that are common in mine tailings. Students will then be required to research lead ion levels that would be considered safe or toxic by the EPA and correlate those concentration levels to their findings from the calculations done on the ores. Students will be asked if acid rain in the Rocky Mountain region will have an effect on the lead ion concentrations. Students should be able to demonstrate an increase in lead ion concentration based upon LeChatelier's principle. This activity may meet the requirement for Societal or Technological Impact of Chemistry. *This activity will be completed after the AP Chemistry exam.

Chemical Thermodynamics

Chapter 19 - Big Idea #5 is addressed in this unit.

I. State functions II. Laws of thermodynamics III. Relationship of change of free energy to equilibrium constants

The student will:

- 1. List and define the meanings and common units for the common thermodynamic symbols.
- 2. Distinguish between a state function and a path function.
- 3. Define internal energy, PV work, enthalpy, entropy, and free energy.
- 4. Use Hess's law to solve problems of energy, entropy, and free energy.
- 5. Define the terms exothermic, endothermic, exergonic, and endergonic.
- 6. Determine the spontaneity of a reaction.
- 7. Discuss the laws of thermodynamics (in order).
- 8. Understand the relationship between free energy change and equilibrium constants.

Laboratory Investigations

<u>Lab Activity #16</u> - Investigation 12: The Hand Warmer Design Challenge: Where Does the Heat Come From? (Chemistry: Guided-Inquiry Experiments – Supplemental Material IV) *This lab addresses Science Practices: 1, 3, 4, 5, 6, 7 AND is <u>Inquiry Lab #6</u> for the course.

Non-Lab Activities for Big Idea #5

- Guided Inquiry Activity #52 Entropy (I): Why Is My Desk So Messy? (Chemistry: A Guided Inquiry – Supplemental Material VI)
- Guided Inquiry Activity #53 Entropy (II) (Chemistry: A Guided Inquiry Supplemental Material VI)
- Guided Inquiry Activity #54 Entropy Changes in Chemical Reactions (Chemistry: A Guided Inquiry – Supplemental Material VI)

*Students will use models and questions from the POGIL activities listed above to develop the concepts of entropy, enthalpy, and Gibb's Free Energy.

Electrochemistry Chapter 20 - Big Idea #3 is addressed in this unit.

- I. Galvanic cells and cell potentials
- II. Electrolytic cells
- III. Redox equations

The student will:

- 1. Use the half-reaction method to balance redox equations.
- 2. Define electrochemical terms: redox, anode, anion, cathode, cation, oxidizing agent, reducing agent, emf, electrode, etc.
- 3. Distinguish between an electrolytic cell and a voltaic cell in terms of function and *G.
- 4. Solve problems using Faraday's law.
- 5. Predict reaction products for both electrolytic and voltaic cells.
- 6. Discuss the importance of and draw a diagram of a standard hydrogen electrode.
- 7. Use a table of Standard Reduction Potentials to compute cell voltages.
- 8. Use LeChatelier's principle to illustrate how the voltage of a galvanic cell can be influenced by changing concentrations of reactants and / or products.
- 9. Diagram voltaic cells using proper notation.
- 10. Establish the relationship between the free energy change, the cell potential, and the equilibrium constant.

Chemical Demonstrations

- The decomposition of water by construction an electrolytic cell.
- Electroplating
- Creating a copper and copper galvanic cell by changing concentrations.

End of Spring Semester

Requirements

- Students are expected to be in class on time with the required materials. The **AP Chemistry** class meets for 50 minutes three days each week and for 55 minutes two days each week.
- The instructional time allocated for the class will be the following: **75%** of the time in the class will be devoted to lecture, scientific demonstrations, computer simulations and non-laboratory inquiry activities. The remaining **25%** of the time in class will be devoted to laboratory investigation.
- An average of 30 minutes per day outside of class is recommended.
- Labs will be introduced throughout the curriculum when appropriate.
- Students will submit two types of lab reports.
 - 1. Formal lab reports: These are to be typed in the format established in the first year chemistry course. The formal lab write-up will be completed in the format:

Purpose 2) Hypothesis / Theory 3) Procedure 4) Data Table Analysis 6) Sources of Experimental Error (SEE's) 7) Conclusion

All data will be presented in table format and Excel graphs imported to the document.

- 2. Informal lab reports: These are to be submitted on the lab handouts. Answer all questions on the sheets and always supply a separate sheet discussing the sources of experimental error and a conclusion for the lab. The S.E.E.'s and conclusion for informal lab reports can be either typed or hand written.
- All labs, both formal and informal, should be kept in a folder for submission to a college for awarding of college credit for a first year chemistry course lab.
- Students in AP Chemistry are expected to take the AP Chemistry Exam in May.