SAMPLE SYLLABUS #1

AP® Chemistry

Curricular Requirements

CR1	The students and teacher have access to college-level resources including a recently published (within the last 10 years) college-level textbook and reference materials in print or electronic format.	*See page:* 2
CR2	The course is structured to incorporate the big ideas and required content outlined in each of the units described in the AP Course and Exam Description (CED).	*See page:* 5
CR3	The course provides opportunities for students to develop skills related to Science Practice 1: Models and Representation.	*See pages:* 5, 12
CR4	The course provides opportunities for students to develop skills related to Science Practice 2: Question and Method.	*See pages:* 11, 12
CR5	The course provides opportunities for students to develop skills related to Science Practice 3: Representing Data and Phenomena.	*See pages:* 5, 6, 9, 10
CR6	The course provides opportunities for students to develop skills related to Science Practice 4: Model Analysis.	*See pages:* 6, 7
CR7	The course provides students with opportunities to develop skills related to Science Practice 5: Mathematical Routines.	*See pages:* 7, 8, 9, 12
CR8	The course provides opportunities for students to develop skills related to Science Practice 6: Argumentation.	*See pages:* 5, 10
CR9	The course provides students with opportunities to apply their knowledge of AP Chemistry concepts to real-world questions or scenarios to help them become scientifically literate citizens.	*See page:* 8
CR10	Students spend a minimum of 25% of instructional time engaged in a wide range of hands-on, inquiry-based laboratory investigations to support learning required content and developing science practices throughout the course. At minimum, 16 labs are performed of which at least 6 are conducted in a guided inquiry laboratory format.	*See page:* 3
CR11	The course provides opportunities for students to record evidence of their scientific investigations. Evidence can be recorded in lab reports or another appropriate formal manner for inclusion in lab notebooks/portfolios (print or digital format).	*See page:* 3

Advanced Placement Chemistry Sample Syllabus #1

Course Overview:

The purpose of this AP Chemistry course is to provide a freshman-level college course to ensure that the student is prepared to succeed in college chemistry. This is accomplished by teaching all the topics detailed in the AP Chemistry Course and Exam Description. The course is organized around the four big ideas and is aligned with the six science practices. Laboratory experiments are conducted to compliment the material being learned. The experiments will include at least 20 labs, of which at least 6 will be inquiry-based labs. Lab time will account for over 25% of the instructional time—some labs are completed in one class period, but many labs require multiple periods. We meet as a class for seven periods a week—at least two-and-a-half of those periods are devoted to laboratory experiments and other like activities. Emphasis in this class is placed on application of chemical concepts with real-world applications. Each of the topics within the nine units are covered in depth, and the students will be assessed after the completion of each topic unit.

Textbooks (Primary text listed first)

Zumdahl, Steven S., Zumdahl, Susan A., DeCoste, Donald J. *Chemistry*, 10th Edition. Cengage Learning. Boston, MA, 2018 **CR1**

Theodore E. Brown, et al., *Chemistry, The Central Science*, 14th Edition. Pearson. New York, NY, 2018

Moog, Richard S., & Farrell, John J., *Chemistry: A Guided Inquiry*, 6th Edition. John Wiley & Sons. Hoboken, NJ, 2014

Trout, Laura, editor. *POGIL Activities for AP Chemistry*. Flinn Scientific & The POGIL Project. Batavia, IL, 2015

CR1
The syllabus must cite the title, author, and publication date of a college-level textbook. The primary course textbook must be published within the last 10 years.

Laboratory Experiment Sources

Zumdahl, Steven S., Zumdahl, Susan A., DeCoste, Donald J. *Lab Manual for Zumdahl, Chemistry*, 10th Edition. Cengage Learning. Boston, MA, 2017

Slowinski, Emil J., Wolsley, Wayne C., Rossi, Robert, *Chemical Principles in the Laboratory*, 11th Edition. Cengage Learning. Boston, MA, 2016

Vonderbrink, Sally Ann. *Laboratory Experiments for Advanced Placement Chemistry*, 2nd Edition. Flinn Scientific, 2006.

