

## AP<sup>o</sup> Chemistry

This two semester course covers chemical principles typical of college and university general chemistry courses. The class meets five days per week for an extended period of 70 minutes daily. The curriculum covers all requirements outlined by the College Board for Advanced Placement Chemistry. It focuses on the quantitative development of chemistry topics found in the first year college-prep chemistry curriculum in addition to the conceptual introduction and mathematical practice of chemistry topics not customarily taught in first year chemistry, such as chemical kinetics, thermodynamics, and detailed treatment of equilibrium concepts. Independent laboratory work and analysis are an integral part of the course. A minimum of one hands-on laboratory experiment is completed each week with students required to come in before or after school to finish the laboratory work if not completed in the scheduled two class periods. Throughout the laboratory and lecture components, there is an emphasis on development of both critical thinking skills and oral and written expression. Students are encouraged to participate in class discussion and are invited to solve problems for the class through board work. Every laboratory experiment is written as a formal report in a bound laboratory notebook and students must demonstrate clarity in both written conclusions and essay questions during evaluation. The goal of the course is on preparing the student to take more advanced science work in college. Students may receive college credit for this course by registering to take the AP test in May and meeting their university's minimum score for the AP chemistry exam.

**Prerequisites:** Chemistry I, Algebra I and II, Geometry I

**Required text:** Zumdahl, Steven, and Susan Zumdahl. *Chemistry*. Houghton Mifflin, 2000, 5<sup>th</sup> ed.

### Lab/Computer Activities

The laboratory portion of the course is both meaningful and enjoyable. During lab activities, students have the opportunity to explore the application of concepts and equations introduced in class. All standard laboratory equipment is utilized along with items not often used in the first year chemistry program, such as spectrophotometers, analytical balances, volumetric flasks and pipets, voltmeters, centrifuges, pH meters, computer data collection probes and software. All students submit a hand-written formal lab report for each lab investigation completed during the year (contained in a bound laboratory notebook). The formal lab report includes an introduction (background concepts, objective,

and hypothesis), procedure, data and observations, calculations, results, and a conclusion incorporating error analysis. Labs are scheduled as appropriate during the week - there is at least one hands-on laboratory experiment completed each week. Students are assigned a partner for some labs but independent work is required for other labs. Students are responsible for the lab and computer equipment that is used and are required to pay the current price for damaged or missing equipment. Proper safety and disposal techniques, including the interpretation of MSDS guides, are reviewed with every laboratory experiment. Because of safety considerations, careless behavior is not tolerated.

**Lab Manual:** Lab investigations will be taken from a variety of sources including:

Slowinski, E., Wolsey, W., and William Masterton. *Chemical Principles in the Laboratory*. Thomson Wadsworth, 2005, 8<sup>th</sup> ed.

North Central Texas College General Chemistry Lab Program for Chem1411 and Chem1412

Hall, James F. *Experimental Chemistry*. Houghton Mifflin, 1997, 4<sup>th</sup> ed.

Milio, F., Debye, N., and Clyde Metz. *Experiments in General Chemistry*. Saunders College Publishing, 1991, 1<sup>st</sup> ed.

**Materials:** Graphing or scientific calculator, class notebook with paper and dividers, bound lab notebook containing graph paper

## Syllabus

(AP Chemistry Course Guide correlations are noted as IA3, IIB4, etc., AP Chemistry Audit curriculum requirements are noted as C1, C2, etc.)

Course Objective	Text references, resources, and assessments	Audit Correlations	Time Frame
<b>Unit 1: Chemistry Foundations</b> <ul style="list-style-type: none"><li>metric measurement</li><li>lab techniques and safety</li><li>classification of matter</li><li>properties of matter</li><li>evidence for atomic theories</li><li>subatomic particles</li><li>atomic number, mass number and isotopes</li><li>nomenclature</li></ul>	Chapter 1 - sections 1.1 - 1.9 Chapter 2 - sections 2.1 - 2.8 Teacher-prepared handouts Chapter 1 recitation problem set Chapter 2 recitation problem set General Lab Techniques and Equipment Lab (hands-on) <ul style="list-style-type: none"><li>students practice using all standard laboratory measuring equipment and review standard techniques such as gravity filtration, decanting, pipet use (completed independently)</li></ul> Separation of a Mixture Lab (inquiry-based, hands-on) <ul style="list-style-type: none"><li>students are given an mixture and have to determine how to separate the components and determine the percentage by mass of each (lab teams)</li></ul> Chromatography Lab (hands-on) <ul style="list-style-type: none"><li>students either determine the unknown amino acids or metal ions in an unknown mixture using paper chromatography (lab teams)</li></ul> Nomenclature Activity Unit Examination	C1 C5 C7  IA1 IA3 V	12 days

