AP Chemistry Course Description

This course is a study of the properties of matter and principles governing chemical reactions, commonly covered in a first-year college course in general chemistry. In line with the College Board's new curriculum framework, this course is structured around six big ideas, exploring key topics of chemistry in depth. The course aims to develop student skills in critical thinking, inductive and deductive reasoning, scientific inquiry, problem solving, and precision in the use of evidence to support claims. Pacing is vigorous and strong reasoning and mathematical skills are required.

Daily class discussion uses a guided questioning approach to learning and construction of concepts. Students are encouraged to test, evaluate, and refine explanations and predictions of natural phenomena through science practices. These practices include generating representations and models, engaging in guided inquiry in the laboratory, developing strategies for collecting and analyzing data, and making connections across concepts and domains. Applications to everyday chemistry are often used to introduce key topics. A subscription to the *ChemMatters* magazine from the American Chemical Society and the requirement to select an article for reading and summarizing provide opportunities to connect chemical principles to societal and technological issues. CR 4

The course is scheduled to meet six 42-minutes per six-day cycle which includes a double-period (90 minutes) for laboratory work. Additional meeting times are used for problem solving, and pre-lab or post-lab discussions. In-class and at-home assignments consist of discussion questions, "during-class inventions" worksheets, on-line activities, problems from the textbook, AP-style problems, and lab reports. A test is given after each unit of study of topics from 1-3 chapters. Students are prepared to take the new AP Chemistry Exam in May.

Big Ideas: CR2

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: Kinetics – Rates of Chemical Reactions

Big Idea 5: Thermodynamics

Big Idea 6: Chemical Equilibrium

Science Practices:

Science Practice 1: Use representations and models to communicate scientific phenomena and solve scientific problems.

Science Practice 2: Use mathematics appropriately.

Science Practice 3: Engage in scientific questioning to extend thinking and/or to guide investigations within the context of the AP course.

Science Practice 4: Plan and implement data collection strategies in relation to a particular scientific question.

Science Practice 5: Perform data analysis and evaluation of evidence.

Science Practice 6: Work with scientific explanations and theories.

Science Practice 7: Connect and relate knowledge across various scales, concepts, and representations in and across domains.

Student Textbook & Resource Books:

- *Chemistry: A Molecular Approach*, Tro, AP Edition, 3rd Edition, Pearson Education Inc., 2014 CR 1
- AP Test Prep Workbook, Pearson Education, Inc., 2014
- *(DCI) During Class Inventions & Computer Lab Activities, Vol. I & Vol. II,* Abraham, Gelder, and Greenbowe, 3rd Edition, Hayden McNeil, 2009
- *Chem Matters* magazine, American Chemical Society
- *(CB) AP Chemistry Guided Inquiry Activities for the Classroom,* College Board Professional Development Publication, 2013

Lab Manuals:

- *AP Chemistry Guided-Inquiry Experiments,* Teacher's Manual, The College Board, 2013
- *Laboratory Experiments for Advanced Placement Chemistry*, Vonderbrink, 2nd Ed., Flinn Scientific, 2006
- *Laboratory Investigations AP Chemistry*, Hostage and Fossett, Peoples Education, 2006
- *Advanced Chemistry with Vernier*, Randall, 2nd. ed.,Vernier Software and Technology, 2007
- *Chemistry in Microscale*, Bool I, Ehrenkranz and Mauch, Micro Mole Scientific, 1996

The Lab Program

The laboratory program challenges the student to think analytically, design and carry out experiments, evaluate acquired data, draw conclusions, and communicate in writing scientifically.

At least 25% of total instructional time is dedicated to the lab program throughout the school year. A minimum of 16 hands-on lab experiments are conducted by students, and a minimum of 6 of these investigations are guided-inquiry investigations. CR 5a

Students use a carbonless duplicate copy lab notebook. A Table of Content is kept up to date through the year. Each lab write-up includes title, purpose, brainstorming method, procedure, picture of lab setup when appropriate, data, data analysis, discussion (including error analysis), pre-lab and post-lab questions. CR 7

Lab list (*GI = Guided Inquiry Labs) – See Syllabus below for descriptions CR 5b
CR 6

- *GI - Global Warming
- *GI - Empirical Formula of an Oxide of Magnesium
- Studying Redox Reactions
- *GI - ID of 4 Unknowns
- *GI - Air Bag
- *GI - Molar Mass of a Volatile Liquid / Gas
- * GI - Reaction Stoichiometry - Mole Ratio of a Chemical Reaction by Job's Method (Continuous Variation)
- * GI - Preparation & Testing of a Buffer Solution
- Standardization of NaOH solution
- Vinegar Analysis – determining the mass percent of acetic acid in vinegar
- *GI – Antacid Analysis – Determining the mass percent of magnesium hydroxide in antacid
- *GI - Bleach Analysis – determining mass percent of sodium hypochlorite in bleach
- Electrolysis of KI solution
- *GI - Hand Warmer and/or Enthalpy of Fusion
- Kinetics – Crystal Violet
- *GI - Beer's Law – Mass Percent of Copper in Brass
- Paper Chromatography & Separation techniques
- *GI - Type of Bonding in a Solid

Syllabus:

The following syllabus shows a general timeline, the units of study that involve chapters and sections in the textbook, lab explorations, in-class activities and at-home assignments, description of each item, Learning Objections and Science Practices per the College Board curriculum framework for AP Chemistry, and the Curricular Requirements for AP Chemistry audit by the College Board.

Timeline	Units (Chapters, Sections) Labs, Activities	Descriptions	Learning Objectives and Science Practices	CR
Late Aug. – early Sept.	**Unit 1**	**Chemical Foundation (Ch 1-2)**		
	Chapter 1	Classification of Matter, Physical & Chemical Changes, Measurement, Dimensional Analysis, Hypothesis, Laws, and Theories	LO 1.17, 2.19, 3.1, 3.10	
	Chapter 2	The early atomic structure, the periodic table, atomic mass and molar mass	LO 1.1, 1.4, 1.14, 1.18, 2.8, 3.5, 3.6	
	Lab (GI)	Global Warming – Students design experimental method to determine personal yearly output of carbon dioxide from breathing alone	SP 2, 3, 4, 5, 6, 7	CR 4
	Lab (GI)	Empirical Formula of an Oxide of Magnesium – Students design method, material quantity, data collection, data analysis, error analysis.	LO 1.1, 3.5, 3.6 SP 2, 4, 5, 6	
	Lab	Paper Chromatography – to learn separation techniques	LO 2.7, 2.10 SP 3, 4, 5, 6	
	Activity	Gravimetric Analysis – Students design method and analyze a given set of data to determine amount of carbonate in water	LO 1.19 SP 2, 3, 5, 6	CR 3c
	DCI Vol.1 Activity	Worksheets on introductory material such as classification of matter, atomic mass, and measurement, taken from *During Class Inventions* by Abraham, Gelder, and Greenbowe	LO 3.1, 3.10	
Early to mid-Sept.	**Unit 2**	**Elements, Compounds, Reactions, Equations, Stoichiometry (Ch 3-4)**		
	Ch 3.1-3.7	Elements and compounds, formulas and names	LO 1.18, 2.1	