Randall, Holmquist, and Volz. *Advanced Chemistry with Vernier*. Vernier Software and Technology, 2007.

College Board. *AP Chemistry Guided Inquiry Experiments: Applying the Science Practices*, 2019.

Self-Authored Labs

Lesson Delivery and Homework

This course is taught using the blended learning or flipped classroom model. Podcasts covering all the topics in the curriculum are created by the instructor. These podcasts are posted on the school's learning management system. Students are assigned the task of watching the podcasts and taking notes on them. Within the podcasts are formative assessment questions, which help guide the students to a better understanding of the material. The students use their textbook for clarification of topics. The students are then assigned problems sets in WebAssign, an online homework site, for each chapter. All units begin with short lectures; however, the bulk of the class time is spent working on the problem sets. During this time, students can ask for assistance from the instructor. Throughout each unit, **Topic Questions** will be provided to help students check their understanding. The Topic Questions are especially useful for confirming understanding of difficult or foundational topics before moving on to new content or skills that build upon prior topics. After students answer a Topic Question, rationales are provided that will help them understand why an answer is correct or incorrect, and their results can reveal misunderstandings to help them identify content and skills needing additional practice. At the completion of each unit, students will answer the **Personal Progress Check** questions prior to the unit assessment. Students will get a personal report with feedback on each topic, skill, and question that they can use to chart their progress, and their results come with rationales that explain each question's answer. Should remediation be deemed necessary, the students and the instructor will collaborate to remedy any deficiencies prior to the unit assessment.

Laboratory

The laboratory portion of this course is designed to be the equivalent of a college chemistry lab. At least 25% of the instructional time is devoted to the students being engaged in hands-on laboratory experiences. **CR10** Students collect both quantitative and qualitative data, analyze and mathematically manipulate the data, and then draw conclusions from the data. All of the labs are written up in a lab book, which then can be produced as evidence to a college that the student has indeed had a suitable lab experience. A completed lab report that consists of the following:

1. Title and introduction, including objective
2. Qualitative and quantitative data
3. Calculations and chemical equations
4. General discussion—which addresses the main concept of the laboratory
5. Error analysis—which addresses percent error as well as sources of error
6. Discussion and Conclusion—which explains and illustrates how the evidence collected supports the conclusion. **CR11**

The labs are completed during a 92-minute double period with some extended time for the inquiry-based activities. Hands-on guided inquiry labs are marked with "(GI)." **CR10**

1. Percentage of Water in an Unknown Hydrate (GI)
2. Determination of the Percentage of $NaHCO_3$ in a Mixture (GI)
3. Empirical Formula of Copper Iodide
4. Molecular Geometry with Modeling Kits and Modeling Software
5. Inquiry Investigation into Behavior of Gases (GI)
6. Molar Volume of a Gas
7. Determination of the Percentage of Copper in Brass (GI)
8. Airbag Inflation (GI)
9. Standardization of Base and Titration of a Solid Acid
10. Rate Law Determination for Decomposition of Crystal Violet (GI)

CR10
The syllabus must include an explicit statement that at least 25% of instructional time is spent engaged in hands-on laboratory experiences.

CR11
The syllabus must include the components of the written reports required of students for all laboratory investigations.

AND

The syllabus must include an explicit statement that students are required to maintain a lab notebook or portfolio (hard-copy or electronic) that includes all their lab reports.

CR10
A minimum of 16 lab investigations with descriptive titles must be listed.

AND

A minimum of six investigations must be identified as guided inquiry.

11. Determination of the Order, Rate Constant, and Activation Energy for a Clock Reaction
12. The Hand Warmer Lab (GI)
13. Heat of Formation of Magnesium Oxide
14. Le Châtelier's Principle—the Rainbow Lab (GI)
15. Determination of the Equilibrium Constant of $FeSCN^{2+}$ System
16. Calculation of the K_{sp} of Calcium Hydroxide
17. Preparation and Examination of Buffers (GI)
18. Determination of K_a by Half-Titration Method
19. Examination of the Titration Curves for Weak and Strong Acids and Bases
20. Comparison of Acid Strength and Salt Hydrolysis Using Indicators
21. Microvoltaic Cells
22. Redox Titration of Hydrogen Peroxide

Technology

Many technologies are used within this course. Students use Vernier LabQuest® to collect temperature, colorimetric data, pH, gas pressure, voltage, melting point, and spectral data. This data is then input into Vernier Logger Pro®, which is used to analyze and graph the data. Microsoft® Excel is also used for analysis. Analytical balances are used throughout the course. In addition, Texas Instruments Nspire CAS CX calculators are utilized.