<p><b>Unit 2:</b> <b>Stoichiometry</b></p> <ul style="list-style-type: none"> <li>• atomic mass and molar mass determination</li> <li>• mole concept and calculations</li> <li>• percentage composition by mass</li> <li>• empirical and molecular formulas</li> <li>• chemical equations and balancing</li> <li>• predict products of reactions</li> <li>• stoichiometric calculations using mass</li> <li>• limiting reactant problems</li> </ul>	<p>Chapter 3 - sections 3.1 - 3.9  Chapter 3a recitation problem set  Chapter 3b recitation problem set  Determination of a Chemical Formula Lab (hands-on) <ul style="list-style-type: none"> <li>➤ students determine the formula for a binary ionic compound (lab teams)</li> </ul> Percentage Composition of a Hydrate Lab (hands-on) <ul style="list-style-type: none"> <li>➤ students determine the percentage of water in an unknown hydrate (independent work)</li> </ul> Limiting Reactants Lab (hands-on) <ul style="list-style-type: none"> <li>➤ students find the percent yield of a reaction using limiting reactants (lab teams)</li> </ul> Unit Examination</p>	<p>C1  C3  C5  C6  C7    IA2  IIIB2  IIIB3  IV1  V</p>	<p>15 days</p>
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<p><b>Unit 3:</b> <b>Solution Stoichiometry</b></p> <ul style="list-style-type: none"> <li>• precipitation reactions and solubility</li> <li>• net ionic equations</li> <li>• simple neutralization reactions</li> <li>• oxidation-reduction reactions</li> <li>• oxidation numbers and balancing redox reactions in solution</li> <li>• molarity calculations</li> <li>• stoichiometric calculations using molarity</li> <li>• titrations</li> </ul>	<p>Chapter 4 - sections 4.1 - 4.10  Chapter 4a recitation problem set  Chapter 4b recitation problem set  Chapter 4c recitation problem set  Teacher-created handouts  Determination of Iron by Redox Titration Lab (hands-on) <ul style="list-style-type: none"> <li>➤ students use redox titration to determine the percent by mass of iron in an unknown sample (lab teams)</li> </ul> Gravimetric Analysis of Chloride Lab (hands-on) <ul style="list-style-type: none"> <li>➤ students determine the percent of chloride in an unknown sample using precipitation and gravimetric analysis (lab teams)</li> </ul> Unit Examination</p>	<p>C2  C3  C5  C6  C7    IIC1  IIC2  IIIA2  IIIA3a  IIIA3b  IIIB1  IIIB2  IIIB3  IV1  V</p>	<p>15 days</p>
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<p><b>Unit 4:</b> <b>Gas Phase Chemistry</b></p> <ul style="list-style-type: none"> <li>• pressure measurement</li> <li>• temperature and kinetic energy</li> <li>• gas law calculations (Boyle, Charles, Avogadro's hypothesis, Dalton's law of partial pressures, Graham's law of diffusion, Combined, Ideal gas law)</li> <li>• stoichiometric calculations using gases</li> <li>• kinetic molecular theory of gases and interpretation of gas laws</li> <li>• deviations from ideal behavior</li> </ul>	<p>Chapter 5 - sections 5.1 - 5.8  Chapter 5a recitation problem set  Chapter 5b recitation problem set  Molar Mass of a Volatile Liquid Lab (hands-on)  ➤ students determine the molar mass of a volatile liquid using gas density (lab teams)  Unit Examination</p>	<p>C2  C3  C5  C6  C7    IIA1a  IIA1b  IIA2a  IIA2b  IIA2c  IIA2d  IIIB3  V</p>	<p>10 days</p>
