ADVANCED CHEMISTRY SYLLABUS

Mrs. Collett

Goals of the course:

- To explore the nature and importance of chemistry in our everyday lives.
- To increase understanding of concepts in chemistry and associated mathematical formulations of principles.
- To gain experience in the laboratory making observations, collecting data, analyzing data, formulating conclusions and reassessing processes.
- To practice group collaboration and how to communicate scientific information both orally and in writing.
- To prepare for the AP Chemistry Exam.

Chapter 1 – Chemical Foundations

I. Scientific Method

II. Measurement and Error

III. Chemical Calculations

The student will:

- Define terms such as matter, element, compound, and mixture.
- Differentiate between accuracy and precision.
- Understand properties of matter and differentiate between physical and chemical change.
- Be able to use scientific notation, SI units and prefixes, and to convert between units.
- Work with the proper number of significant figures.
- Work problems using dimensional analysis.

Chapter 2 – Atoms, Molecules, and Ions

I. Atomic Theory

II. Nuclear Stability and Radioactive Decay

III. Periodic Table

IV. Nomenclature

The student will:

- Describe Dalton's Atomic Theory.
- Be able to use the atomic number and mass number of an isotope to calculate the number of protons, neutrons and electrons.
- Relate the stability of a nucleus to the number of protons and neutrons and balance nuclear equations (Chapter 18).
- Understand the arrangement of the Periodic Table and know the locations of metals, non-metals, and metalloids.
- Name monatomic and polyatomic ions, given the formula, and vice versa.
- Name inorganic compounds using the Stock system and write formulas.
- Name simple organic compounds, including isomers, and know functional groups (Chapter 22).

Chapter 3 – Stoichiometry (2 weeks for Chapters 1-3)

I. Atomic Masses

II. The Mole

III. Percent Composition

IV. Formulas

V. Chemical Equations

VI. Limiting Reactants

The student will:

- Work problems involving mole concepts, percent composition, empirical formulas, and molecular formulas.

- Write and balance chemical equations.
- Solve problems involving limiting reactants and percent yield.
- Use experimental data to determine empirical and molecular formulas.

Laboratory – Finding the Ratio of Moles of Reactants in a Chemical Reaction

Chapter 4 – Types of Chemical Reactions and Solution Stoichiometry (2 weeks)

I. Reaction Types
   A. Precipitation Reactions
   B. Acid-Base Reactions
   C. Oxidation-Reduction Reactions
      1. Oxidation Number
      2. Electron Transport

II. Stoichiometry
   A. Net Ionic Equations
   B. Balancing Equations Including Oxidation-Reduction Equations

The student will:

- Define terms such as electrolyte (strong and weak), acid, base, precipitate, oxidation, and reduction.
- Classify reactions by type.
- Predict if a precipitate will form using the solubility rules.
- Use the properties of metals and nonmetals to predict reaction products.
- Write and balance chemical equations.
- Use the Periodic Table to predict oxidation states.
- Perform calculations related to molarity and dilution.

Laboratory – Separation and Qualitative Analysis of Cations and Anions

Chapter 5 – Gases (2 weeks)

I. Gas Laws of Boyle, Charles, and Avogadro

II. Ideal Gas Law

III. Dalton's Law of Partial Pressures

IV. Kinetic-Molecular Theory

V. Real Gases

The student will:

- Perform calculations using Boyle's Law, Charles' Law, Avogadro's Law, Ideal Gas Law, and Van der Waal's equation.
- Use Dalton's Law of Partial Pressures in calculations.
- Discuss the kinetic-molecular theory and deviations from ideal behavior.
- Understand effusion and diffusion.

Laboratory – Molecular Weight of a Volatile Liquid; Molecular Weight by Diffusion

Chapter 6 – Thermochemistry (1 week)

I. First Law of Thermodynamics

II. Enthalpy and Calorimetry

III. Hess's Law

IV. Standard Enthalpies of Formation

The student will:

- Learn terms such as enthalpy, exothermic, endothermic, heat of formation, heat of reaction, calorimetry, etc.
- Solve heat problems.
- Use Hess's Law to calculate enthalpy change.

- Perform calculations with standard heats of formation.