Tests

At the completion of each unit's podcasts, problem sets, and labs, a unit test is given. Like the AP Exam, the unit test consists of two parts: multiple choice and free response. A semester exam is also given—as well as a final exam that is taken prior to the AP Exam. This final is then used to determine what areas need to be reviewed during the final two weeks prior to the AP Exam.

Review

Review sessions throughout the year are common; however, the bulk of the review occurs from mid-April through the first week in May. During this time, students are given multiple choice and free response reviews for each chapter or topic. These are collected and become assessments during the fourth nine weeks.

COURSE OUTLINE CR2

First Nine Weeks				
AP Unit (Big Ideas)	**Chapter**	**Topics (Skill)**	**Labs**	**Sample Activities**
1 (SPQ, SAP)	1, 2, 3	Sig Figs (2.D/5.F) 1.1 Moles and Molar Mass (5.B) 1.2 Mass Spectrometry of Elements (5.D) 1.3 Elemental Composition of Pure Substances (2.A) 1.4 Composition of Mixtures (5.A)	▪ Percentage of Water in an Unknown Hydrate (GI) ▪ Determination of the Percentage of $NaHCO_3$ in a Mixture (GI)	▪ Students use data to sketch appropriate mass spectra for selected elements. **(SP 3)** CR5
1 (SPQ, SAP)	7	1.5 Atomic Structure and Electron Configuration (1.A) 1.6 Photoelectron Spectroscopy (4.B) 1.7 Periodic Trends (4.A) 1.8 Valence Electrons and Ionic Compounds (4.C)	▪ Empirical Formula of Copper Iodide	▪ Working in groups of two, students use atomic emission spectra to determine the identity of elements. **(SP 1)** CR3 ▪ Students work in groups to predict and explain atomic properties based on location in the Periodic Table. Students utilize electron configuration and Coulomb's Law in their explanations to justify their assertions. **(SP 6)** CR8
Complete Personal Progress Checks (MCQ and FRQ) for Unit 1				

CR2
The syllabus must include an outline of course content by unit title or topic using any organizational approach to demonstrate the inclusion of required course content and associated big ideas. All nine units and all four big ideas must be included.

CR5
The syllabus must include a **brief description** of an activity or series of activities **(not including the labs listed in CR10)** in which students create representations or models of chemical phenomena. Activities must be labeled with the relevant science practice(s).

CR3
The syllabus must include a **brief description** of an activity or series of activities **(not including the labs listed in CR10)** in which students describe models and representations, including across scales. Activities must be labeled with the relevant science practice(s).

CR8
The syllabus must include a **brief description** of at least one activity or series of activities **(not including the labs listed in CR10)** in which students develop an explanation or scientific argument. Activities must be labeled with the relevant science practice(s).

First Nine Weeks				
AP Unit (Big Ideas)	**Chapter**	**Topics (Skill)**	**Labs**	**Sample Activities**
2 (SAP)	8, 9, 10	2.1 Types of Chemical Bonds (6.A) 2.2 Intramolecular Force and Potential Energy (3.A) 2.3 Structure of Ionic Solids (4.C) 2.4 Structure of Metals and Alloys (4.C) 2.5 Lewis Diagrams (3.B) 2.6 Resonance and Formal Charge (6.C) 2.7 VSEPR and Bond Hybridization (6.C)	▪ Molecular Geometry with Modeling Kits and Modeling Software	▪ Given the chemical formulas of molecules (some that follow the octet rule and some that utilize an expanded octet), students draw Lewis dot structures, predict and name the molecular shapes, and construct models of the molecules out of gumdrops and toothpicks with approximate bond angles shown. **(SP 3)** CR5 Students research the actual bond angles and explain any differences between actual values and their predictions. **(SP 4)** CR6
Complete Personal Progress Checks (MCQ and FRQ) for Unit 2				

CR5
The syllabus must include a **brief description** of an activity or series of activities **(not including the labs listed in CR10)** in which students create representations or models of chemical phenomena. Activities must be labeled with the relevant science practice(s).

