RHINEBECK CENTRAL SCHOOL DISTRICT
PRIORITIZED CURRICULUM
AP CHEMISTRY SYLLABUS

COURSE OVERVIEW

Advanced Placement Chemistry is a first year college level course, with a substantial laboratory component. Students must complete written Laboratory reports and maintain a lab portfolio. All students are required to take the advanced placement examination as well as our final exam (Similar in nature to the AP). Students are required to be independent learners and team players. All are expected to make important contributions to class activities. They must invest a significant amount of time solving problem sets and preparing for classroom discussions. Very little class time is devoted to drill or "routine learning." I try to make the class as student centered as possible, but I do lecture on complex topics. Numerous relevant demonstrations are included to stimulate interest and discussion. We focus on challenging areas, especially those that integrate principles from multiple chapters. Group or team problem solving is employed to ensure active student participation. All of our laboratories are hands on. Depending on the lab, students work as individuals or a part of a group. Pre-labs consist of discussion and written Exercises. Students must demonstrate facility with lab equipment and techniques. Students must collect, organize, and communicate lab data and results. We discuss possible improvement or modifications to original procedures. Assessments include quizzes, tests, exams, lab portfolios, and class activities and projects.

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TEXTBOOK AND LAB SOURCES

TEXT: Chemistry, by Raymond Chang, 7th edition, 2002. (Approved)

LAB SOURCES

Flinn Scientific – Lab Manuals
Flinn Scientific – Lab Kits (A.P.)
CER: Modular Laboratory Program in Chemistry
SOTM (Science on the Move) – National Science Foundation Program
Inquiry lab project
Advanced Placement Chemistry Labs

Lab 1 Safety Lab (2 hours) Includes MSDS sheets, safety agreement, technique and handling of wastes.
Lab 2 Separating the Components of a Ternary Mixture (23 hours)
Lab 3 Introducing Volumetric Techniques by Analyzing Bleaching Solution (3 hours)
Lab 4 Determining the Empirical Formula of Copper Chloride (3 hours)
Lab 5 A Sequence of Reactions for Transforming Copper (4 hours)
Lab 6 Titrating a Hydrochloric Acid Solution with a Standard Solution of Sodium Hydroxide (2 hours)
Lab 7 Experimental Determination of Molar Volume and Comparing Equal Volumes of Different Gases (2 hours)
Lab 8 Finding the Ration of Moles of Reactants in a Chemical Reaction (12 hours)
Lab 9 Thermo-chemistry and Hess's Law (2 hours)
Lab 10 Bright Line Emission Spectra and Determining Wavelength (also flume tests) (1 – 2 hours)
Lab 11 Periodic Trends: Metals and Nonmetals (12 hours)
Lab 12 Molecular Geometry (12 hours)
Lab 13 Paper and Liquid Chromatography (2 hours)
Lab 14 Evaporation Rate and Molecular Structure (Intermolecular forces) (1 hour)
Lab 15 Molar Mass by Freezing Point Depression (2 hours)
Lab 16 Studying the Rate of Reaction of Potassium Permanganate and Oxalic Acid (23 hours)
Lab 17 Micro-scale – Kinetics of a Reaction (23 hours)
Lab 19 Studying the pH of Strong Acid, Weak Acid, Salt and Buffer Solutions (3 hours)
Lab 18 Equilibrium and LeChatelier's Principle (23 hours)
Lab 20 Determination of Ka of weak Acids (Flinn kit) (23 hours)
Lab 21 Determination of the Equilibrium Constant for the Formation of FeScnII (3 hours)
Lab 22 Separation and Qualitative Determination of Cations and Anions (Flinn kit)
Lab 23 An Activity Series (Flinn kit)
Lab 24 Electrochemical and Electrolytic Cells
Lab 25 Synthesis, Isolation, and Purification of an Ester
Lab 26 Polymer Reactions

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CHAPTER 1: CHEMISTRY-THE STUDY OF CHANGE

Topics	Objectives	Labs	Assignments	Timeline
▪ The study of Chemistry ▪ The Scientific Method ▪ Classifications of matter ▪ The three states of matter ▪ Physical and chemical properties of matter ▪ Measurement ▪ Handling numbers ▪ The Factor Label ▪ Method of solving problems	▪ Describe matter and its physical states ▪ Describe the four main parts of the scientific method ▪ Define chemistry ▪ Distinguish between elements, compounds, and solutions ▪ Distinguish between homogenous and heterogeneous mixtures ▪ Distinguish between physical and chemical properties of a substance ▪ Express base units and derived units of the SI ▪ Learn the prefixes used in the SI ▪ Distinguish between weight and mass ▪ Express numbers and perform calculations in exponential notation ▪ Determine the number of significant figures in a given number and in a number that is the result of a mathematical calculation ▪ Round off numbers to the desired digit	▪	▪	▪ Summer Review

* This material has already been covered in Course 1 Chemistry. Students need a brief review. Skills and knowledge are used throughout the year in class and lab. Assessment: chapter test.

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CHAPTER 2 – ATOMS, MOLECULES, AND IONS

Topics	Objectives	Labs	Assignments	Timeline
▪ The Atomic Theory ▪ The structure of the atom ▪ Atomic number, mass number and isotopes ▪ The Periodic Table ▪ Molecules and ions ▪ Chemical formulas ▪ Naming compounds	Students will: ▪ Name and describe the three subatomic particles of most importance to chemistry and give their location within the atom ▪ Write the symbol of an isotope having been given its mass number and element name ▪ Determine the number of protons, neutrons, and electrons in an atom given its isotopic symbol ▪ Define the terms molecule and ion ▪ Determine the numbers of protons and electrons in given monatomic cations and anions ▪ Learn the formulas of several polyatomic ions ▪ Distinguish between molecular and empirical formulas, and write empirical formulas when molecular formulas are given ▪ Write the formulas of inorganic compounds from their names ▪ Write the names of several types of inorganic compounds given their formulas	▪	▪	▪ 1 week

* Note: Much of this material has already been covered in Course I Chemistry. Our primary focus is laboratory work and checking problems sets. Assessments include chapter tests.

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CHAPTER 3 – MASS RELATIONSHIPS IN CHEMICAL REACTIONS

Topics	Objectives	Labs	Assignments	Timeline
▪ Atomic mass ▪ Molar mass of an element and Avogadro's number ▪ Molecular mass ▪ The mass spectrometer ▪ Percent composition of compounds ▪ Experimental determination of empirical formulas ▪ Chemical reactions and chemical equations ▪ Amounts of reactants and products ▪ Limiting reagents ▪ Reaction yield	Students will: ▪ Describe the atomic mass unit scale and the carbon 12 standard of the scale ▪ Determine the average atomic mass of an element given the masses and percent abundances of its isotopes ▪ Determine the molecular mass of a compound given its molecular formula ▪ Define the mole as a base unit of the SI ▪ Calculate the number of moles in a given amount of an element or a compound ▪ Calculate the number of atoms, molecules, or formula units in a given amount of a substance ▪ Determine the percent composition of a compound with a know formula ▪ Determine the empirical formula of a compound given the percent composition ▪ Determine a molecular formula when the molar mass is given ▪ Write mole ratios relating the amounts of reactants and products in a chemical reaction ▪ Calculate the mass of a substance that is produced or consumed in a chemical reaction given the mass of any other species involved in the reaction. ▪ Determine which reactant is the limiting reagent in a chemical reaction ▪ Calculate the percent yield of a product	▪	▪	▪ 1 week

*Note – Activities include student presentation of problem sets, team problem solving, laboratory activities, and graded assignments. Assessments are tests and lab reports.

