Advanced Placement Chemistry

Course Audit

General Course Information:

The AP chemistry class meets on a rotating 5-day schedule. All periods are 90 minutes, meeting 3 days out of five. The school follows a Physics first program. The AP Chemistry Course is available to sophomores, juniors, and seniors. The pre- requisites for sophomores being grade higher than 90% in Physics class and for juniors and seniors having already taken a year of chemistry (either Regular or Honors) and securing at least a grade higher than 85%.

Text Book:

Brown, LeMay, Burstein: Chemistry, The Central Science (AP Edition)
Prentice Hall (10th Edition)

Summer Assignment:

All the students enrolled in AP Chemistry Course are required to complete a with a summer assignment. This assignment is collected on the first day of the academic year. The summer assignment is an overview of basic chemistry topics. Students are expected to learn commonly used mono-, di-, and poly atomic ions. The assignment is posted on the school web site for the convenience of students, who register into the program during summer with a listing of chemistry websites to assist them as they complete the summer assignment.

Tests:

Regular assessment is given after lab work and instruction is completed on a topic. The test consists of 25-30 multiple choices and 4-5 free response questions. Formula sheet, periodic table and constant values are provided for the open ended part of the test, using the format from AP test. In addition, students are regularly quizzed on predicting chemical reactions. Grading rubrics meet or exceed the required standards set by the College Board exam. Students complete a practice AP assessment modeled after the AP chemistry tests for midterm and final exam.

Labs:

Each student maintains a lab note book. Most of the labs reports are formal. Most of the labs are hands-on, certain labs are virtual simulations used from online sources. Each lab requires collection of data, observations, analysis, and conclusions. All labs require 90 min. (double period). There are at least 16 standard labs for the year. Students work collaboratively in the lab and most often complete lab work in pairs. Each student submits individual formal report.

Hands-on activities:

Students present observations and conclusions to their peers based on the data and their conclusions for most hands-on activities. These presentations are followed by class discussions, where students are able to defend their data and conclusions while their classmates offer supportive and constructive feedback on the material presented.

Instructional Materials:

Students are provided with instructional materials consisting of class notes, problems, and sample chemical equations. Students also receive additional reading related the topic discussed in class. Problem- solving strategies are practiced in class and required as students complete homework assignments. Problems are assigned as homework. Students work is evaluated using the criteria for showing adequate supporting work, units, and significant figures as described by the AP chemistry course standards.

Grading Policy:

Grades are based on tests (60%), labs (20%), and homework (20%).

Review for AP:

Students are provided with review materials for the AP exam. Materials consist of practice multiple- choice and open ended sample questions. Strategies to help students clearly communicate their understanding of a concept are discussed and practiced.

Course Description:

Week 1 Review summer assignment

Summer assignment packet consists of reading material and problems on basic chemistry topics. summer assignment packet consists of general chemistry questions related to matter, states of matter, basic physical science vocabulary, naming and representing elements using chemical symbols, dimensional analysis problems based on simple unit conversions, significant figures, differences between atoms and ions, list of Polyatomic ions, names of common acids and bases, empirical formula, percentage composition.

Activity 1: To identify and understand the purpose of different lab equipment and lab instruments.

Activity 2: Discuss guidelines for lab safety, demonstrate the hazardous nature of common acidic, basic reagents used in labs. Reacting the reagents with different types of clothing materials and egg protein.

Lab: Reaction in a Zip-Lock bag. Students verify the law of conservation of mass. In the second part of the experiment students will observe reaction of some compounds. Students will write and balance the reactions. (Acid/base, exo/endo). Students will check pH of the solutions.
(Chemicals used Sodium bicarbonate, Calcium Chloride, Phenol-red indicator,

Distilled water)

Week 2 Types of Reactions, Oxidation-Reduction reactions, Separation techniques.

Define common types of inorganic reactions: combination, decomposition, single replacement, double replacement reactions.
Define Oxidation, Reduction. Calculate oxidation number.
Understand separation methods like filtration, distillation, and chromatography.

Activity 1: Observe the Redox reaction, Iron nail is immersed in a solution of Copper(II)Sulfate.

Activity 2: Separation of Ink- dye using paper chromatography.