Laboratory – Thermochemistry and Hess's Law

Chapter 7 – Atomic Structure and Periodicity (2 weeks)

I. Evidence for the Atomic Theory

II. Bohr Model

III. Quantum Mechanical Model

IV. Quantum Numbers

V. Orbital Shapes and Energies

VI. Periodic Relationships Including Ionization Energies, Atomic Radii, and Electron Affinities

VII. Properties of a Group: The Alkali Metals

The student will:

- Discuss the Bohr model of the atom and compare it to the quantum mechanical model.
- Understand how line emission spectra are formed.
- Use equations that relate the energy, frequency, and wavelength of photons.
- Work problems involving quantum numbers.
- Know and apply the rules for filling orbitals and determining electron configuration, including the Pauli exclusion principle, Hund's rule and notable exceptions.
- Know the shapes of the s, p, and d orbitals.
- Discuss periodic trends such as atomic radii, ionization energy, and electron affinity.
- Understand the terms diamagnetic and paramagnetic.

Chapters 8 and 9 – Bonding (2 weeks)

I. Types of Chemical Bonds

A. Ionic

B. Covalent

II. Electronegativity

III. Bond Polarity and Dipole Moments

IV. Bond Energy and Enthalpy

V. Localized Electron Bonding Model

VI. Lewis Structures

VII. Resonance

VIII. VSEPR Model

IX. Hybridization

The student will:

- Understand different bonding concepts.
- Use periodic trends of electronegativity to predict bond type.
- Distinguish between polar and nonpolar molecules.
- Calculate the enthalpy of a reaction using bond energies.
- Draw Lewis structures for common atoms, ions, and molecules, including resonance structures.
- Use VSEPR theory to predict geometry and bond angles in simple molecules and ions.
- Identify different types of orbital hybridization.
- Understand sigma and pi bonds.

Laboratory – Molecular Models

Chapter 10 – Liquids and Solids (1 week)

I. Intermolecular Forces

A. Dipole-Dipole Forces

1. Hydrogen Bonding

B. London Dispersion Forces

II. Types of Solids

III. Vapor Pressure and Changes of State

IV. Phase Diagrams

The student will:

- Discuss the kinetic-molecular theory as it applies to liquids and solids.
- Discuss intermolecular forces and relate them to physical properties such as surface tension, capillary action, viscosity, vapor pressure, and boiling point.
- Understand the different types of solids and know examples of each.
- Interpret heating curves and phase diagrams, including characteristic points such as triple point, critical temperature and critical pressure.

Chapter 11 – Properties of Solutions (1 week)

I. Solution Composition

II. Solution Formation

III. Factors Affecting Solubility

IV. Vapor Pressures of Solutions

V. Boiling Point Elevation and Freezing Point Depression

VI. Osmotic Pressure

VII. Colligative Properties of Electrolyte Solutions

The student will:

- Define terms related to solutions.
- Perform calculations with different solution concentrations such as molarity, mass percent, molality, and mole fraction.
- Apply Raoult's law.
- Discuss factors that affect solubility.

- Solve problems involving vapor pressure lowering, boiling point elevation, freezing point depression and osmotic pressure.

Chapter 12 – Chemical Kinetics (2 weeks)

I. Reaction Rates

II. Rate Laws

III. Reaction Mechanisms

IV. Collision Theory and Activation Energy

V. Catalysis

VI. Kinetics of Radioactive Decay

The student will:

- Describe how temperature, concentration, surface area and catalysts affect rate of reaction.
- Use experimental data to determine the order of reaction, rate equation, rate constant (including proper units), and to postulate a reaction mechanism.
- Interpret graphical data relating to both differential and integrated rate laws.
- Solve problems involving activation energy and the Arrhenius equation.
- Perform calculations related to half-life.

Laboratory – First Kinetics Lab; Hydrogen Peroxide Decomposition

Chapter 13 – Chemical Equilibrium (2 weeks)

I. Characteristics of Equilibrium

II. The Equilibrium Constant

III. Homogeneous and Heterogeneous Equilibria

IV. Solving Equilibrium Problems

V. Le Chatelier's Principle

The student will:

- Understand the concept of dynamic equilibrium.
- Write the law of mass action for any system at equilibrium.
- Calculate K and K_p and know how they are related.
- Apply Le Chatelier's Principle to predict the shift in position in order to re-establish equilibrium.
- Predict the effect of changes in concentration, pressure, or temperature on equilibrium.

