AP Chemistry Syllabus: Work in Progress (for 22-23)

Course Description:

This is an advanced placement course designed to prepare the student for the AP Chemistry exam, and covers the equivalent of one full year of college level General Chemistry. It is a rigorous math-based course, with a strong laboratory component. It is intended for students who have demonstrated a willingness to commit considerable time to studying and completing assignments outside of class, and who have successfully completed a prior course in chemistry during high school. The primary goal of the course is for students to understand the basic principles of modern chemistry—including stoichiometry, reactions, kinetics, equilibria, thermodynamics, electrochemistry, and more—while also demonstrating the ability to use that understanding in the solution and meaningful communication of mathematically based laboratory and textbook problems.

Methods of Evaluation:

Students will be evaluated by using, but not limited to, the following:

- Teacher-constructed quizzes and examinations
- Laboratory exercises and scientific-formatted lab reports (for student portfolios)
- Homework and class work
- Classroom participation
- Standardized examinations

Assignments and Points:

Homework assignments will typically be worth 10 points each. Lab reports, to which you will attach a rubric (see website), will be worth 32 points each.

There will be frequent quizzes on most topics worth 10-20 points each, unit exams worth 40-60 points, and a semester-cumulative final exam at the end of the first semester worth 100 points.

IT IS UNLIKELY THAT YOU WILL PASS THE CLASS IF YOU FAIL TO CONSISTANTLY DO THE HOMEWORK AND LAB REPORTS. (However, you might still pass the AP exam.)

Grading Policy:

I *estimate* 600 to 800 points available per semester. Cumulative available points equal 100 percent. A test point is weighted no more nor less than any other point. The following scale will be used for assigning letter grades:

A = 100 - 90% B = 89 - 80% C = 79 - 70% D = 69 - 60% F = 59% or less.

A ***C minus*** (70-73%) is considered in danger of failing, as is anything in the ***D*** range. An ***F*** is, of course, failing.

Bonus points may be available on rare occasion at teacher's discretion.

Primary Textbook:

Zumdahl, S.S., S.A. Zumdahl, and D.J. DeCoste (2018). Chemistry, 10th ed. Boston, MA: Cengage Learning.

Primary Lab Manual:

Vonderbrink, S.A. (2001). Laboratory Experiments for Advanced Placement Chemistry. Batvia, IL: Flinn Scientific.

Supplementary Textbook:

Chang, R. (2002). Chemistry, 7th ed. New York, NY: McGraw-Hill.

Supplementary Lab Manual:

Nelson, J. H. and Kemp, K. C. (2003). Laboratory Experiments: Chemistry, The Central Science, 9th edition. Upper Saddle River, NJ: Pearson Education.

Lab-source Key (Look at fonts.)**:** Vonderbrink, *Nelson and Kemp*, other

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Course Outline: (Times are approximate.)

UNIT I: CHEMISTRY FUNDAMENTALS (4 weeks)

A. Chapter One: Chemical Foundations <Problems (*In* Zumdahl et al): ***Show your work for***: 31-91 odd, 95-99 odd, and 109.>

1. Measurements in Chemistry
    a. Metric System
    c. Significant Figures
2. Dimensional Analysis: Factor-label Method of Problem Solving

Lab: Analysis of Ag in an Alloy (a gravimetric analysis); **or** *Gravimetric Analysis of a Chloride Salt* (3 hours)

B. Chapter Two: Atoms, Molecules, and Ions (summer assignment material) <Problems (*In* Zumdahl et al): ***Show your work where applicable for***: 39, 41, 45, 47, 53-91 odd, and 99-107 odd>

1. Atomic Structure
2. Isotopes
3. Atomic Mass
4. Compounds: Ionic and Molecular
5. Inorganic Nomenclature

C. Chapter Three: Stoichiometry <Problems **(***In* Zumdahl et al**): *Show your work for***: 39-133 odd, 137-143 odd, and 147-161 odd.>

1. The Mole
2. Molar Mass
3. Empirical and Molecular Formulas
4. Percentage Composition
5. Calculations Using Balanced Equations
6. Limiting Reactants/Reagents