	Ch 3.8-3.10	The mole, percent composition, empirical & molecular formulas	LO 1.1, 1.2, 1.3, 1.18, 3.6	
	Ch 3.11	Chemical Equations	LO 1.17, 1.18, 3.1, 3.2, 3.3, 3.4	
	4.1	The Greenhouse Effect		
	4.2-4.3	Stoichiometry	LO 1.17, 3.3, 3.4, 3.10	
	4.4-4.5	Solution Stoichiometry	LO 2.1, 2.9, 3.10	
	4.6-4.9	Reactions and Equations – precipitation, acid/base, redox	LO 1.20, 2.1, 3.1, 3.2, 3.3, 3.4, 3.8, 3.10	
	Lab	Studying Redox Reactions – Students run 10 redox reactions, write equations and draw particulate views of reactants and products	LO 3.8 SP 1, 6	
	Lab (GI)	ID of 4 Unknowns – Given a NaOH solution of known concentration and unidentified solutions of barium nitrate, phenolphthalein, sulfuric acid, and nitric acid, all in disposable pipets, students design method to determine experimentally the ID of the 4 solutions and to determine the concentration of each acid	LO 1.20, 3.7 SP 3, 4, 5, 6	
	Lab (GI)	Molar Mass of a Volatile Liquid – Given a small amount of an unknown volatile liquid, students design method to experimentally determine the molar mass; students also devise experimental method and analyze data to determine molar mass of butane gas	SP 2, 3, 4, 5, 6	
	Lab (GI)	Reaction Stoichiometry – Students use the continuous variation method to explore the effect of mixing various quantities of two solutions on temperature and how the experiment determines stoichiometry of the reaction	LO 3.3, 3.4, 3.11 SP 2, 3, 4, 5, 6	
	Activity	From the mileage used in a family car in a year and the car's capacity in miles per gallon of gasoline, students calculate the car's yearly contribution of CO_2 from the burning of gasoline in oxygen	LO 1.4, 3.1, 3.2	CR 3c CR 4
	DCI Vol. I Activity	Worksheets on mole-mass conversions, percent composition, empirical and molecular formulas, stoichiometry, equations, etc.	LO 1.1, 1.2, 1.3, 1.18, 3.1, 3.3, 3.4	CR 3a, CR3c

	CB Guided Inquiry Activity	Understanding the Meaning of a Balanced Chemical Equation – using pictorial and symbolic representations for chemical reactions	LO 1.4, 1.17, 1.18, 3.1, 3.2, 3.4	CR 3a, CR 3c
End of Sept.-early Oct.	**Unit 3**	**Gases (Ch 5)**		
	5.1, 5.2	Pressure		
	5.3-5.7, 5.9	Gas Laws and Gas Stoichiometry	LO 2.4, 2.5, 2.6, 3.1, 3.3, 3.4	
	5.8	Kinetic Molecular Theory	LO 2.4, 2.5	
	5.10	Real Gases	LO 2.4, 2.5, 2.12	
	Lab (GI)	Air Bag – Students design method to produce a simulated air bag using a zip-lock sandwich bag, hydrochloric acid, and baking soda.	SP 2, 3, 4, 5, 7	
	DCI Vol. I Activity	Worksheets on gas laws, gas stoichiometry, and pictorial experiments relating gas pressure, temperature, and volume	LO 2.5, 2.6	CR 3b
Mid-Oct.	**Unit 4**	**Chemical Equilibrium (Ch 14)**		
	14.1	Hemoglobin and Equilibrum	LO 6.1	
	14.2-14.6, 14.8	The Equilibrium Concept and Calculations	LO 5.17, 6.1, 6.2, 6.6, 6.7	
	14.7	Reaction Quotient – Predicting direction of change	LO 6.4, 6.6	
	14.9	Le Chatelier's Principle	LO 5.16, 6.3, 6.8, 6.9, 6.10	
	On-line Activity	From the Oklahoma State U's website. students explore the extent of a reaction and effects of a stress on a system at equilibrium	LO 6.1, 6.3, 6.4, 6.8, 6.9 SP 1, 5, 6	CR 3f
	DCI Vol. II Activity	Worksheets on pictorial representations and calculations of equilibrium systems	LO 6.2, 6.4, 6.5, 6.6, 6.7	CR 3f
	Demo	Cobalt Chloride Equilibrium Demo	LO 6.1, 6.2,	
Nov.	**Unit 5**	**Acids and Bases (Ch 15)**		
	15.1-15.4	Acids and Bases – Nature, Definitions, Strength, Ka	LO 2.2, 3.1, 3.7, 6.7, 6.11, 6.15, 6.16, 6.17, 6.19	
	15.5	Autoionization of water and pH	LO 6.14	
	15.6	Calculations of concentration and pH	LO 6.12, 6.19	

	15.7	Base Solutions	LO 6.11, 6.15, 6.16, 6.17	
	15.9	Polyprotic acids (no calculations)	LO 6.13, 6.17	
	15.8, 15.10	Acid properties of salts, acid strength and molecular structure	LO 2.2, 6.17	
	DCI Vol. II Activity	Worksheets on acid-base theories, pH, Ka and Kb, salts, and equilibrium concentrations	LO 6.11, 6.12, 6.15, 6.16, 6.17	CR 3f
Late Nov.-early Dec	**Unit 6**	**Buffers, Titrations, and Ksp (Ch 16)**		
	16.2, 16.3	Buffer systems	LO 6.1, 6.11, 6.20	
	16.4	Titrations and pH curves	LO 1.20, 6.11, 6.12, 6.13, 6.20	
	16.5-16.7	Solubility Product, Precipitation, Qualitative Analysis	LO 6.21, 6.22, 6.23	
	Lab	Standardization of NaOH Solution – learn lab techniques and discuss experimental errors	LO 1.20, 6.12, 6.13 SP 2, 5	
	Lab	Vinegar Analysis – Titration of commercial vinegar with NaOH solution to determine the mass percent of acetic acid in vinegar	LO 1.20, 6.12, 6.13 SP 2, 5, 6, 7	
	Lab (GI)	Anatacid Analysis – Students design method to determine experimentally the mass percent of magnesium hydroxide in an antacid tablet	LO 1.20, 3.4, 6.12, 6.13 SP 2, 3, 4, 5, 6, 7	
	Lab (GI)	Preparation and Testing of a Buffer (reference: College Board lab manual) – Students choose a set of chemicals and design the method to prepare a buffer solution of target pH, and to test its effectiveness by adding HCl and NaOH to separate quantities of the buffer solution	LO 6.18 SP 2, 3, 4, 5, 6, 7	
	On-line Activity	From Iowa State U website, students explore acid-base titrations to determine concentration of analyte using titrant of known concentration	LO 3.1, 6.12, 6.13 SP 2, 5, 6	CR 3c CR 3f
	DCI Vol. II Activity	Worksheets on titrations, buffer systems, solubility and precipitation	LO 6.13, 6.19, 6.20, 6.21, 6.22, 6.23	CR 3f

Mid-Dec	**Unit 7**	**Kinetics (Ch 13)**		
	13.2, 13.5	Rate of reaction, factors	LO 3.1, 4.1, 4.4, 4.5, 4.6	
	13.3-13.4	Rate laws- differential and integrated	LO 4.1, 4.2, 4.3	
	13.6	Reaction mechanisms	LO 3.1, 4.7	
	13.7	Catalysis	LO 3.1, 4.8, 4.9	
	Lab	Kinetics of Crystal Violet – Students determine the order of the reaction of crystal violet and sodium hydroxide using a colorimeter and Vernier technology	LO 4.2 SP 3, 4, 5, 6	
	Oral Activity	Given multiple sets of concentrations vs. time conditions, students determine orally the kinetic orders of reactions and calculate rate constants with units	LO 4.2	CR 3d
	DCI Vol. II Activity	Worksheets using graphical representations and given kinetic data, on reaction rates, order, differential and integrated rate laws, and half-life calculations	LO 4.2, 4.3	CR 3d
Jan.	**Unit 8**	**Thermochemistry (Ch 6, 8.1, 9.4, 9.10, 11.5-11.7, and 12.3) and Thermodynamics (Ch 17)**		
	6.1-6.4	Introduction to Energy – terms and the first law of thermodynamics, temperature, energy, heat, and work	LO 3.11, 5.2, 5.3, 5.4, 5.5, 5.6	
	11.5-11.7	Heat of Vaporization, Heat of Fusion, and Heating Curve for Water	LO 5.6, 5.7	
	12.2-12.3	Solution Energetics	LO 2.8, 2.15, 5.1, 5.8, 5.10	
	8.1, 8.3, 9.4, 9.10	Coulomb's Law, Lattice Energy, Bond Energy and Bond Length	LO 2.14, 2.21, 5.1, 5.8	
	6.6-6.7 (Skip 6.5)	Calorimetry	LO 3.11, 5.4, 5.5, 5.6, 5.7	
	6.8	Relationships Involving Change of Enthalpy	LO 5.4, 5.8	
	6.9	Standard Heat of Formation	LO 5.6, 5.8	
	17.1-17.2	Introduction to Spontaneity		
	17.3-17.4	Entropy	LO 5.2, 5.12, 5.13	
	17.5	Gibbs Free Energy	LO 5.13, 5.14, 5.18	
	17.6-17.7	Changes in Entropy and Free Energy in chemical reactions	LO 5.12, 5.13, 5.14, 5.15, 5.16, 5.18	

	17.8	Free energy for non-standard states	LO 5.12, 5.13, 5.18	
	17.9	Free energy and equilibrium	LO 5.12, 5.13, 5.17, 5.18, 6.25	
	Lab (GI)	Hand Warmer – Students explore the effectiveness hand warmers (reference: College Board lab manual); and/or Enthalpy of Fusion – Students design experiment to determine the enthalpy of fusion of ice	LO 5.4, 5.5, 5.6, 5.7 SP 2, 3, 4, 5, 6, 7	
	Activity	Exploring Hess's Law for the Heat of Formation of Magnesium Oxide - Given brief procedures of 3 experiments (mixing hot water and cold water, mixing HCl and Mg, and mixing HCl and MgO), students brainstorm the rationales behind each experiment and determine the heat of formation of MgO using given data	LO 5.4, 5.5, 5.6, 5.7, 5.8 SP 2, 3, 5, 6	CR 3e
	Activity	After a video demonstration of the Thermite reaction, students relate chemical principles of the huge amount of heat evolved to the food calories produced by a single cheeseburger	LO 1.4, 3.1, 3.2, 3.3, 5.6, 5.8	CR 3c CR 3e CR 4
	DCI Vol. I Activity	Worksheets using both pictorial representations and calculation problems on temperature, heat, calorimetry, Hess's Law, and enthalpy	LO 5.4, 5.5, 5.6, 5.7	CR 3e
Feb	**Unit 9**	**Electrochemistry (Ch 18)**		
	18.2	Balancing redox equations	LO 3.2, 3.8	
	18.3-18.7, 18.9	Galvanic cell, standard electrode potentials, cell potential, relationship with free energy, equilibrium constant, and concentration, batteries, corrosion	LO 3.1, 3.8, 3.12, 3.13	
	18.8	Electrolysis	LO 3.12, 3.13, 5.15	
	Lab (GI)	Bleach Analysis – Students design method to determine the mass percent of sodium hypochlorite in commercial bleach using redox titration	LO 3.8, 3.9 SP 2, 3, 4, 5, 6, 7	
	Lab	Fuel Cell Model Car – Students learn how solar energy causes water to decompose and how a galvanic cell recombines the elements and converts electrical energy into mechanical energy to run the car	LO 3.5, 3.6, 3.12, 3.13 SP 1, 4, 6, 7	

	Lab	Electrolysis of KI Solution – Students set up a microscale system to electrolyze KI solution and visualize evidence for the half-reactions	LO 3.12, 3.13 SP 3, 5, 6	
	On-line Activity	From the Oklahoma State U website, students explore the effects of different electrodes in a galvanic cell	LO 3.13	CR 3c
	DCI Vol. II Activity	Worksheets on redox reactions, cell potentials in galvanic (voltaic) and electrolytic cells, and electrolysis	LO 3.8, 3.12, 3.13	
Late Feb	**Unit 10**	**Atomic Theory (Ch 7 & 8)**		
	7.2	The nature of light	LO 1.6, 1.12, 1.15	
	7.3	Atomic Spectroscopy & Quantum Mechanics	LO 1.6, 1.9, 1.10, 1.12, 1.13, 1.15	
	7.6	Atomic Orbitals (excluding quantum numbers)	LO 1.6, 1.9, 1.10, 1.12, 1.13, 1.15	
	8.2-8.4	Electronic configuration, Coulomb's Law, Photoelectron Spectroscopy (PES)	LO 1.6, 1.7, 1.8, 1.9, 1.10, 1.12, 1.13, 2.23, 2.24, 5.1, 5.8	
	8.5-8.8	The Periodic Table and Periodic Trends	LO 1.6, 1.7, 1.9, 1.10	
	8.9	Alkali Metals, Halogens, and Noble Gases	LO 1.7, 1.9, 1.10, 1.11	
	Lab	Beer's Law – Mass Percent of Copper in Brass (Reference: College Board lab manual))	LO 1.16, 3.4 SP 2, 4, 5, 6	
	On-line Activity	PES – using on-line spectral data from the U of Arizona website to elucidate electronic configuration of elements	LO 1.7 SP 1, 5, 6	CR 3a
	DCI Vol. I Activity	Worksheets on electromagnetic radiation, Bohr model and Shell model of the atom, electron configuration, shielding, and ionization energy, using both pictorial representations for visualization and tabulated data for prediction of trends	LO 1.5, 1.6, 1.9, 1.10, 1.11, 1.12, 1.13	CR 3a
March	**Unit 11**	**Bonding (Ch 9 and 10, 23.2, 23.4)**		

	9.1-9.3	Types of bonds and electron dot representation	LO 2.17, 2.24, 2.26, 2.27, 2.28, 2.31, 2.32	
	9.4	Ionic Bonding and Lattice Energy	LO 2.17, 2.18, 2.19, 2.23, 2.24	
	9.5	Covalent Bonding	LO 2.17, 2.18	
	9.6	Electronegativity and Bond Polarity	LO 2.17, 2.18, 5.1	
	9.7-9.9	Molecular Structures, Resonance, Formal Charge, Exception to Octet Rule	LO 2.21	
	9.11	Bonding in Metals	LO 2.20, 2.26, 2.27	
	23.2, 23.4	Properties of Metals, Alloys	LO 2.25, 2.26, 2.27, 2.28	
	10.2-10.4	VSEPR Theory	LO 2.21	
	10.5	Molecular Polarity	LO 2.21	
	10.6-10.7	Valence Bond Theory and Hybridization	LO 2.21	
	10.8	Molecular Orbital Theory and Delocalization	LO 2.21	
	DCI Vol. I Activity	Worksheets on ionic and covalent bonds, Lewis structures, resonance and formal charges, bond energies, and bond angles	LO 2.1, 2.14, 2.17-2.19, 2.21 SP 1, 6	CR 3b
Late-March-early April	**Unit 12**	**Liquids, Solids, Solutions, Intermolecular Forces (Ch 11 and 12, 20.14, 21.1-21.4; skip 11.10 and 11.11)**		
	11.1-11.3	The 3 States and IMF	LO 2.1, 2.3, 2.11, 2.12, 2.13, 5.9, 5.10, 5.11	
	11.4-11.9	Phase Diagram and Properties of 3 States due to IMF, Water	LO 2.3, 2.15, 2.16, 2.23, 2.24, 5.9, 5.10	
	11.12	Solids - Types	LO 2.29, 2.30, 2.31, 2.32	
	12.2-12.5	Solutions: Types, Energies, and Concentrations	LO 2.8, 2.9, 2.14, 2.15, 6.24	
	12.6	Colligative Properties – qualitative treatment		
	20.14, 21.1-21.4	Polymers, Lipids, Carbohydrates, Proteins, DNA	LO 5.11	
	Lab (GI)	Types of Bonding of Solids – Students design experiments to investigate the types of bonding in several given solids	LO 2.22 SP 3, 4, 5, 6	

	DCI Vol. I Activity	Worksheets involving pictorial and graphical representations and tabulated data, students explain, draw pictures, or calculate values regarding vapor pressure and intermolecular forces	LO 2.1, 2.3, 2.4, 2.5, 2.11, 2.13, 2.16, 2.29, 2.30	CR 3b
Mid- to late April		Review for AP Exam		
Mid-May		Practice SAT Chemistry after AP Exam		