

ADVANCED PLACEMENT CHEMISTRY SYLLABUS

AP Chemistry 2 (1332)

AP Chemistry is the equivalent of a full year 6-8 hour college chemistry lecture and laboratory course. This is a very intense, fast-paced course. Curriculum is set by the National College Board with required topics and lab to be completed. Laboratory notebooks are a requirement. Graphing calculators are a necessity. Registration in this course implies commitment to take the national AP Chemistry exam given by the College Board in May and to pay a portion of the exam fee. A summer assignment will be required by teacher and also due to the time requirement set by the College Board for advanced placement sciences, there will be an additional 50 minute class 2 times a week, which will be set by the course instructor.

Prerequisite: Biology 1 (Pre AP level is highly recommended.) and Chemistry 1 (Pre AP level is highly recommended) and Algebra 2 credit, Physic credit or concurrent enrollment.

Class meets 50 minutes, Monday-Friday, and outside of the school day 50 minutes twice a week as labs require more time.

Lab notebook:

Lab reports are a very important part of this class. This class requires a lab notebook which can be purchased the first day of school. The lab notebook will have carbon copy pages which will be turned in to the teacher, the originals are kept by the student for review by college professors.

Each lab will consist of the following:

- A. Pre-lab- which will include the purpose, rewriting the procedure, any required reading, answering pre-lab questions, and writing all data tables. The pre-lab will be turned in before the student is allowed to perform the lab
- B. During the lab all data will be collected directly in the lab book.
- C. Post lab- all calculations and graphs will be completed in this section. There will also be a conclusion which will discuss the theory of the lab, the purpose for doing the experiment, what the calculations show, why the experiment worked or didn't work, and any sources of error that may have made results less accurate. Any post lab questions must be answered after the conclusion. The carbon copy of the post lab will be turned in no more than 1 week after the lab is completed.

RESOURCES:

Chemistry, Zumdahl, fifth edition, Steven S. Zumdahl, Susan A. Zumdahl

Chemistry and Chemical Reactivity, 2nd edition, Kotz and Purcell

Laboratory Experiments for Advanced Placement Chemistry, Sally Ann Vonderbrink

Chemistry with Calculators, Holmquist, Randall, Volz Vernier Lab Pros

Various labs collected throughout the past from multiple sources as single handouts.

Teaching Reaction Predictions (Equation writing guide) Kristen Jones

Ultimate Chemical Equations Handbook, George Hague and Jane Smith

The Best Test Preparation for the Advanced Placement Examination, Research and Educational Association

AP Chemistry, Multiple Choice Questions in Preparation for the AP Chemistry Exam

AP Released Exams (College Board)

May of prior year

CHAPTER 1, 2 AND 3 ARE ASSIGNED AS SUMMER REQUIRED READING AND PROBLEM SETS ARE GIVEN WITH THE READING MATERIAL. ALL PROBLEM SETS ARE DUE 3RD DAY OF SCHOOL. KOTZ PURCELL BOOK GIVEN TO STUDENT AND ASSIGNMENTS ARE FROM PROBLEM SET FROM KOTZ

(16 DAYS FOR REVIEW OF, QUIZZING OF AND TESTING OF FOR CHAPTERS 1, 2 AND 3)

IN CLASS REVIEW OF SUMMER ASSIGNMENT COVERS THE FOLLOWING FOR CHAPTERS 1, 2, 3 FROM ZUMDAHL

CHEMICAL FOUNDATIONS CHAPTER 1 (ASSIGNED SUMMER READING AND PROBLEM SETS)

- I. Dimensional analysis
- II. Significant figures
- III. Density

ASSESSMENT: QUIZ

LABORATORY INVESTIGATION

DENSITY LAB

(Students find density of organic liquids and identify an unknown)

ATOMS, MOLECULES, AND IONS CHAPTER 2 (ASSIGNED READING AND PROBLEMS SET DURING SUMMER)

- I. Conservation of mass, law of definite proportions and law of multiple

- Proportions.
- II. Dalton's atomic theory
- III. Atomic masses, Avogadro's hypothesis
- IV. Early atomic investigations
 - a. J. J. Thomson
 - b. Milliken
 - c. Rutherford
 - d. Becquerel
- V. Modern atomic structure
- VI. Molecules and ions
- VII. Intro to periodic table
- VIII. Formula writing and naming (**summer packet on this due**)
 - a. Ionic
 - b. Covalent
 - c. Acids