Lab: Finding the Ratio of Moles of Reactants in a Chemical Reaction; **or** *Chemical Formulas* (3 hours)

UNIT II: ATOMIC STRUCTURE, PERIODICITY, AND BONDING (4 weeks)

A. Chapter Seven: Atomic Structure and Periodicity <Problems (*In* Zumdahl et al): *Do odd-numbered* Exercises *and odd* Additional Exercises.>

1. Bohr's Theory
2. Emission Spectra
3. Electron Configurations, Electron Dot, Shell Notations
4. Photoelectric Effect
5. Photoelectron Spectroscopy (PES)
6. Trends
7. Coulomb's Law Applied to I.E.
8. Links to Quantum Mechanics

Lab: Flame tests (1 hour)

B. Chapter Eight: Bonding: General Concepts <Problems (*In* Zumdahl et al): *Do odd-numbered* Exercises *and* 133.>

1. Lewis Dot Diagrams
2. Lewis Structures
3. Resonance Structures
4. Double and Triple Bonds
5. Electronegativity and Bond Polarity
6. Dipole Moments
7. VSEPR (Valence-Shell Electron-Pair Repulsion) Model

Lab: Molecular Models (1 hour)

C. Chapter Nine: Covalent Bonding: Orbitals <Problems (*In* Zumdahl et al): *Do odd-numbered* Exercises 21-43, *and* 67, 69a & b, 75, *and* 77.>

1. Molecular Geometry
2. Valence Bond Theory
3. Hybridization
4. Delocalized pi bonding

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UNIT III: STATES OF MATTER (3 weeks)

A. Chapter Five: Gases <Problems (*In* Zumdahl et al): ***Show your work where applicable for***: 41-129, *and* 131-135 *odd*, and 139-145 *odd*.>

1. Boyles', Charles', and Avogadro's laws
2. Ideal Gas Law
    a. Gas constant
    b. Density
    c. Molecular mass
    d. Deviations
3. Dalton's Law of Partial Pressures (wet gases)
4. Mole fraction and partial pressures
5. Kinetic Theory of Gases
6. Maxwell-Boltzman distribution
7. Graham's Law

Lab: Molecular Mass of a Volatile Liquid; **or** *Behavior of Gases: Molar Mass of a Vapo*r (3 hours)

B. Chapter Ten: Liquids and Solids <Problems (*In* Zumdahl et al): *Do odd-numbered* Exercises 37-47, 91-103 *odd*, 111-117 *odd*, and 121 *and* 125.>

1. Kinetic-Molecular Theory
2. Intermolecular Forces
    a. Ion-dipole
    b. Dipole-dipole
    c. London dispersion forces
    d. Hydrogen bonding

C. Chapter Eleven: Properties of Solutions (not colligative properties) <Problems (*In* Zumdahl et al): ***Show your work where applicable for***: 35-57 *odd*.>

1. Solutions and Concentration
2. Separation of Mixtures and Chromatography (actually in Chapter One)

UNIT IV: CHEMICAL REACTIONS (6 weeks)

Chapter Four and Supplementary: Reactions and Solution Stoichiometry <Problems (*In* Zumdahl et al): ***Show your work where applicable for***: 27-123 *odd* and Reactions Worksheets>

1. Patterns of Chemical Reactivity
2. Aqueous Solutions
    a. Electrolytes
    b. Non-electrolytes
3. Solubility Guidelines
4. Ionic Equations
5. Precipitation Reactions
6. Acid-Base Reactions
7. Oxidation-Reduction Reactions (balancing)
8. Molarity and Dilution
9. Titrations
10. Beer-Lambert Law
11. Reactions (supplementary material)

Labs: Synthesis of Alum (2 hours), **and** Identification of Alum (5 hours); *Colorimetric Determination of Iron* (4 hours), **and** Analysis of Commercial Bleach (a quantitative redox titration) (3 hours)

SEMESTER-ONE FINAL EXAM (from UNIT I through UNIT IV, ideally)

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UNIT V: KINETICS (2 weeks)

Chapter Twelve: Chemical Kinetics <Problems (*In* Zumdahl et al): >

1. Rate of Reactions
2. Rate Laws
3. First Order and Second Order Reactions
4. Activation Energy and Temperature Dependence
5. Collision Theory
6. Reaction Mechanisms
7. Rate Determining Step
8. Catalysis