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<p><b>Unit 5:</b> <b>Thermochemistry</b></p> <ul style="list-style-type: none"> <li>• state functions</li> <li>• calorimetry calculations</li> <li>• Hess's law calculations</li> <li>• enthalpy of formation and reaction</li> </ul>	<p>Chapter 6 - sections 6.1 - 6.4  Chapter 6a recitation problem set  Chapter 6b recitation problem set  Determine the Specific Heat of a Metal Lab (hands-on)  ➤ students use a simple calorimeter to find the specific heat of an unknown metal sample (independent)  Determine the Enthalpy of Reaction Lab (hands-on)  ➤ students find the enthalpy of two separate chemical processes and then compare the sum of the enthalpies to the enthalpy of the reaction carried out in one step (lab teams)  Unit Examination</p>	<p>C3  C5  C6  C7    IIIE1  IIIE2  IV1  V</p>	<p>10 days</p>
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<p><b>Unit 6:</b> <b>Atomic Structure and Periodicity</b></p> <ul style="list-style-type: none"> <li>• light and the Bohr atomic model</li> <li>• atomic spectra and orbitals</li> <li>• quantum model and quantum numbers</li> <li>• orbital diagrams and electron configurations</li> <li>• nuclear equations</li> <li>• radioactivity and half-life calculations</li> <li>• history of the periodic table</li> <li>• periodic trends (radii, ionization energy, electron affinity, valence)</li> <li>• chemical family characteristics</li> </ul>	<p>Chapter 7 - sections 7.1 - 7.13  Chapter 21 - sections 21.1 - 21.3  Chapter 7a recitation problem set  Chapter 7b recitation problem set  Chapter 21 recitation problem set  Teacher-created handouts  Halogen and Alkaline Earth Lab Investigation (hands-on)      ➤ students investigate the solubility of alkaline earth metal compounds and the replacement activity of the halogens, then use their findings to identify an unknown group II halide salt (lab teams)  Atomic Structure video  Periodic Table video  Unit Examination</p>	<p>C1  C4  C5  C6  C7    IA1  IA4  IA5  IC  IV2  V</p>	<p>12 days</p>
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<p><b>Unit 7:</b> <b>Chemical Bonding</b></p> <ul style="list-style-type: none"> <li>• electron affinity</li> <li>• metallic bond characteristics</li> <li>• ionic bond characteristics</li> <li>• covalent bond characteristics</li> <li>• Lewis diagrams and formal charge</li> <li>• VSEPR and molecular geometry</li> <li>• hybridization and resonance</li> <li>• sigma and pi bonds</li> <li>• bond polarity and electronegativity</li> <li>• molecular polarity and dipole moments</li> </ul>	<p>Chapter 8 - sections 8.1 - 8.13 Chapter 9 - section 9.1 Teacher-created handouts Chapter 8a recitation problem set Chapter 8b recitation problem set VSEPR video Molecular Model Project</p> <ul style="list-style-type: none"> <li>➤ students are assigned an organic compound containing from 3 to 6 carbon atoms and build a 3D model demonstrating correct bond angles and hybridization (independent)</li> </ul> <p>Molecular Model Lab (dry lab)</p> <ul style="list-style-type: none"> <li>➤ students use a chemical model set to visualize VSEPR geometry (lab teams)</li> </ul> <p>Unit Examination</p>	<p>C1 C4</p> <p>IB1a IB1c IB2a IB2b IB2c IB3 IV2</p>	<p>10 days</p>