CR6
The syllabus must include a **brief description** of an activity or series of activities **(not including the labs listed in CR10)** in which students analyze and interpret models and representations on a single scale or across multiple scales. Activities must be labeled with the relevant science practice(s).

First Nine Weeks				
AP Unit (Big Ideas)	**Chapter**	**Topics (Skill)**	**Labs**	**Sample Activities**
3 (SPQ, SAP)	10	3.1 Intermolecular Forces (4.D) 3.2 Properties of Solids (4.C) 3.3 Solids, Liquids, and Gases (3.C)		▪ Given several compounds, students explain why they differ in physical state at the same temperature using IMFs. **(SP 4)** CR6
	5	3.4 Ideal Gas Law (5.C) 3.5 Kinetic Molecular Theory (4.A) 3.6 Deviation from Ideal Gas Law (6.E)	▪ Inquiry Investigation into Behavior of Gases (GI) ▪ Molar Volume of a Gas	▪ Students work in groups on deviations from the Ideal Gas Law POGIL. **(SP 4)** CR6
	11, 7, Appendix 3	3.7 Solutions and Mixtures (5.F) 3.8 Representations of Solutions (3.C) 3.9 Separation of Solutions and Mixtures, Chromatography (2.C) 3.10 Solubility (4.D) 3.11 Spectroscopy and the Electromagnetic Spectrum (4.A) 3.12 Photoelectric Effect (5.F) 3.13 Beer-Lambert Law (2.E)	▪ Determination of Percentage Copper in Brass (GI)	▪ Students use an online simulation to determine the effects of changing the polarity of the solvent and components of a mixture in a thin-layer chromatography experiment. Students calculate R_f values to determine if solvent distance affects the separation of components proportionately. **(SP 5)** CR7
Complete Personal Progress Checks (MCQ and FRQ) for Unit 3				

CR6
The syllabus must include a **brief description** of an activity or series of activities **(not including the labs listed in CR10)** in which students analyze and interpret models and representations on a single scale or across multiple scales. Activities must be labeled with the relevant science practice(s).

CR7
The syllabus must include a **brief description** of at least one activity or series of activities **(not including the labs listed in CR10)** in which students solve problems using mathematical relationships. Activities must be labeled with the relevant science practice(s).

Second Nine Weeks				
AP Unit (Big Ideas)	**Chapter**	**Topics (Skill)**	**Labs**	**Sample Activities**
4 (SPQ, TRA)	4	4.1 Introduction for Reactions (2.B) 4.2 Net Ionic Equations (5.E) 4.3 Representations of Reactions (3.B) 4.4 Physical and Chemical Changes (6.B) 4.5 Stoichiometry (5.C) 4.6 Introduction to Titration (3.A) 4.7 Types of Chemical Reactions (1.B) 4.8 Introduction to Acid-Base Reactions (1.B) 4.9 Oxidation-Reduction (Redox) Reactions (5.E)	▪ Airbag Inflation (GI) ▪ Standardization of a Base and Titration of a Solid Acid	▪ Students translate descriptions of chemical changes into appropriate net-ionic equations. **(SP 5)** CR7 ▪ Students balance redox reactions from provided half-reactions. **(SP 5)** CR7
Complete Personal Progress Checks (MCQ and FRQ) for Unit 4				

Real World Application CR9

Students complete the Airbag Lab. Using a balanced equation, stoichiometry, and the ideal gas law, students predict the amount of reactant necessary for reaction to fully inflate a quart bag. Students then research the reaction(s) occurring in an actual airbag when it is inflated, as well as the safety of the products of the reaction(s).

CR7

The syllabus must include a **brief description** of at least one activity or series of activities **(not including the labs listed in CR10)** in which students solve problems using mathematical relationships. