

AP Chemistry

Course Description & Program Overview:

The AP Chemistry course is designed to be the equivalent of first year college general chemistry course. The course is structured around the six big ideas articulated in the AP Chemistry curriculum framework provided by the College Board. **[CR2]** A special emphasis will be placed on the seven science practices, which capture important aspects of the work that scientists engage in, with learning objectives that combine content with inquiry and reasoning skills **[CR6]**.

AP Chemistry meets on Mondays, Tuesdays and Fridays for 50 minutes, and on Wednesdays and/or Thursdays for 90 minutes. The 50 minute periods are used for lectures, classroom discussions, demonstrations, and group/individual inquiry work. The 90 minute periods are used for student to perform traditional and inquiry based laboratory experiments. Students are expected to maintain a composition laboratory notebook in a specific format, and the experiments, performed, are pulled from various college resources and The College Board, AP Chemistry Guided Inquiry Experiments: Applying the Science Practices. 2013 **[CR5]**. Students are expected to purchase "The Ultimate Chemical Equation Handbook" which is used through-out the school year to develop students' skills in Descriptive Chemistry. Beginning the second quarter, students will take a weekly Net Ionic quiz. Students are assigned daily homework from the textbook, AP free response packets and other resources, and weekly quizzes are given to measure students' comprehension, understanding and applications of concepts covered. At the conclusion of each unit, a test is given containing 10 multiple choice questions and 3-5 free response questions from previous AP Chemistry exams. The tests are designed to simulate the AP exam experience, and prepare students for success in May. AP Chemistry is open to all students that have completed a year of chemistry who wish to take part in a rigorous and academically challenging course.

Goals of the Course:

1. Students will become critical and independent thinkers to successfully function in an ever changing scientific and technological society.
2. Students will be able to interpret and analyze scientific issues using problem solving skills.
3. Students will develop an appreciation and curiosity for the natural world.
4. In a traditional and inquiry laboratory experiment, students will physically manipulate equipment, materials, and chemicals to collect and record (in the laboratory notebook) qualitative and quantitative data; use the data collected to compare results, develop conclusions, verify hypotheses, and communicate a clear understanding of the experiment in a written form.
5. Students will use Structured Inquiry to investigate a teacher-presented question through a prescribed procedure
6. Student will use Guided Inquiry to investigate a teacher-presented question using student designed or selected procedure.
7. Students will use Open Inquiry to investigate topic-related questions that are formulated through student designed or selected procedures.
8. Students will earn an acceptable score on the AP Chemistry Examination in May.

Required Materials:

Graphing calculator, splash proof goggles, and a composition laboratory notebook

Laboratory Experiments Requirements:

The experiments completed require following or developing processes and procedures, taking observations, and data manipulation. Students will communicate and collaborate in laboratory groups; however, each student will write a laboratory report in a laboratory notebook for every experiment he/she performs. A minimum of 25% of student contact time will be spent doing hands-on laboratory activities. Details for the laboratory experiments report is listed below. [CR5a]

The 10 Parts of a Laboratory Experiment Report [CR7]

A specific format will be given to the student for each experiment. Students must follow that format and label all sections very clearly. AP Chemistry laboratory reports are much longer and more in depth than the ones completed in the first year chemistry course. Therefore, it is important that students don't procrastinate when doing pre-laboratory and post-laboratory work. Late laboratory reports will not be accepted. Experiments not completed in class must be done at lunch or before/ after school by appointment.

Pre-Lab Work Pre-laboratory work is to be completed and turned in on the day the experiment is performed.

1. **Title** The title should be descriptive. For example, "pH Titration Lab" is a descriptive title and "Experiment 5" is not a descriptive title.
2. **Date** This is the date the student performed the experiment.
3. **Purpose** A purpose is a statement summarizing the "point" of the lab.
4. **Procedure Outline** Students need to write an outline of the procedure. They should use bulleted statements or outline format to make it easy to read. If a student is doing a guided inquiry lab, he/she may be required to write a full procedure that he/she developed.
5. **Pre-Lab Questions** Students will be given some questions to answer before performing the experiment. They will need to incorporate the question in the answer. It is important to produce an accurate record of experimental work.
6. **Data Tables** Students will need to develop and create data tables and/or charts to record the data.

Curricular Requirements

CR 1 Students and teachers use a recently published (within the last 10 years) college-level chemistry textbook.

CR2 The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR3a The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 1: Structure of matter.

CR3b The course provides students with opportunities outside the laboratory environment to meet the

learning objectives within Big Idea 2: Properties of matter-characteristics, states, and forces of attraction.

CR3c The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 3: Chemical reactions.

CR3d The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 4: Rates of chemical reactions.

CR3e The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 5: Thermodynamics.

CR3f The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 6: Equilibrium.

CR4 The course provides students with the opportunity to connect their knowledge of chemistry and science to major societal or technological components (e.g., concerns, technological advances, innovations) to help them become scientifically literate citizens.

CR5a Students are provided the opportunity to engage in investigative laboratory work integrated throughout the course for a minimum of 25 percent of instructional time.

CR5b Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6 The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

CR7 The course provides opportunities for students to develop, record, and maintain evidence of their verbal, written, and graphic communication skills through laboratory reports, summaries of literature or scientific investigations, and oral, written, and graphic presentations.

Big Idea 1: Structure of matter

Big Idea 2: Properties of matter-characteristics, states, and forces of attraction

Big Idea 3: Chemical reactions

Big Idea 4: Rates of chemical reactions

Big Idea 5: Thermodynamics

Big Idea 6: Equilibrium

Course Outline:

First Semester – First Quarter

Unit 1 & 2 – “What is Chemistry?”

Topics:

- Define Chemistry
- Scientific Method
- Physical & Chemical Properties & Changes
- States of Matter – pure substances and mixtures
- Dalton’s Atomic Theory, the atom, subatomic particles and average atomic mass
- Periodic Table history, organization and the elements
- Chemical reactions- naming compounds, writing, types, and balancing
- Recording Measurements & Significant Figures

Experiment - “Introduction to Laboratory Safety and Equipment”
- “Identifying Unknown Metals Using the Property of Density”

Unit 3 – “Stoichiometry”

Topics:

- Calculating Molecular & Formula Masses
- Avogadro’ Number & The Mole
- Determining Empirical & Molecular Formulas and % Composition of a compound
- Balancing Chemical reactions and determining the limiting reactants, theoretical yield, percent yield and percent error.

Experiments - “% Composition of a New Penny”
- “Stoichiometry of the Alkali Metals”
- “Determination of Percent Potassium Chlorate”

Unit 4 – “The Properties of Gases”

Topics:

- Kinetic Theory of Gases
- Manometers & Barometers
- Gas Laws-Boyle’s, Charles’, Gay-Lussac’s, Dalton’s, and Avogadro’s,
- Ideal Gas law solving for density, molecular mass and stoichiometry problems
- Collecting a gas over water
- Solving Graham’s Law –Effusion & Diffusion
- Real Gas Law –van der Waals’ Equation

Experiments - “Determination of Standard Molar Volume and the Gas Constant”
- “Graham’s Law of Effusion”

Unit 5 - “Electron Configurations”

Topics:

- Electromagnetic Radiation

- Continuous & Atomic Line Spectra
- Dual Nature of Light
- Planck, photon, $E = mc^2$
- DeBroglie equation
- Bohr's Atomic Model
- The principle, second, magnetic and orbital shapes & energies
- Hund's Rule
- Pauli Exclusion Principle and electron spins
- Aufbau Principle
- Heisenberg Uncertainty Principle
- Writing Electron Configurations

Experiment - Atomic Spectra-“Flame Test for Various Metals”

Unit 6 – “Periodic Property Patterns

Topics:

- Periodic families-metals, nonmetals and metalloids and their properties
- Valence & favorite ion
- Patterns of Reactivity, Ionization energy and Electron affinity on the periodic table
- Electronegativity and bonding
- Calculating Effective nuclear charge and its influence on periodic properties
- Assigning oxidation numbers and balancing redox reactions

Experiments - “Periodic Patterns of the Alkali and Alkaline Earth Metals”

- “Periodic Patterns of the Halogens”
- “Oxidation State of Manganese”

First Semester – Second Quarter

Units 7 & 8 – Chemical Bonding I & II

Topics:

- Types of Bonding & Octet Rule
- Exceptions to Octet Rule
- Lewis Dot Structures for elements and compounds
- Electronegativity-polar covalent bonds, nonpolar covalent bonds, polar molecule & dipole moment
- Bond energy, bond length and bond order
- Formal Charge & Resonance structures
- Determining Molecular Geometry-VSEPR
- Valence Bond Theory & Molecular Orbital Theory
- Hybridization of orbital
- Multiple Bonds-sigma and pi bonds

Experiment: “Determining the Molecular Geometry of Compounds”

Unit 9 – “Thermochemistry & Thermodynamics”

Topics:

- Thermo properties, phase change diagram, types of energy, units, system and surroundings
- First Law of Thermodynamic
- State Functions
- Calorimetry & solving calorimetric problems
- Hess’s Law of Summation
- Standard Enthalpy of Formation
- Enthalpy calculated from bond energies
- Spontaneous reactions –thermodynamics versus kinetics, driving forces
- The Second & Third Laws of Thermodynamics
- Entropy-determining sign, calculating values, molecular level interpretation
- Free Energy-calculations from tables, thermochemical data, equilibrium constant, interpretation of reaction spontaneity

Experiments: - “Calorimetry-The Energy of Food”

- ” Hess’s Law – Heat of Formation of Magnesium Oxide”

Unit 10 – “Solids & Liquids”

Topics:

- Forces influencing Intermolecular attraction-dipole-dipole, London dispersion, hydrogen bonding
- Properties of liquids
- Process of phase changes, phase change diagram & phase diagram
- Dynamic Equilibrium
- LeChatelier’s Principle
- Crystalline/amorphous solids & their properties

Chemistry - A Guided Inquiry Activities – Average Valence Electron Energies & Partial Charge

- Polar, Nonpolar and Ionic Bonds
- Dipole Moments

Experiments - “Triple Point of Dry Ice

- “Molar Mass of a Volatile Liquid”

Unit 11 – “Nuclear Chemistry”

Topics:

- Law of Conservation of Mass-Energy
- Nuclear stability and radioactive decay
- Mass defect & nuclear binding energy
- Types of radioactive decay & writing nuclear equations
- Kinetics of radioactive decay
- Nuclear fission and fusion
- Detection and uses of radioactivity

Unit 12 – “Organic Chemistry”

Topics:

- The naming of alkanes, alkenes and alkynes
- Basic information about alkanes, alkenes and alkynes
- Functional Groups
- Esterification reactions & Polymerization reactions
- Experiment: “Preparation of Esters”

Second Semester- Third Quarter

Unit 13 - “Solution’s Properties & Chemical Reactions”

Topics:

- Solution’s concentrations: molarity, molality, normality, mole fraction
- Solubility Rules & factors affecting solubility
- Activity Series of the elements
- Vapor pressure and Raoult’s Law
- Boiling point elevation and freezing point depression
- Osmotic pressure and Henry’s Law
- Colligative Properties
- Solubility Constant(K_{sp}) and solving equilibrium problems
- Analysis of MSDS sheet

Experiments: - “Descriptive Chemistry-Reactions and net ionic equations”

- “Qualitative Detection and Identification of Unknown”
- “Freezing Point Depression –Making Ice Cream”
- “Determination of the Solubility Product for an Ionic Compound”

Unit 14 – “Electrochemistry”

Topics:

- Galvanic cells
- Standard reduction potential
- Cell potential, electrical work and free energy
- Cell potential and concentrations
- Nernst’s Equation
- Batteries
- Electrolysis
- Commercial electrolytic processes

Experiments: - “Exploring Electrochemistry”

- “Electrolysis of Water”

Unit 15 - “Acids and Bases”

Topics:

- Nature of Acids & Bases
- Naming and classifying acids and bases
- pH scale

- Calculating pH of strong/weak acid/base solutions
- Polyatomic acids
- Acid/Base properties as salts
- Acid/Base properties as oxides
- Lewis acid/base
- Bronsted-Lowry acid/base
- Solving acid/base problems
- Common ion
- Buffer solutions and capacity
- Titrations and pH curves
- Indicators for titration
- Solubility equilibria and solubility product (K_a & K_b)
- Equilibria involving complex ions
- Precipitation behavior as pH is varied

Experiments: "Buffer Experiment"

"Acid/Base Titration"

"Determination of Dissociation Constants of Weak Acids"

"Determination of the Equivalent Mass and pK_a of an Unknown Acid"

Second Semester – Fourth Quarter

Unit 16 – "Reaction Rates"

Topics:

- Reaction Rates
- Factors affecting Reaction Rates
- Rate Laws
- Determining Rate Laws
- Arrhenius equation and activation energies
- Reaction Mechanisms
- Integrated Rate Laws
- Catalysts

Experiments: - "Factors Affecting Rate Law-Iodine Clock Experiment"

- "Study of the Kinetics of a Reaction"

Post-Laboratory Work

1. **Calculations and Graphs** Students should show how calculations are carried out. Graphs need to be titled, axes need to be labeled, and units need to be shown on the axis. To receive credit for any graphs, they must be at least $\frac{1}{2}$ page in size.
2. **Conclusions** This will vary from lab to lab. Students will usually be given direction as to what to write, but it is expected that all conclusions will be well thought out and well written.
3. **Post Laboratory Error Analysis Questions** Follow the same procedure as for Pre-Laboratory Questions.

Advanced Placement Chemistry — The Laboratory Notebook A record of laboratory work is an important document, which will show the quality of the laboratory work that students have performed.