ASSESSMENTS: Quiz on polyatomics
 Quiz on formula writing and naming
 Quiz on atomic structure

- LABORATORY a. Determination of empirical formula of silver oxide
- b. Plate of silver mirror and calculations

(Students use measurement and calculations to determine thickness of silver plating on a mirror and eventually calculate the diameter of an atom)

STOICHIOMETRY CHAPTER 3 (ASSIGNED DURING SUMMER, ONLY A REVIEW)

- I. Atomic Masses (average atomic mass calculations)
- II. Mole
 - a. Carbon 12 definition, Avogadro's number
 - b. Molar mass calculation
 - c. Mass-mole-atom calculations
- III. % composition-mass percent calculations
- IV. Determination of formula for a compound
 - a. Empirical
 - b. Molecular

ASSESSMENT: QUIZ

- V. Chemical Equations
 - a. Reactants vs. product
 - b. States of matter in reactions
 - c. Relationships of reactants to products
 - d. Balancing chemical equations
- V Stoichiometry
 - a. Mole ratios

- b. Mass to mass calculations
- c. Stoichiometrical quantities
- d. Limiting reactants
- e. % yield

ASSESSMENT: QUIZ

ASSESSMENT: CHAPTER 1, 2 AND 3 TEST

LABORATORY INVESTIGATIONS

- a. It's a gas – student designed laboratory to fill a plastic bag without bursting – stoich, limiting reagent, and gas law
- b. % hydration of MgSO_4
- c. % composition of post 82 penny
- d. Gravimetric analysis of a metal carbonate
(Students use gravimetric analysis to determine an unknown group 1 metal)

TYPES OF CHEMICAL REACTION AND SOLUTION STOICHIOMETRY CHAPTER 4 (11 DAYS)

- I. Universal solvent water – polarity of water, nature of hydration, aqueous solutions
- II. Aqueous solutions
 - a. Electrolytes vs. non electrolytes
 - b. Strong vs. weak in ionic compounds
 - c. Solubilities
 - d. Strong acids vs. weak acids
 - e. Strong bases vs. weak bases
- III. Solutions
 - a. Molarity
 - b. Dilutions
 - c. Molarity conversions
 - d. Preparation of solutions
 - e. Stoichiometry through molarity

ASSESSMENT: QUIZ

- IV. Precipitation rxns and predicting precipitates
- V. Oxidation reduction reactions
 - a. Oxidation states
 - b. Assigning oxidation numbers
 - c. Balance of electrons (transport)
 - d. Balancing oxidation reduction reactions in acidic and basic solutions
- VI. Single replacement reactions and activity series related to reduction Potentials

- VII. Acid base reactions
 - a. Arrhenius, Bronsted, Lewis definitions
 - b. Neutralization rxn
 - c. Titrations
 - d. Polyprotic acids and Multiple ions of OH⁻
- VIII. Molecular, Ionic and Net Ionic equations , spectator ions
- IX. Demo – conductivity of non, weak and strong electrolytes using electrical circuit with light bulb and conductivity probes
 - Demo - K, Na, Li and H₂O single replacement
 - Demo – Production of H₂ gas Zn and HCl
 - Demo - Lead nitrate and KI precipitate

ASSESSMENT: QUIZ

ASSESSMENT: CHAPTER TEST

LABORATORY INVESTIGATIONS

- a. Titration of acid using standardized NaOH solution by KHP
- b. Determination of Molarity of CuCl₂ solution using dryer duct aluminum
- c. Lab- determining the molar ratio of reactants by measuring temp
- d. Finding ratio of moles of reactants in a chemical rxn.
(Students use method of continuous variations to determine mole ratios of 2 reactants)

WRITING NET IONIC AND PREDICTING REACTIONS (11 DAYS) SUPPLEMENTAL WORK PACKAGE

- I. Net ionic, spectator ions and states(gases, aqueous and solids)
 - II. Single replacement
 - III. Double replacement
- ASSESSMENT QUIZ
- IV. Redox
 - V. Anhydrides
 - VI. Complex ions
 - VII. Combustions
 - VIII. Acid base
 - IX. Decomposition
 - X. Synthesis

ASSESSMENT QUIZ

ASSESSMENT PRACTICE TESTS (2)