Activity 3: Types of precipitation reactions (silver nitrate, sodium chloride, Potassium bromide, barium chloride, Magnesium sulfate)

Lab: Gravimetric analysis of a chloride salt. (Unknown chloride sample, 0.5 M silver nitrate, 6.0M nitric acid, Acetone, distilled water)

Week 3 & 4 Atoms, Molecules, Ions, Chemical formulas, mass relationships

Part A Atomic theory, Intro to atomic theory: Cathode rays, Electrons, Protons, Neutrons, isotopes, isobars, isotones, Relative abundance of isotopes, calculation of average atomic mass

Lab: Isotopes of "Pennium". In this lab activity students determine the relative abundance of the isotopes of an imaginary element called "Pennium" using different masses of pennies. (Pre and post 1982 pennies)

Part B Atomic mass, Molecular mass, Avogadro's number, Percent composition, Empirical formula, Limiting reagent and percent yield.

Activity: Limiting Reagent - The reaction between Vinegar and baking soda.

Lab: Limiting reagent: Percent yield of copper in the reaction between copper (II) sulfate.

Lab: Hydrate**:** To determine the formula of the hydrate alum salts like $AlK(SO_4) . 12 H_2O$.

Week 5 **Electronic Structure of Atoms and Quantum Theory**

Wave nature of light, Quantized energy and photons, Photoelectric effect, Line spectra , Bohr's model, energy states of the hydrogen atom, Uncertainty principle, Quantum numbers, Orbitals, representation of Orbitals, Hund's rule, Pauli's exclusion principle, Aufbau's principle, Electronic configuration.

Activity: Spectral analysis of fluorescent lights (Sodium, Argon, Hydrogen, oxygen, Neon, Helium)

Lab: Flame test (using nichrome wire, 0.1 M solutions of barium nitrate, copper nitrate, strontium nitrate, copper nitrate, potassium nitrate, calcium nitrate, sodium chloride, lithium nitrate.

Lab: Online virtual simulation "photoelectric effect lab".

Week 6 **Periodic Classification of Elements**

Earlier development of periodic table (Dobernier triad, Mendeleev's periodic law) Modern periodic law, General arrangement of elements based on electronic classification, Classification of metals, non-metals, transition, inner transition , Calculation of effective nuclear charge, Study of trends (Atomic radius, Ionization energy, Electro negativity, metallic character, electron affinity).

Activity: Reactivity of alkali and alkaline metals with water.
(lithium, sodium, potassium, calcium, magnesium)

Lab: Plot periodic trends for the first 40 elements and analyze the data. Atomic number (Ionization potential / electron affinity / atomic radius / metallic).

Week 7 & 8 **Basic concepts on chemical bonding & Molecular geometry.**

Part A Chemical bonds, types of bonds-ionic, covalent, coordinate covalent, polar, non-polar, drawing Lewis dot models, calculate formal charge, resonance forms, exceptions to octet rule, strength of covalent bonds-bond length, bond energies, bond angles)

Part B Molecular shape, VSEPR model, molecule shape and molecular polarity, atomic orbital model, hybrid orbital, multiple bonds (delocalization), molecular orbital theory.

Activity: Use Ball-Stick model to predict the shape of given molecule.

Lab: Determine formula of lead iodide. (25 ml, 0.1M each sodium iodide and lead

nitrate solutions)

Week 9 Gases

Characteristics of Gases, Kinetic molecular theory, Measurable variables of gases, pressure, temperature, volume, amount of gas, Gas laws- Boyle's , Charles, Dalton, Avagodro's , Gay-Lussac, Graham's law of effusion) , Combined gas equation, Ideal gas law, Ideal gas behavior)

Lab: To calculate the 'R' (universal gas constant) value using reaction between zinc and hydrochloric acid.

Week 10 Thermo chemistry

The first law of thermodynamics, Internal energy, relating internal energy to work and heat, Endothermic and Exothermic reactions, Enthalpy, Heats of formation, Calorimeter, Hess law.

Activity: Determining Heat capacity of a lead sinker.
Online applet lab related to heat capacity.

Lab: Determine the heat caloric content in potato chip.

Week 11 & 12 Intermolecular forces, Solids & Liquids

Intermolecular forces (ion-dipole, dipole-dipole, london dispersion, hydrogen bonding, comparing the intermolecular forces, properties of liquids viscosity, surface tension, phase changes, triple point, critical point, structures of solids crystalline, amorphous, bonding in solids molecular solids, covalent- network solids, ionic solids, metallic solids.

Activity: How many drops can pile on a Penny?

