AP® Chemistry Sample Syllabus 2

Syllabus 1029717v1

Curricular Requirements		Page(s)
CR1	Students and teachers use a recently published (within the last 10 years) college-level chemistry textbook.	1
CR2	The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.	1, 7, 8, 9, 10, 11, 12
CR3a	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 1: Structure of matter.	10
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.	11
CR3c	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 3: Chemical reactions.	9
CR3d	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 4: Rates of chemical reactions.	8
CR3e	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 5: Thermodynamics.	7
CR3f	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 6: Equilibrium.	8
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.	9
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.	2
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.	2, 3, 4
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.	2, 3, 4
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.	2

TEXTBOOK:

Chemistry and Chemical Reactivity, Kotz, Treichel and Townsend (publisher Brooks/Cole Cengage) 8th Edition – AP Edition © 2012 **[CR1]**

CR1—Students and teachers use a recently published (within the last 10 years) college-level chemistry textbook.

STRUCTURE OF THE COURSE: [CR2]

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

AP Chemistry is built around six big ideas and seven science practices. The big ideas are:

Big Idea 1: The chemical elements are fundamental building materials of matter, and all matter can be understood in terms of arrangements of atoms. These atoms retain their identity in chemical reactions.

Big Idea 2: Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.

Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.

Big Idea 4: Rates of chemical reactions are determined by details of the molecular collisions.

Big Idea 5: The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.

Big Idea 6: Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations.

The science practices for AP Chemistry are designed to get the students to think and act like scientists. The science practices are:

Science Practice 1: The student can use representations and models to communicate scientific phenomena and solve scientific problems.

Science Practice 2: The student can use mathematics appropriately.

Science Practice 3: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.

Science Practice 4: The student can plan and implement data collection strategies in relation to a particular scientific question.

Science Practice 5: The student can perform data analysis and evaluation of evidence.

Science Practice 6: The student can work with scientific explanations and theories.

Science Practice 7: The student is able to connect and relate knowledge across various scales, concepts, and representations in and across domains.

LABORATORY INVESTIGATIONS:

The laboratory portion of this class is designed to be the equivalent of a college laboratory experience. Because some colleges require proof of the laboratory portion of the course before granting credit, all students will keep a laboratory notebook, provided by the teacher. At a minimum, twenty-five percent of instructional time will be spent in the laboratory. **[CR5a]**

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.

When the students finish AP Chemistry, they are encouraged to take their laboratory notebook with them to college. It includes nineteen laboratory investigations. They are all "wet labs." Seven of the labs are guided inquiry based. Each report in the student's laboratory notebook has sections on purpose, procedure, equipment needed, data, analysis, questions for the students to answer, and conclusion. **[CR7]**

Students must turn in completed laboratory reports for each lab. Each student is required to communicate their results once per semester using a method of their choice (PowerPoint, Poster, Article, etc.)

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.

Laboratory Equipment

The school is equipped with a full range of glassware (beakers, flasks, burets, eudiometer tubes, pipets, etc.), instruments (Spec-20s, analytical balances, centrifuges, ovens, etc.), and data gathering probes. All of the students have access to a computer with a full range of MS Office products on them. In addition, all computers have Data Studio on them so students can use that program to analyze laboratory data. Data can be collected (1) by the students, (2) via computer, or (3) via data gathering handheld units. All data is recorded in their laboratory notebook.

Laboratory Investigation Sequence

First Nine Weeks

MSDS and laboratory safety

- Students read and understand MSDS (and GHS compliant SDS when implemented)
- Students demonstate safe laboratory practices for various laboratory situtations

Qualitative description (SP 5) **[CR5b] & [CR6]**

- To investigate the color of various ions in a flame test
- To investigate the color of various ions in solution
- To develop the solubility rules from reactions that produce precipitates and observe their color

Empirical formula of hydrate (LO 3.5; SP 1, 2, 5, 6) **[CR5b] & [CR6]**

- To find the percentage of water in a hydrate
- To use the MSDS sheets to find information about unknown substances
- To find the empirical formula of an unknown hydrate

Guided Inquiry Lab – Empirical formula by direct combination (LO 3.5; SP 1, 2, 3, 4, 5, 6, 7) **[CR5b] & [CR6]**

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.

- Students will not be given any procedures to determine the empirical formula – they have to develop them on their own
- To find the empirical formula of an unknown compound
- To distinguish between the molecular formula and the empirical formula of a compound

Stoichiometry of a reaction (LO 6.9; SP 1, 2, 3, 5) **[CR5b] & [CR6]**

- To find the mole ratio of a chemical reaction
- To identify the soluble and insoluble products of a reaction

Redox Titration of Bleach (LO 3.9; SP 1, 2, 3, 5) **[CR5b] & [CR6]**

- To find the percent of sodium hypochlorite in bleach
- To use the technique of titration to determine a reactant

Thermochemistry: Enthalpy and specific heat (LO 5.7; SP 1, 2, 3, 5, 6) **[CR5b] & [CR6]**

- To determine the specific heat of an unknown solution
- To determine the $\triangle H_{rxn}$

Second Nine Weeks

Guided Inquiry Lab - Kinetic study of thiosulfate in acid solution (LO 4.1, 4.2; SP 1, 2, 3, 4, 5, 6, 7) **[CR5b] & [CR6]**

- To study the kinetics of the reaction between thiosulfate and hydrochloric acid
- To graph laboratory data and to determine the order of the reaction

Chemical kinetics: Iodine Clock reaction (LO 4.1, 4.2; SP 1, 2, 5, 6, 7) **[CR5b] & [CR6]**

- To study the effects of concentration on the kinetics of a reaction
- To determine the rate law for a reaction
- To determine the rate constant for a reaction

Determination of molar volume of a gas (SP 1, 2, 5, 6) **[CR5b] & [CR6]**

- To verify the molar volume of a gas, using butane gas (C_4H_{10})
- To use the techniques of error analysis to determine the validity of your answer

Calculation of the Ideal Gas Constant, R (SP 1, 2, 5, 6) **[CR5b] & [CR6]**

- To experimentally verify the value of the ideal gas constant
- To determine the precision and accuracy of the experimental data

Molar mass of a volatile liquid by the Vapor Density Method (SP 1, 2, 5, 6) **[CR5b] & [CR6]**

- To determine the molar mass of a liquid by the vapor density method

Constuction of an electrochemical cell (SP 1, 2, 5, 6) **[CR5b] & [CR6]**

- Students construct various electrochemical cells and measure their voltages

Third Nine Weeks

Guided Inquiry Lab - Acid-base titration part I (LO 1.20, 6.13, 6.18, 6.20; SP 1, 2, 3, 4, 5, 6, 7)

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.

- Students will not be given any procedures for this lab – they have to develop them on their own **[CR5b] & [CR6]**
- To prepare an unknown concentration solution of NaOH and then to standardize it using a standard solution of HCl
- To use the solution of NaOH, now standardized, in Experiment Fourteen to determine the concentration of a weak acid, and in Experiment Fifteen to determine the K_a of an acid

Guided Inquiry Lab – Acid-base titration part II (LO 1.20, 6.13, 6.18, 6.20; SP 1, 2, 3, 4, 5, 6, 7)

Students will not be given any procedures for this lab – they have to develop them on their own **[CR5b] & [CR6]**

- To use a previously standardized solution to titrate an unknown solution
- To use a pH meter to determine the concentration of an unknown solution
- To construct an acid-base titration curve and determine the pK_a of a weak acid (LO 1.15, 1.20, 6.13, 6.18, 6.20; SP 1, 2, 3, 4, 5, 6, 7) **[CR5b] & [CR6]**
- To determine the K_a of acetic acid from an acid-base titration curve
- To determine the K_a of an unknown acid using the (non titration curve) half-equivalence point
- To determine the K_a of BTB using a spectrophotometer

Fourth Nine Weeks

Guided Inquiry Lab - Separation by paper chromatography (LO 2.7, 2.10; SP 1, 3, 5, 6, 7)

- Students translate the technique to thin-layer or column chromatography (students choose which extension to do) **[CR5b] & [CR6]**
- To separate food colors into their different compounds
- To investigate the various techniques of chromatography

Guided Inquiry Lab - "Four bottle problem" (LO 1.19, 2.10, 2.22, 3.10; SP 1, 3, 4, 5, 6, 7) **[CR5b] & [CR6]**

- Students are given eight bottles with labels that have been removed. They are to take four bottles at random and develop a series of tests to put the correct label on each bottle

Guided Inquiry Lab - How much zinc is in a penny (LO 1.16; SP 1, 2, 3, 4, 5, 6, 7) **[CR5b]** & **[CR6]**

- Students design an experiment to determine the amount of zinc in a post 1982 penny

Molecular Geometry Lab (SP 1, 6, 7) **[CR5b] & [CR6]**

- Students draw Lewis Dot Diagrams and then build the models corresponding to the Lewis Dot Diagrams

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.

Summer Homework:

Students complete the ONboard Chemistry program on-line before coming to AP Chemistry. This summer homework assignment can be done on an independent basis as the student's summer schedule permits. Information on the ONboard Chemistry program can be found at www.onboard.mcgraw-hill.com/. Students are required to show mastery of their learning by sending the teacher the final comprehensive assessment – which constitutes 25% of the final exam grade for the first semester. This material is incorporated in ALL exams given in this class. If a student does not want to complete the on-line component of the summer homework, a textbook is issued at the start of summer vacation and alternative assignments from the textbook will be provided.

The program consists of seven modules. Each module is broken into several units. The table of contents are below.

Module 1: Math Skills and Models

01: Scientific Notation
02: Significant Figures
03: Units, Conversions, and Dimensional Analysis
04: Percent Error
05: Graphing
06: Estimation
07: Math Sense
08: Solving Equations

Module 2: Understanding the Scientific Method

01: AP Science Practices
02: Scientific Questions
03: Data, Claim, and Evidence
04: Representations and Models

Module 3: Matter and Structure

01: Atomic Structure and Electron Configuration
02: Elements, Compounds, and Mixtures
03: States, Properties, and Changes in Matter

Module 4: Periodicity and Nomenclature

01: Introduction to the Periodic Table
02: Periodic Trends
03: Bonding
04: Nomenclature

Module 5: The Mole and Molarity

01: Avogadro's Number, Conversions and Calculations
02: Empirical and Molecular Formulas
03: Molarity

Module 6: Reactions and Stoichiometry

01: Writing and Balancing Chemical Equations
02: Oxidation Numbers and Redox Reactions
03: Classifying Chemical Reactions
04: Acid and Base Reactions
05: Reaction Stoichiometry

Module 7: Gas Laws

01: Kinetic Molecular Theory
02: Individual Gas Laws
03: Combined and Ideal Laws
04: Gas Stoichiometry

SEQUENCE:

First Nine Weeks			AP Chemistry Curriculum		
Chapter	*Topics Covered*	*Activities*	*Big Ideas* **[CR2]**	*EU*	*LO*
Five Principles of Chemistry Reactivity: Energy and Chemical Reactions	• Energy • Specific Heat • First Law of Thermodynamics • Enthalpy and calorimetry • Hess's Law		3 5	3.C 5.A 5.B 5.C 5.E	3.11 5.3 5.4 5.5 5.6 5.7
Nineteen Principles of Chemical Reactivity: Entropy and Free Energy	• Spontaneous versus non-spontaneous (thermodynamically favored versus not favored) • Entropy • Free Energy • Three laws of thermodynamics • Concept of equilibrium	• Given a set of conditions, the students determine if the situation is thermodynamically favored or not favored by looking at entropy, enthalpy, and Gibbs Free Energy (LO 5.13) **[CR3e]**	2 5 6	2.B 5.A 5.C 6.D	2.15 5.3 5.12 5.13 5.14 5.15 5.16 5.17 5.18 6.25
Second Nine Weeks			**AP Chemistry Curriculum**		
Chapter	*Topics Covered*	*Activities*	*Big Ideas* **[CR2]**	*EU*	*LO*
Twenty Principles of Reactivity: Electron Transfer Reactions	• Review redox reactions • Oxidation versus reduction • Oxidizing and Reducing agents • Galvanic and voltaic cells • Electrolysis	• Students balance by the half-reaction method • Students balance by oxidation number change method	3 5 6	3.A 3.B 3.C 5.E 6.A	3.2 3.8 3.12 3.13 5.15 6.1

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

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

Chapter	*Topics Covered*	*Activities*	*Big Ideas* **[CR2]**	*EU*	*LO*
Fifteen Chemical Kinetics: The Rates of Chemcial Reactions	• Reaction rates • Relative rates • Rate law, general form • Determination of rate law • Graphical methods for zero, first, and second order rate laws. • Mechanisms	• Students complete the worksheets "Simple Rate Laws" and "Not So Simple Rate Laws" and use the given data to determine the order of each reactant (LO 4.2) **[CR3d]** • Students complete the "candy decay chain" activity (M&Ms decay into Skittles which decay into Sweetarts which decay into Smarties, which are stable). They construct four graphs, to show the relationship over time of the four candies and the half-life of each candy is determined (this models nuclear decay – first order kinetics). (LO 4.3) **[CR3d]**	4	4.A 4.B 4.C 4.D	4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8 4.9

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

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

Third Nine Weeks			**AP Chemistry Curriculum**		
Chapter	*Topics Covered*	*Activities*	*Big Ideas* **[CR2]**	*EU*	*LO*
Sixteen Principles of Reactivity: Chemical Equilibria	• Nature of equilibrium • Equilibrium constant • K_c and K_p • Use of ICE tables to solve K_c, K_p • Conversion between K_c, K_p • Le Chatelier's Principle	The students review the PowerPoint presentation entitled "Equilibrium Made Easy" and given a set of problems, determine the type of equilibrium problem it is (i.e. given K or asked to find K) and then determine the missing values by using an ICE table. This activity focuses on the structure of equilibrium questions. (LO 6.5) **[CR3f]**	6	6.A 6.B	6.1 6.2 6.3 6.4 6.5 6.6 6.7 6.8 6.9 6.10

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

Chapter	*Topics Covered*	*Activities*	*Big Ideas* **[CR2]**	*EU*	*LO*

Seventeen Principles of Reactivity: The Chemistry of Acids and Bases	• Concepts of acid and bases
	  • Arrhenius
	  • Bronsted-Lowry
	  • Lewis
	• Strength of acid and bases
	• pH and pOH
	• K_a, K_b
	• Finding pH of strong and weak acids and bases
	• Auto-ionization of water and K_w
	• pH of different salts
			6	3.B
				6.A
				6.C
					2.1
					2.2
					3.7
					6.1
					6.11
					6.12
					6.14
					6.15
					6.16

Eighteen Principles of Reactivity: Other Aspects of Aqueous Equilbria	• Acid-base titration curves • Indications and their roles • Common ion-effect • Buffers • Solubilty product constant, K_{sp}		1 3 6	1.E 3.A 6.A 6.C	1.20 3.3 6.1 6.12 6.13 6.15 6.16 6.17 6.18 6.19 6.20 6.21 6.22 6.23
	• Relationships • Relating thermodynamics to electrochemistry • Relating electrochemistry to equilibrium via thermodynamics	Students conduct an investigation into the major components of acid rain and write the reactions that occur between the pollutant and the compounds naturally present (i.e. water, oxygen, carbon dioxide). (LO 3.2) **[CR3c] & [CR4]**	3 4 5 6		

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

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

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.

Fourth Nine Weeks - Review			AP Chemistry Curriculum		
Chapter	*Topics Covered*	*Activities*	*Big Ideas* **[CR2]**	*EU*	*LO*
Two Atoms, Molecules and Ions	• Atomic structure • Average atomic mass • Isotopes	Students use a mass spectrometer printout of the relative masses of isotopes of an element to determine (a) the percentages of the isotopes and (b) the average atomic mass of the element. (LO 1.14) **[CR3a]**	1 2 3	1.A 1.B 1.E 2.C 3.B	1.1 1.17 2.17 3.5 3.6
Three Chemical Reactions	• Double Replacement, single replacement, combustion, decomposition, combination reactions, gas forming • Solubility rules • Precipitation reactions • Acid-base reactions • Redox reactions • Combustion analysis		1 2 3 5 6	1.A 1.E 2.A 2.B 2.D 3.A 3.B 3.C 5.D 6.C	1.4 1.17 1.18 2.8 2.9 2.14 3.1 3.2 3.3 3.4 3.8 3.9 3.10
Four Stoichiometry: Quantitative Information and Chemical Reactions	• Nomenclature • Molar mass of compounds • Hydrated compounds • Balancing equations • Percent composition • Excess and limiting reagents • Percent yield		1 3	1.A 1.D 1.E 3.A 3.B	1.1 1.2 1.3 1.4 1.14 1.17 1.18 1.19 3.1 3.3 3.4 3.6

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.

Chapter	*Topics Covered*	*Activities*	*Big Ideas* **[CR2]**	*EU*	*LO*

Six
The Structure of Atoms
 	
Seven
The Structure of Atoms and Periodic Trends
	• Different models
	• Quantum view of atom
	• Electron Configurations
	  • Aufbau
	  • Hund's Rule
	  • Pauli Exclusion Principle
	• Periodic Trends
	  • Coulomb's Law
	  • Different trends
	• Photoelectron Spectroscopy
			1
			5
				1.B
				1.C
				1.D
				5.E
					1.5
					1.6
					1.7
					1.8
					1.9
					1.10
					1.12
					1.13
					1.15

Eight
Bonding and Molecular Sturcture
 	
Nine
Bonding and Molecular Structure: Orbital Hybridization
	• Bonding
	  • Metallic
	  • Ionic
	  • Covalent
	• Types of energy associated with different structures:
	  • bond dissociation energy
	  • lattice energy
	• Types of covalent bonds, sigma, pi, resonance structures
	• Lewis Dot Diagrams
	• Formal Charge
	• VSEPR Theory
	• Hybridization
		The students are provided with Potential Energy Curves and compare single, double, and triple bonds – looking for patterns and investigating the strength of the different types of bonds. (LO 2.17) **[CR3b]**	1
			2
			5
				1.B
				1.C
				1.D
				2.C
				2.D
				5.C
					1.7
					1.8
					1.15
					2.1
					2.17
					2.18
					2.21
					2.23
					2.24
					5.1
					5.8

Eleven Gases and their Properties	• Ideal versus Real • Gas Laws • Kinetic Molecular Theory		1 2 3 5	1.A 2.A 2.B 3.A 5.A	1.3 1.4 2.4 2.5 2.6 2.12 2.15 3.4 5.2

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

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.

Chapter	*Topics Covered*	*Activities*	*Big Ideas* **[CR2]**	*EU*	*LO*

Twelve Intermolecular Forces and Liquids
 	
Thirteen The Chemistry of Solids
 	
Fourteen Solutions and Their Behavior
	• Intermolecular Forces
	  • London
	  • Induced dipole – induced dipole
	  • Dipole – dipole
	• Bond versus molecular polarity
	• Properties of liquids
	• Structures of solids
	• Phase Change Diagrams
	• Solution Chemistry
	  • Supersaturated solutions
	  • Saturated solutions
	  • Unsaturated solutions
			1
			2
			5
			6
				1.C
				2.A
				2.B
				2.C
				2.D
				5.B
				5.D
				6.A
				6.C
					1.11
					2.1
					2.3
					2.8
					2.9
					2.11
					2.13
					2.14
					2.15
					2.16
					2.19
					2.20
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					2.23
					2.24
					2.25
					2.26
					2.27
					2.28
					2.29
					2.30
					2.31
					2.32
					5.6
					5.9
					5.10
					5.11
					6.24

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