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<p><b>Unit 8:</b> <b>Liquids and Solids</b></p> <ul style="list-style-type: none"> <li>intermolecular forces (dipole-dipole, hydrogen bonding, London dispersion forces)</li> <li>kinetic molecular theory of liquids and solids</li> <li>types and structure of solids (emphasis on cubic crystal calculations)</li> <li>lattice energy calculations</li> <li>vapor pressure and Clausius-Clapeyron equation</li> <li>phase changes and energy calculations (heat of vaporization and fusion)</li> <li>phase diagrams (triple point and critical point)</li> </ul>	<p>Chapter 10 - sections 10.1 - 10.9 Phase Change Lab (hands-on)</p> <ul style="list-style-type: none"> <li>students determine the freezing point of a substance using cooling curve data (teams using electronic temperature sensors and computer data collection)</li> </ul> <p>Chapter 10a recitation problem set Chapter 10b recitation problem set Graph Analysis Project (dry lab)</p> <ul style="list-style-type: none"> <li>students analyze several phase diagrams, heating curves and vapor pressure curves and make conclusions relating to intermolecular forces (independent)</li> </ul> <p>Unit Examination</p>	<p>C2 C3 C5 C6 C7</p> <p>IB1a IB1b IIB1 IIB2 IIB3 IIB4 IIIE2 V</p>	<p>10 days</p>
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<p><b>Unit 9: Solution Chemistry</b></p> <ul style="list-style-type: none"> <li>solubility and types of solutions</li> <li>concentration calculations (molarity, molality, % by mass, mole fraction, normality)</li> <li>colligative properties (Raoult's law, osmotic pressure, freezing and boiling point changes)</li> </ul>	<p>Chapter 11 - sections 11.1 - 11.7 Saturation demo (teacher demonstration) Chapter 11a recitation problem set Chapter 11b recitation problem set Freezing point Lab (hands-on)</p> <ul style="list-style-type: none"> <li>students use freezing point depression and the data from a prior lab to determine the molar mass of an unknown (lab teams)</li> </ul> <p>Determination of Concentration Lab (hands-on)</p> <ul style="list-style-type: none"> <li>students design a procedure to analyze a salt solution to determine the Molarity, molality, % by mass, and mole fraction (independent)</li> </ul> <p>Unit Examination</p>	<p>C2 C5 C6 C7</p> <p>IIC1 IIC2 IIC3 IIC4 V</p>	<p>10 days</p>
<p><b>Unit 10: Chemical Kinetics</b></p> <ul style="list-style-type: none"> <li>reaction rates</li> <li>rate laws, rate constants, and orders of reaction</li> <li>integrated rate laws</li> <li>mechanisms and catalysts</li> <li>activation energy calculations (Arrhenius equation)</li> </ul>	<p>Chapter 12 - sections 12.1 - 12.8 Chapter 12a recitation problem set Chapter 12b recitation problem set Order of Reaction Lab (hands-on)</p> <ul style="list-style-type: none"> <li>students determine the order of reaction using the iodination of acetone reaction (lab teams)</li> </ul> <p>Determine Activation Energy Lab (hands-on)</p> <ul style="list-style-type: none"> <li>students use the Arrhenius equation and lab data from the prior iodination lab to determine activation energy (lab teams)</li> </ul> <p>Unit Examination</p>	<p>C3 C5 C6 C7</p> <p>IIID1 IIID2 IIID3 IIID4 IIID5 IV1 V</p>	<p>10 days</p>