Laboratory – Determination of the Equilibrium Constant for the Formation of $FeSCN^{2+}$

Chapter 14 – Acids and Bases (1 week)

I. Relative Strength of Acids and Bases

II. The pH Scale

III. Percent Dissociation

IV. Polyprotic Acids

V. Acid-Base Properties of Salts

VI. Molecular Structure and Acid-Base Properties

VII. Acid-Base Properties of Oxides

VIII. Lewis Acid-Base Model

The student will:

- Understand the Bronsted-Lowry, Arrhenius, and Lewis theories of acids and bases.
- Identify strong acids and bases.
- Calculate pH for acids, bases and salts.
- Identify acid-base conjugate pairs and use them to predict reaction products.
- Write balanced equations for acids, bases, and salts.

Laboratory – Determination of the Dissociation Constant of Weak Acids

Chapter 15 – Applications of Aqueous Equilibria (3 weeks)

I. Solutions of Acids or Bases Containing a Common Ion

II. Buffers

III. Titrations

IV. Indicators

V. Solubility Product

VI. Precipitation and Qualitative Analysis

VII. Complex Ions

The student will:

- Perform acid-base equilibrium calculations.
- Understand how a buffer works.
- Understand the techniques associated with titrations and produce a titration curve.
- Understand how indicators work and how to select them.
- Recognize salts that undergo hydrolysis and write reactions.
- Write solubility product expressions for slightly soluble compounds.
- Predict the effect of a common ion on the solubility of a salt.
- Perform calculations involving solubility and complex ion equilibria.

Laboratory – Determining the Solubility Product Constant of Calcium Hydroxide; Standardization of a Solution and Redox Titration

Chapter 16 – Spontaneity, Entropy and Free Energy (1 week)

I. Spontaneous Processes, Entropy, and the Second Law of Thermodynamics

II. Temperature and Entropy

III. Chemical Reactions and Changes in Entropy and Free Energy

IV. Dependence of Free Energy on Pressure

V. Free Energy and Equilibrium

The student will:

- Determine the spontaneity of a reaction.
- Discuss the laws of thermodynamics.
- Apply the concepts of entropy and free energy qualitatively and quantitatively.
- Understand the relationship between free energy change and equilibrium constants.

Chapter 17 – Electrochemistry (2 weeks)

I. Galvanic Cells

II. Standard Reduction Potentials

III. Cell Potential, Electrical Work, and Free Energy

IV. Dependence of Cell Potential on Concentration

V. Electrolysis

The student will:

- Define electrochemical terms.
- Distinguish between a galvanic cell and an electrolytic cell and predict reaction products.
- Perform calculations using Faraday's Law and the Nernst equation.
- Understand the relationship between free energy change, the cell potential, and the equilibrium constant.

Laboratory – Determination of an Electrochemical Series

Course review and AP Exam preparation

Additional laboratory work, special topics, and field trips, as time permits

Text

Zumdahl, Steven and Zumdahl, Susan. *Chemistry*, 7th edition. Houghton Mifflin Company, 2007. ISBN 13: 978-0-618-52844-8

Additional Resources

Released AP exam multiple choice, free response questions, and equations. Lab handouts from a variety of sources including:

Vonderbrink, Sally Ann. *Laboratory Experiments for Advanced Placement Chemistry*, 2nd edition. Flinn Scientific, Inc., 2006.

Hostage, David and Fossett, Martin. *Laboratory Investigations: AP* Chemistry*. Peoples Education, 2006.

Requirements

Class meets for 45 minutes on Days 1 through 4. In addition, students will meet in the chemistry room for study hall. Class does not meet on Day 5. Laboratory work usually is performed on Day 6 in a double period (plus study hall) for 130 minutes.

Students keep a laboratory notebook. Formal laboratory reports are due within one week of completion of each lab. Specific requirements for lab reports will be described in class. It is important to keep the lab notebook and lab reports, as some colleges may request to inspect them before issuing course credit.

Students are expected to take the AP Chemistry Exam in May. Colleges may offer course credit and/or placement, depending on the score earned.

Grading

Laboratory work counts as 20 percent of the class grade. Homework and class participation count as 20 percent. Tests and quizzes constitute 60 percent of the total grade.

Signatures

Each student and his/her parent or guardian is to sign this sheet, acknowledging having read the course syllabus. Please return this page to Mrs. Collett. Additional copies of this syllabus will be posted on the Ridgeview Classical Schools website: www.ridgeviewclassical.com.

_____	_____
Student signature	Parent/guardian signature