ASSESSMENT UNIT TEST

LABORATORY INVESTIGATION

- a. Predicting reactions net ionic
- b. Separation & Qualitative determination of Cations & Anions
(Students will analyze a solution of 6 cations & any combination of 6 anions.
Students will use “known” solutions to develop techniques to find unknowns)

GASES CHAPTER 5 (8 DAYS)

- I. Kinetic theory of gases and ideal gases, Pressure, barometer
- II. STP
- III. Boyles, Charles, Avogadro's, Gay-Lussac laws
- IV. Combined gas law
- V. Ideal gas law inclusion of following
 - a. Molar mass
 - b. Density
 - c. General

ASSESSMENT QUIZ

- VI. Temperature and Kinetic energy
- VII. Root means square velocity
- VIII. Diffusion and Effusion
- IX. Van der Waal's equation and relevance of a and b corrections - deviation of ideal gas law at low T, high P and high N
- X. Dalton's law of partial pressures

ASSESSMENT: QUIZ

ASSESSMENT: TEST

LABORATORY INVESTIGATIONS

- a. Boyles law (CBL)
- b. Molar volume of a gas (Mg + HCl)
- c. Determination of molar mass of volatile liquids
(Liquids are volatized and condensed in a fixed volume. Condensed liquid is masses and the molar mass is experimentally determined.)

THERMOCHEMISTRY CHAPTER 6 (8 DAYS)

- I. Energy of system vs. surroundings
- II. Calculation of energy changes through heat transfer and work
- III. Calories, Joules, pressure volume work, heats of fusion, vaporization
- IV. Heat transfer at constant pressure vs. constant volume
- V. State functions
- VI. Specific heat, heat capacity, molar heat capacity, molar heats of combustion
- VII. Calorimetry – constant volume and pressure calorimetry

ASSESSMENT: QUIZ

- VIII. Enthalpy
 - a. Hess's law
 - b. Heats of formation (standard state)
 - c. Stoichiometry in heat problems
- IX. IX.. Heat of reactions problem solving from heats of formations
Demo – Thermite reaction

ASSESSMENT: QUIZ

ASSESSMENT: CHAPTER TEST

LABORATORY INVESTIGATIONS

- a. Determination of specific heats of metals (calorimetry)
- b. Hess's Law (Heat of formation of MgO)
- c. Determination of molar mass by freezing point depression

KINETICS CHAPTER 12 (10 DAYS)

- I. Rates (definition by differentials)
- II. Rates vs. spontaneity (Gibbs Free Energy)
- III. Factors that change rates (Temp, concentration, catalysts)
- IV. Initial rates through experiments, general rate law (differential rate law)
 - a. Determining orders through inspection
 - b. Determining order by ratio method and Logarithms
 - c. Rate constant and unit determination

ASSESSMENT: QUIZ

- V. Integrated rate laws
 - a. Derivation of 0, 1st and 2nd order
 - b. Graphing – paper, calculator, excel – solving for slope and linear regressions. Determining order through graphing
 - c. Half lives
 - d. Problem solving for T, A and A₀
- VI. Mechanisms or reactions
 - a. Rate determining steps
 - b. General rate laws determination using slow steps
 - c. Molecularity
- VII. Activation Energy and the Arrhenius Equation
 - a. Determination of rate constant change with temperature change
 - b. Activation energy determination
 - c. Energy graphs of reactants, products and activation energies

ASSESSMENT: QUIZ

ASSESSMENT: CHAPTER TEST

LABORATORY INVESTIGATIONS

- a. Crystal Violet rate determination (CBL Lab calorimeter)
- b. Thiosulfate in acid (graph paper determination)

THERMODYNAMICS CHAPTER 16 (9 days)

- I. 1st law of thermodynamics – E of universe constant
- II. 2nd law of thermodynamics
 - a. Spontaneous reactions increase entropy of universe

- b. Definition of entropy
 - 1. Nature spontaneously proceeds to higher entropy
 - 2. $S_{\text{univ}} = S_{\text{sys}} + S_{\text{surr}}$
 - 3. S_{univ} + spontaneous
 - 4. S_{sys} determined by number of gas molecules
 - 5. S_{surr} determined by heat $\Delta H/T$
 - 6. Exothermic ΔS_{surr} positive
- III Gibb's Free Energy
 - a. $\Delta G = \Delta H - T\Delta S$
 - b. H vs. S for spontaneous reactions $\Delta G < 0$
 - 1. - vs. +
 - 2. - vs. -
 - 3. + vs. +
 - 4. + vs. -

ASSESSMENT: QUIZ

- III. Summation of standard entropies for ΔS
- IV. Summation of standard free energies of formation ΔG
- V. Relation of G to temp and pressure $G = G^\circ = RT \ln Q$
- VI. Relation $\Delta G = 0$ at equil and $Q = K$
- VII. Third law of thermodynamics and absolute 0

ASSESSMENT: QUIZ

ASSESSMENT: TEST

LABORATORY INVESTIGATIONS:

Thermodynamics enthalpy of a rxn. Hess' Law

EQUILIBRIUM CHAPTER 13 (10 DAYS)

- I. Mass action law, definition of equilibrium and temperature related
- II. Deriving K and K_p , relationship of K to K_p change in moles of gas
- III. Determine K when reversing reaction, multiplying by coefficient and summing reactions.
- IV. Perfect square calculations
- V. K determinations using quadratic equation and graphing
- VI. Small K and large K, x is negligible, avoid quadratic equation
- VII. Le Chatelier's principle involving shifts
 - a. Concentrations changes
 - b. Pressure changes
 - c. Temperature changes exo vs endo
 - d. Introduction of inert gases

VIII. Catalyst and equilibrium

Assessments. Quiz (2) and Test

Laboratory investigation:

- a. Evaluating equilibrium constant with thiocyanate ion using the spectrophotometer

- b. Also Graphing exercise on quadratic (graphing calculator)
- c. Chatelier's lab

ACID AND BASES CHAPTER 14 (9 DAYS)

- I. Acid base definitions.
- II. Conjugate pairs
- III. Strong vs Weak acid and bases
- IV. K_a of an acid and base (weak)
- V. Water as an acid and base
- VI. K_a of water, auto ionization
- VII. Calculating H^+ and OH^- conc.
- VIII. pH and pOH calculations involving weak and strong acid/bases
- IX. pH of mixtures
- X. % percent dissociation
- XI. Polyprotic acid and pHs
- XII. pH properties of salts
- XIII. Lewis acids

Assessments: Quizzes and Test

Laboratory investigation

- a. Determination of K_a of a weak acid
- b. Determination of unknown acid by K_a
- c. Beers law lab (supplemental work) concentration (spec 20 or CBL)

APPLICATIONS OF IONIC EQUILIBRIUM CHAPTER 15 (11 DAYS)

- I. Common ion effect and calculating pH
- II. Buffer solutions definition and composition of
- III. Buffer solution calculations, and choosing an appropriate buffer system by pK_a
- IV. Addition of strong acids or bases to buffered solutions
- V. Buffering range of solutions, relations of A to HA, buffering range by concentrations of A vs HA
- VI. Changes in pH outside of buffering range
- VII. Strong acids to strong bases
- VIII. Titration curves
- IX. Indicators, choosing one by K_a values of 10% rule
- X. Solubility products and K_{sp} calculations
- XI. K_{sp} and determination of selective precipitations

Assessments 2 Quizzes and chapter test

Laboratory investigation

- a. Selecting indicators for acid base titrations
- b. Preparation & properties of Buffer solutions

- c. Solubility constant determination lab
- d. Qualitative analysis

ELECTROCHEMISTRY CHAPTER 17 (7 DAYS)

- I. Labeling and setup of a galvanic cell
- II. Reduction potentials and half reactions (determination of cell voltages)
- III. Standard states
- IV. Cell potentials with concentrations Nernst Equation
- V. Electrolytic cells

ASSESSMENT QUIZ AND TEST

LABORATORY INVESTIGATION

- a. Self directed electrolytic cell made, using solution of KI. Goal of this lab is for student to find I being oxidized, and K not being reduced, rather H being reduced and hydroxide base being formed with indicator present to show base.
- b. Electrolysis Lab
(Students will find reduction potentials of a series of rxns using voltaic cells to determine the activity series)

NUCLEAR CHEMISTRY (FAST REVIEW) CHAPTER 18 (5 DAYS)

- I Nuclear stability, band of stability, radioactive decay (transmutations)
- II Kinetics of radioactive decay – 1st order
- III Alpha, beta, gamma, positron, neutron emissions, balancing nuclear reactions
- X. Mass defect calculations and binding energy calculations
- XI. Nuclear decay series of uranium
- XII. Fission reactions and critical mass.
- XIII. Nuclear reactors
- XIV. Fusion reaction

ASSESSMENT QUIZ AND TEST

LABORATORY INVESTIGATION

Decay series manipulatives for Uranium to Lead 208

ORGANIC CHEMISTRY CHAPTER 22 7 DAYS

- I. Alkane, Alkene, Alkynes nomenclature and structure, structural isomers
- II. Functional groups and naming
(aldehydes, alcohol, ketones, carboxylic acids, amines, esters, amides, ethers, alkyl halides.)
- III. Basic functional group chemistry –
- IV. Polymerization basic polymers, 4 or 5 examples showing bonding
- V. Amino acids and proteins
- VI. Carbohydrates

- VII. Nucleic acids and Lipid
- VIII. Chiral carbons and stereo isomers
- Aromatics and conjugated bond system
- Demo – polymers

**ASSESSMENT QUIZ AND TEST
LABORATORY INVESTIGATIONS**

- a. Aspirin synthesis
- b. Synthesis isolation and purification of an ester

ATOMIC STRUCTURE AND PERIODICITY (FAST REVIEW) 6 DAYS

- I. Electron configuration
- II. Valence electrons and lewis structure
- III. Periodic trends
 - a. Atomic radius
 - b. Ionic radius cation and anion
 - c. Electronegativity
 - d. Electron affinity
 - e. Shielding
 - f. Ionization energies
- IV. Quantum numbers
- V. Aufbau, Pauli exclusion, Hund's rule
- VI. Dual nature of light wave and particle
- VII. Wave equation and photoelectric effect
- VIII. Plancks equation
- IX. DeBroglie's equation
- X. Bohr model of atom

ASSESSMENT Quiz

Laboratory – flame tests

(students will identify an unknown based on emission spectra.)

Emission tubes.

(Students will use emission tubes to determine emission spectra of various elements and compounds, and will predict emission spectra of compounds)

**BONDING and LIQUIDS AND SOLIDS AND SOLUTIONS CHAPTER 8, 9,
10, 11 REVIEW 12 DAYS**

- I. Covalent, Ionic and metallic
- II. Delocalize electrons in metals
- III. Alloys, interstitial and substitutional
- IV. Ionic bond formation
- V. Electronegativity use in bonding determination
- VI. Covalent – polar vs non polar
- VII. Intermolecular forces

- a. Hydrogen bonding
- b. Dipole – Dipole
- c. London dispersion
- VIII. Electronic structure vs Molecular structure
- IX. Lone pair vs bonded pair
- X. Polarity of molecules
- XI. VSEPR model
 AB_2 AB_3 AB_4 AB_3E AB_2E_2 AB_5 AB_4E AB_3E_2 AB_2E_3 AB_6 AB_5E AB_4E_2
- XII. Resonance structures and bond lengths and strengths
- XIII. Hybridizations, sp sp^2 and sp^3 – linear, trigonal, tetrahedral
- XIV. Sigma and pi bonds, p_x overlaps vs p_y and p_z overlap
- XV. Vapor pressure and changes in state
- XVI. Phase diagrams
- XVII. Colligative properties- vapor pressure (boiling points) freezing points.
- XVIII. Osmotic pressure
- XIX. Colligative of electrolytes in solution
- XX. Molality
- ASSESSMENT QUIZ (2)
- LABORATORY
 ELECTRONIC AND MOLECULAR STRUCTURES VSEPR FOR
 ELECTRON CONFIGURATIONS OF LINEAR THROUGH OCTAHEDRAL
 USING STYROFOAM BALLS AND TOOTHPICKS

PRACTICE TESTING SPREAD THROUGHOUT THE YEAR 20 DAYS

AP MOCK EXAMINATIONS 1994 AND 1999 TOTAL EXAM

4 FREE RESPONSE QUESTIONS SETS FROM 4 DIFFERENT YEARS

AP MULTIPLE CHOICE EXAMINATIONS

- EXAMINATION I**
- EXAMINATION II**
- EXAMINATION III**

RESEARCH EDUCATION ASSOCIATION TESTS (MULTIPLE CHOICE)

- EXAM 1**
- EXAM 2**
- EXAM 3**
- EXAM 4**