<p><b>Unit 11: General Chemical Equilibrium and Solubility Equilibrium</b></p> <ul style="list-style-type: none"> <li>• equilibrium characteristics</li> <li>• equilibrium constant (<math>K_p</math> and <math>K_c</math>)</li> <li>• equilibrium expression and calculations</li> <li>• LeChatelier's principle</li> <li>• solubility product constant and calculations (<math>K_{sp}</math>)</li> <li>• precipitation prediction and qualitative analysis</li> <li>• complex ion equilibrium</li> </ul>	<p>Chapter 13 - sections 13.1 - 13.7  Chapter 13a recitation problem set  Chapter 13b recitation problem set  Determine <math>K_{eq}</math> Lab (hands-on)</p> <ul style="list-style-type: none"> <li>➤ students determine the equilibrium constant for the reaction between thiocyanate and ferric ion using spectrophotometry and Beer's Law (lab teams)</li> </ul> <p>Chapter 15 - sections 15.6 - 15.8  Chapter 15b recitation problem set  Complex Ion Lab (hands-on)</p> <ul style="list-style-type: none"> <li>➤ students produce several complex ions and write equations for the reactions (lab teams)</li> </ul> <p>K<sub>sp</sub> Lab (hands-on)</p> <ul style="list-style-type: none"> <li>➤ students determine the K<sub>sp</sub> of calcium hydroxide by a neutralization titration with hydrochloric acid (lab teams)</li> </ul> <p>Unit Examination</p>	<p>C3  C5  C6  C7</p> <p>IIC1  IIC2a  IIC2b2  IV1  V</p>	<p>15 days</p>
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<p><b>Unit 12: Acid-Base Properties and Reactions</b></p> <ul style="list-style-type: none"> <li>• acid-base properties</li> <li>• definitions (Arrhenius, Bronsted-Lowry, Lewis)</li> <li>• strength and concentration</li> <li>• pH and pOH calculations</li> <li>• acid-base equilibrium (<math>K_a</math>, <math>K_b</math>, <math>K_w</math>)</li> <li>• amphoterism</li> <li>• coordination complexes</li> <li>• neutralization reactions and titrations</li> <li>• hydrolysis of salts</li> <li>• <math>pK_a</math> and <math>pK_b</math></li> <li>• common ion effect</li> <li>• buffer solutions</li> </ul>	<p>Chapter 14 - sections 14.1 - 14.6  Chapter 15 - sections 15.1  Chapter 14a recitation problem set  Chapter 14b recitation problem set  Chapter 15a recitation problem set  Ka Labs (hands-on)</p> <ul style="list-style-type: none"> <li>➤ students determine the <math>K_a</math> of a weak acid using pH meters to measure the hydronium ion concentration existing in a molar solution they have created (lab teams)</li> <li>➤ students determine the <math>K_a</math> of bromothymol blue using spectrophotometric data and pH data to find the graphical midpoint and <math>pK_a</math></li> </ul> <p>Chapter 15 - sections 15.2 - 15.4  Chapter 14 - section 14.8  Chapter 15b recitation problem set  Chapter 14c recitation problem set  Indicator-Buffers Lab (hands-on)</p> <ul style="list-style-type: none"> <li>➤ students test various indicators to determine the ranges and prepare buffer solutions of known pH for the tests (lab teams)</li> </ul> <p>Acid-base Titration Lab (hands-on)</p> <ul style="list-style-type: none"> <li>➤ students determine the concentration of either a weak acid or base through titration with endpoint determined by pH meter (lab teams)</li> </ul> <p>Unit Examination</p>	<p>C3  C5  C6  C7</p> <p>IIIA1  IIC2b1  IIC2b3  IV1  V</p>	<p>18 days</p>
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<p><b>Unit 13: Thermodynamics and Electrochemistry</b></p> <ul style="list-style-type: none"> <li>• spontaneity</li> <li>• enthalpy review</li> <li>• entropy</li> <li>• free energy calculations (formation and reaction)</li> <li>• relationships between G and <math>K_{eq}</math></li> <li>• redox review</li> <li>• galvanic cells</li> <li>• standard reduction potentials</li> <li>• Nernst equation</li> <li>• electrolytic cells</li> <li>• Faraday's law</li> <li>• relationships between G, K, and E</li> </ul>	<p>Chapter 16 - sections 16.1 - 16.8  Chapter 16a recitation problem set  Chapter 16b recitation problem set  Enthalpy Lab (hands-on)      ➤ students determine the enthalpy of several reactions and physical changes (independent)  Chapter 17 - sections 17.1, 17.2, 17.4, 17.7  Chapter 17a recitation problem set  Chapter 17b recitation problem set  Cell Potential Lab (hands-on)      ➤ students determine the cell potential for several chemical cells and test the Nernst equation by varying concentrations (lab teams)  Electrolysis Lab (teacher demonstration)  Unit Examination</p>	<p>C3  C5  C6  C7    IIIA3a  IIIA3b  IIIA3c  IIIE1  IIIE2  IIIE3  IIIE4  IV1  V</p>	<p>12 days</p>
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<p><b>Unit 14:</b> <b>Organic Chemistry</b></p> <ul style="list-style-type: none"> <li>• simple organic nomenclature</li> <li>• functional groups</li> <li>• structural isomerism and chirality</li> </ul>	<p>Chapter 22 - sections 22.1 - 22.3, 22.5 Chapter 22a recitation problem set Synthesis of an Organic Compound Lab (hands-on) ➤ students prepare various organic compound as selected by student interest - aspirin, esters, etc. (independent) Unit Examination</p>	<p>C1 C5 C7  IB3 IV3 V</p>	<p>6 days</p>
<p><b>Unit 15:</b> <b>Qualitative Analysis</b></p> <ul style="list-style-type: none"> <li>• Identify the cation and anion in an unknown salt</li> </ul>	<p>Teacher-created lab resources Independent student investigation (hands-on) ➤ students develop a flowchart to analyze an unknown salt and determine the identity of the cation and the anion (independent)</p>	<p>C3 C4 C5 C7  IIC1 IIIA2 IV1 IV2 V</p>	<p>5 days</p>