(Micropipet, 10 ml of liquid detergent solution, 10 ml of saturated sodium chloride solution, 10 ml of saturated sodium carbonate solution, tap water)

Week 13 & 14 Properties of Solutions

Types of solutions, Factors affecting solubility, nature of solute- solvent, temperature, pressure, surface area, Concentration methods (Mass %, ppm, ppb, mole fraction, molarity, molality, normality), conversion of concentration units, colligative properties(lowering the vapor pressure, boiling point elevation, freezing point depression, osmosis, determination of molar mass).

Lab: Depression in freezing points of different solutions**.(** 0.1 M sodium chloride

solution, Magnesium chloride, Aluminum Chloride, Sugar solution)

Week 15 & 16 Chemical Kinetics

Factors that effect reaction rates, reaction rates, concentration and rates, rate law, units of rate law, using initial rates to determine rate laws, first order, second order, half-life, temperature and rate, collision model, orientation factor, activation energy, Arrhenius equation, determining the activation energy, Reaction mechanisms, multiple steps, rate laws, rate-determining steps, catalysis.

Lab: Determine the rate of reaction and its order.
(0.2 M KI, 0.4 M $Na_2S_2O_3$ (freshly prepared), 1% starch solution boiled, 0.2 M KNO_3)

Week 17 & 18 Chemical Equilibrium

The concept of equilibrium, equilibrium constant, magnitude of equilibrium constants, direction of equilibrium position, heterogeneous equilibrium, calculating equilibrium constants, application of equilibrium constants, Le- Chatelier principle, changes in reactant or product, effects of volume and pressure changes, effect of temperature changes, the effect of catalysis.

Lab: Le Chatelier's principle – To study the effects of concentration and temperature on equilibrium positions.

(0.1 M solutions of Copper(II) sulfate, Nickel(II)chloride, Cobalt(II)chloride, Potassium chloride, Sodium Carbonate, 1.0M HCl, 0.1M HCl, 6M HNO_3, 0.01 M silver nitrate).

Week 19, 20 Acids and Bases

Part A: Definition of acids & bases (Arrhenius, Bronsted- Lowry, Lewis acids-base), conjugate acid-base , pH, auto ionization of water, relative strengths of acids and bases, pH scale, calculating weak dissociation acid and bases constants (k_a) , (k_b) polyprotic acids, relationship between K_a, K_b. acid-base properties of salt solution, factors that affect acid strength.

Part B: Buffer solutions, Buffer capacity, composition and action of buffered solutions, calculating the pH of a buffer, addition of strong acids or base to buffers, strong acid-strong base titrations, weak acid- strong base titrations, titrations of polyprotic acids, solubility product, and common ion effect, indicators, types of indicators, working principle of an indicator.

Lab: Titrations (Acid-base) strong acid, strong base.

Lab: Hydrolysis of salts and pH of buffer solutions(0.1M solutions of sodium acetate, zinc chloride, ammonium chloride, sodium carbonate, sodium chloride, 6.0 M acetic acid, 6.0 M sodium hydroxide, indicators- methyl orange, methyl red, bromomethyl blue, phenolphthalein, phenol red, standard buffer solution (pH 4.5).

Lab: Titration/ redox: Potassium permanganate and Iron (III) chloride

Week 21 Chemical Thermodynamics

System, surrounding, isothermal, adiabatic, closed system, isolated system, spontaneous processes, entropy and second law of thermodynamics (S), 3rd law of thermodynamics, entropy changes in the surrounding, Gibbs free energy, free energy and temperature.

Week 22 & 23 Electrochemistry

Balancing half-reactions using oxidation-reduction**,** Electrochemical cells, voltaic cells, cell EMF under standard conditions, Free energy and Redox reactions, EMF and Free energy, cell EMF under nonstandard condition, Nernst equation, Electrolysis, Faradays first law.

Lab: Study of constant electrochemical cells using copper, iron, lead, zinc, magnesium electrodes) and salt solutions.

Week 24 Nuclear Chemistry

Factors affecting nuclear stability, mass defect, binding energy, n/p ratio, radioactivity, types of decays (alpha, beta, gamma, positron, electron capture), fission, fusion, half-life, uses of isotopes, biological effects of radiation.

Lab: Find half-life of an isotope of an imaginary element "pennium" using pennies.

Week 25 Organic Chemistry

Functional groups, naming of organic hydrocarbons, isomerism (chain, positional, functional, cis-trans geometrical, optical isomers), types of reactions (substitution, addition, combustion, esterification, saponification, polymerization)

Lab: Synthesis of Esters.