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CHAPTER 4 – REACTIONS IN AQUEOUS SOLUTION

Topics	Objectives	Labs	Assignments	Timeline
▪ General properties of aqueous solutions ▪ Precipitation reactions ▪ Acid/base reactions ▪ Oxidation reduction reactions ▪ Concentration of solutions ▪ Gravimetric analysis ▪ Acid/base titrations ▪ Redox titrations	Students will: ▪ Define solute, solvent, and solution ▪ Distinguish between non-electrolytes, weak electrolytes, and strong electrolytes ▪ Write molecular, ionic, and net ionic equations for precipitation reactions ▪ Predict which product will precipitate when two electrolyte solutions are mixed ▪ Write equations that show the ionization of acids and bases in water ▪ Define acids and bases according to Bronsted's definition ▪ Describe monoprotic, diprotic, and triprotic acids ▪ Write molecular, ionic, and net ionic equations for neutralization reactions, define oxidation, reduction, half-reaction, oxidizing agent, and reducing agent0 ▪ Assign oxidation numbers to the atoms in molecules, simple ions, and polyatomic ions ▪ Define molarity and calculate the molarity of a solute in solution ▪ Determine the amount of a solute needed to prepare a solution of specific concentration ▪ Describe the steps involved in the dilution of a solution of known concentration, and calculate the concentration of the diluted solution ▪ Use the balanced chemical equation to predict the yield of a precipitate given information about the amounts of the reactants ▪ Use data about the mass of a precipitate to calculate the concentration of an unknown ▪ Calculate the amount of a base needed to neutralize a given amount of acid ▪ Use titration data to calculate the concentration of an unknown acid or base solution ▪ Use the results of Redox titration to calculate the concentration of an unknown solution	▪	▪	

*Note Students are given ample practice predicting products and writing balanced equations as a group activity on the chalkboard/wipe board. Assessments include graded assignments, quizzes, tests, and associated lab activities.

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CHAPTER 5 - GASES

Topics	Objectives	Labs	Assignments	Timeline
▪ Substances that exist as gases ▪ Pressure of a gas ▪ The Gas Laws ▪ The ideal gas equation ▪ Gas Stoichiometry ▪ Dalton's Law of Partial Pressures ▪ The Kinetic Molecular Theory of Gases ▪ Deviation from ideal behavior	Students will: ▪ List the properties that are characteristic of gases ▪ Interconvert pressure readings among the common units used to express pressure ▪ Calculate the pressure of a gas tapped in an open tube manometer ▪ State Boyle's, Charles's, and Avogadro's, laws and know what variables are held constant for each law ▪ Solve problems involving these laws ▪ Solve problems involving the combined gas law ▪ Solve problems using Dalton's law of partial pressures ▪ Apply the ideal gas equation to calculate one of its variables ▪ Determine the density of an ideal gas of know molecular mass ▪ Determine the molecular mass of an ideal gas of given density ▪ Calculate the volume of any gaseous reactant consumed or of any gaseous product generated in a chemical reaction, given the mass of any species involved in the reaction ▪ Describe the assumptions on which the kinetic molecular theory is based ▪ Calculate the root-mean-square speeds of given molecular gases ▪ List two molecular properties responsible for deviations from ideal as behavior and identify the conditions under which gases will be most likely to behave in a non-ideal manner ▪ Calculate the pressure of a real gas as predicted by the Vander Waals equation	▪	▪	1 week

***** Note Our Laboratory work such as collecting gases by water displacement, determining molar volume, and comparing equal volumes of different gases, molecular mass of a volatile liquid gives students an excellent opportunity to practice the content of this chapter. Assessments include graded problem sets, group problem solving, team building work sheets, lab reports, quizzes and chapter tests.

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CHAPTER 6 – THERMOCHEMISTRY

Topics	Objectives	Labs	Assignments	Timeline
▪	Students will: ▪ Understand and explain fundamental principles of thermodynamics including: energy conversions, heat flow, work, enthalpy and entropy. ▪ Sole a variety of calorimetry problems ▪ Distinguish between constant pressure and constant volume calorimetry ▪ Recognize state functions ▪ Explain Hess's Law and use it to calculate enthalpy changes ▪ Define standard molar heat of formation and use in problem solving ▪ Be able to graphically analyze data, calculate the heat capacity of a calorimeter, determine enthalpies of reactions, combine equations and enthalpies algebraically	▪	▪	1.5 weeks

* Note I - consider this to be an extremely important chapter because of its connections to challenging material covered in future chapters. Activities include lecture, demonstrations, problem solving, and team problem solving and student presentations. Assessments include in-class discussions, graded assignments, quizzes, tests, and lab reports.

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CHAPTER 7, 8, AND 23 – ATOMIC AND NUCLEAR STRUCTURE UNIT

Chapter 7-Quantum Theory and the Electronic Structure of Atoms
Chapter 8-Periodic Relationships among the Elements
Chapter 23-Nuclear Chemistry

Topics	Objectives	Labs	Assignments	Timeline
▪	Students will: ▪ Explain how models of the atom have changed with new thinking and scientific discoveries ▪ In addition to our regular text work, students will interpret demonstrations, carry out short and full length experiments, and summarize selected reading to reinforce their knowledge ▪ Be required to master and utilize fundamentals of atomic structure, electron configurations, orbital notation, and effective nuclear charge ▪ Students will write essays relating these characteristics to similarities and variations in the properties of elements ▪ Make predictions based on position of element in the periodic table ▪ Perform lab activities and explain results which show trends in chemical behavior ▪ Perform flame tests and determine the wave length of lines within the visible spectrum of certain elements ▪ Solve problems involving quantum numbers and energy changes associated with electron transitions ▪ Describe natural and man induced radioactive changes ▪ Calculate nuclear mass defect and binding energy ▪ Solve half-life problems ▪ Compare the benefits and problems associated with nuclear technology	▪	▪	2 weeks

* Note – Assessments include graded assignments, quizzes, tests, and lab reports.

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CHAPTER 9 – CHEMICAL BONDING I: BASIC CONCEPTS

Topics	Objectives	Labs	Assignments	Timeline
▪	Students will: ▪ Explain ionic, polar, and non-polar covalent bonding ▪ Use fundamental knowledge of atomic structure, bonding and thermo-chemistry to calculate lattice energies ▪ Be able to draw and select appropriate Lewis Structures for molecules or ions ▪ Draw resonance structures ▪ Use bond energies to estimate heats of reaction ▪ Use periodic trends to predict bond type	▪	▪	1 week

*Note: Assessments include graded assignments, quizzes, tests, and lab reports

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CHAPTER 10 – CHEMICAL BONDING II MOLECULAR GEOMETRY AND HYBRIDIZATION OF ATOMIC ORBITALS

Topics	Objectives	Labs	Assignments	Timeline
▪	Students will: ▪ Use the VSEPR Model to predict molecular geometries ▪ Explain trends in dipole moments ▪ Give appropriate hybrid orbitals ▪ Explain and apply molecular orbital theory and delocalized molecular orbitals	▪		12 weeks

*Note: Assessments include graded assignments, quizzes, tests, and lab reports.

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CHAPTER 11 – INTERMOLECULAR FORCES OF LIQUIDS AND SOLIDS

Topics	Objectives	Labs	Assignments	Timeline
▪	Students will: ▪ Use KMT to describe and explain the behaviors of liquids and solids ▪ Describe the various types of intermolecular forces, and explain how they affect the physical properties of liquids, solids, and gases. ▪ Describe and explain key properties of liquids ▪ Solve problems related to crystal structure and x-ray diffraction ▪ Know the properties of different types of crystals ▪ Understand and calculate energy changes associated with phase changes ▪ Use heating curves and phase diagrams to make predictions	▪	▪	2 weeks

*Note: Assessments include graded assignment, quizzes, tests and lab reports.

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CHAPTER 12 – PHYSICAL PROPERTIES OF SOLUTIONS

Topics	Objectives	Labs	Assignments	Timeline
▪	Students will: ▪ Give a molecular view of the solution process ▪ Explain variations in solubility based on structure, temperature, and pressure ▪ Describe, explain, and utilize colligative properties including vapor pressure lowering, boiling point elevation, freezing point depression, and osmotic pressure ▪ Do important calculations associated with colligative properties ▪ Experimentally determine the freezing point, the molal freezing point constant, and the molar mass of an unknown	▪		2 weeks

*Note Assessments include graded assignment, quizzes, tests and lab reports.

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CHAPTER 13 – CHEMICAL KINETICS

Topics	Objectives	Labs	Assignments	Timeline
▪	Students will: ▪ Give factors that can affect the rates of reaction ▪ Describe how reaction rates are measured and graphed ▪ Distinguish between average and instantaneous rates. ▪ Use the method of initial rates to determine the rate law, determine the order of reaction, and calculate the rate constant with appropriate units ▪ Use integrated rate laws to solve problems and determine half-life ▪ Summarize zero, first, and second order reactions with regards to the plot needed to give a straight line, integrated rate law, relationship of the rate constant to the slope of the straight line, and half-life ▪ Determine possible reaction mechanisms ▪ Use the Arrhenius equation to determine activation energies ▪ Explain the role of catalysts	▪	▪	2 weeks

*Note Assessments include graded assignments, quizzes, tests, and lab reports.

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CHAPTER 14 – CHEMICAL EQUILIBRIUM

Topics	Objectives	Labs	Assignments	Timeline
▪	Students will: ▪ Describe the dynamic nature of physical and chemical equilibria ▪ Write appropriate equilibrium expressions ▪ Contrast Q and K valves ▪ Predict the direction to establish equilibrium ▪ Write and manipulate equilibrium expressions ▪ Convert between Kp and Kc ▪ Develop reaction tables and solve equilibrium problems from simple to complex ▪ Explain the relationship between the equilibrium position and the magnitude of the equilibrium constant ▪ Use LeChatelier's principle to predict the effect of stresses on the equilibrium system ▪ Recognize that catalysts affect rates, but do not alter the equilibrium position or constant ▪ Know that equilibrium constants are temperature dependent	▪	▪	2 weeks

*Note Assessments include graded assignments, quizzes, tests, and lab reports.

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CHAPTER 15 – ACIDS AND BASES

Topics	Objectives	Labs	Assignments	Timeline
▪	Students will: ▪ Apply Arrhenius, Bronsted-Lowry, and Lewis Theory to various reactions involving acids and bases ▪ Describe amphoteric substances ▪ Use Ka and Kb valve to predict the relative strengths of conjugates and their impact on pH ▪ Explain neutralization and hydrolysis ▪ Define and use in calculations: Kw, Ka, Kb, pH, and PoH ▪ Use Ka and Kb to determine pH and the concentrations of ions for weak acids, polyprotic acids, and weak bases ▪ Recognize the molecular structure of acids and bases and how it affects their strength ▪ Explain hydrolysis and do pH calculations ▪ Give the reactions of acidic and basic anhydrides	▪	▪	1 week

*Note Assessments include graded assignments, quizzes, tests, and lab reports.

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CHAPTER 16 – ACID-BASE EQUILIBRIA AND SOLUBILITY EQUILIBRIA

Topics	Objectives	Labs	Assignments	Timeline
▪ In this critical chapter our primary focus is solving challenging equilibrium problems. ▪ In addition to regular text homework, we devote significant time to solving new problems in a collaborative fashion. Students are required to present problems to the class and the results of our labs are shared and discussed. We do extensive lab work related to all important aspects of this chapter. ▪ NOTE: Because of the difficulty and importance of this chapter, we take as much time as possible to promote in-depth knowledge and student's ability to deal with new situations.	Students will: ▪ Explain and save problems involving: the common ion effect, buffers, buffering capacity, various types of titrations, construct titration curves, indicator selection, solubility equilibria, complex ion equilibria, pH and solubility, and qualitative analysis	▪	▪	3 weeks

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CHAPTER 17 – CHEMISTRY IN THE ATMOSPHERE

Topics	Objectives	Labs	Assignments	Timeline
This chapter is handled primarily as independent reading and students are required to present a brief report on a significant and related environmental issue such as acid rain or mercury contamination. We also use relevant chemical changes to reinforce student knowledge of reactions and equation writing, especially reactions involving carbon compounds, oxides, carbonates, and allotropes of oxygen.	Students will: ▪ Describe the composition of the atmosphere and critical cycles such as nitrogen and carbon ▪ Give specific ways in which man impacts the environment and write specific equations involved in these changes	▪	▪	Independent Study

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CHAPTER 18 – ENTROPY, FREE ENERGY, AND EQUILIBRIUM

Topics	Objectives	Labs	Assignments	Timeline
We focus on mastering fundamentals and integration with other areas such as equilibrium and electrochemistry. Topics included in this chapter are: the three laws of thermodynamics, spontaneous processes and entropy, Gibbs free energy equation, predicting entropy changes and reaction spontaneity, calculation of free energy changes, effect of temperature and free energy and chemical equilibrium, understand the relationship between free energy, work and efficiency	Students will: ▪ Participate in significant in-class discussion time ▪ Emphasis on relationships with other areas equilibrium and electrochemistry ▪ Calculate changes in enthalpy, entropy, and free energy ▪ Use thermodynamic data to calculate K at various temperatures ▪ State the relationship between the change in standard free energy and the equilibrium constant for a given reaction	▪	▪	2 weeks

*Note – Assessments include graded assignments, quizzes, tests, and lab reports.

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CHAPTER 19 - ELECTROCHEMISTRY

Topics	Objectives	Labs	Assignments	Timeline
▪ Galvanic (electrochemical) cells ▪ Calculation of standard and non-standard cell potentials, ▪ Nernst Equation ▪ Relating work ▪ Free energy ▪ Cell potential and equilibrium ▪ Concentration cells ▪ Electrolysis ▪ Electroplating	Students will: ▪ Do lab work to produce an activity series and discuss and compare their results to text activity series and standard electrode potentials ▪ Construct electrochemical cells under close to standard and non-standard conditions (different concentrations) and compare their results to predicted values ▪ Run electrolysis such as decomposition of H_2O and electroplating of metals, predict amount of products and compare to their experimental results ▪ Perform interesting and relevant demonstrations ▪ Balance redox reactions (team competition) on wipe board, predict amount of product during electrolysis, compute cell voltages, apply Nernst Equation, diagram and label cells, know the relationship between work, free energy change, cell potential and the equilibrium constant	▪	▪	1-2 weeks

*Note: Assessments include graded assignments, quizzes, tests and lab reports.

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UNIT ORGANIC CHEMISTRY

Chapter 24 - Organic Chemistry

Chapter 25 - Synthetic and Natural Organic Polymers

Topics	Objectives	Labs	Assignments	Timeline
▪ Nature and characteristics of organic compounds ▪ Aliphatic and aromatic hydrocarbons ▪ Chemistry of functional groups (organic reactions) ▪ Natural and synthetic polymers Much of fundamental organic chemistry was covered in Course I Chemistry. We review fundamentals and focus on reactions with emphasis on polymerization. Demonstrations and lab work builds student interest and promotes understanding of synthetic organic chemistry.	Students will: ▪ Recognize, classify, and name organic compounds ▪ Synthesize organic products in lab ▪ Draw structural formulas representing organic reactions including: - Substitution - Addition - Esterification - Saponification - Polymerization	▪	▪	