Lab: Study of the Kinetics of a Reaction (a clock reaction); **or** *Rates Chemical of Reactions: A Clock Reaction* (4 hours)

UNIT VI: THERMODYNAMICS (2 weeks)

A. Chapter Six: Thermochemistry <Problems (*In* Zumdahl et al): > and <Heating-curve problems (worksheet)>

1. Enthalpy (including bond enthalpies from Chapter 8)
2. Calorimetry
    a. Specific heat
    b. Heat capacity
    c. Constant-volume calorimetry
    d. Constant-pressure calorimetry
3. Standard Enthalpy of Formation
4. Hess's Law
5. Heat of Solution and Dilution

Labs: Thermochemistry and Hess's Law (3 hours); **and/or** Vapor Pressure and Enthalpy of Vaporization of Water (2 hours)

B. Chapter Seventeen: Chemical Thermodynamics <Problems (*In* Zumdahl et al): >

1. Spontaneous Reactions and Entropy
2. Second Law of Thermodynamics
3. Third Law of Thermodynamics
4. Gibbs Free Energy
5. Free Energy and Chemical Equilibrium
6. Coulomb's Law (Chapter 8) vs. P.E.

C. **Chapter Eight, Section 8.8: Bond Enthalpies** <Problems (*In* Zumdahl et al): >

UNIT VII: EQUILIBRIA (8 weeks)

A. Chapter Thirteen: Chemical Equilibrium <Problems (*In* Zumdahl et al): >

1. Equilibrium Expression
2. Relationship Between Kinetics and Equilibrium
3. Determining Equilibrium Concentrations
4. Le Châtelier's Principle

Lab: Determination of the Equilibrium Constant for the Formation of $FeSCN^{2+}$ (3 hours)

B. Chapter Fourteen: Acids-Base <Problems (*In* Zumdahl et al): >

1. Bronsted Acids and Bases
2. Conjugated Acid-Base Pairs
3. Strength of Acids and Bases
4. Binary and Ternary Acids
5. Acid-Base Reactions
6. Lewis Acids and Bases
7. Weak Acids and Bases
8. Ionization Constants
9. Conjugated Acid-Base Ionization Constants
10. Diprotic and Polyprotic Acids
11. Acid-Base Properties of Salts

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UNIT VII continued

C. Chapter Fifteen: Acids-Base Equilibria <Problems (*In* Zumdahl et al): >

1. Common Ion Effect
2. Buffer Solutions (Henderson-Hasselbalch equation derivation & usefulness)
3. Acid-Base Titrations (mono- and di- protic acid with strong base)
4. Acid-Base Indicators
5. Amphoterism

Labs: *Standardization of a Solution* (2 hours); **and** *Titration of a Polyprotic Acid* (3 hours); Buffers (1 hour)

D. Chapter Sixteen: Solubility and Complex Ion Equilibria <Problems (*In* Zumdahl et al): >

1. Solubility and Solubility Product
2. pH and Solubility
3. Complex Ion Equilibria and Solubility
4. Qualitative Analysis Scheme

Lab: Qualitative Analysis (8 hours)

UNIT VIII: ELECTROCHEMISTRY (1 week)

Chapter Eighteen: Electrochemistry <Problems (*In* Zumdahl et al): >

1. Review of Redox Reactions (See UNIT II: CHEMICAL REACTIONS.)
2. Galvanic Cells
3. Standard Electrode Potentials
4. Spontaneity of Redox Reactions
5. Effect of Concentration on Cell EMF (Nernst equation derivation & usefulness)
7. Batteries
8. Corrosion
9. Electrolysis

Lab: Electrochemical Cells; **or** Electroplating; **or** An Activity Series (2 hours)

UNIT IX: REVIEW FOR AP EXAM

AP EXAM (TBA)

Labs to close out the year: Determination of the Hardness of Water (4 hours); Determination of phosphates in water (4 hours); *Synthesis of Asprin* (3 hours), **and** *Analysis of Asprin* (3 hours); **and** Esterification (2 hours)

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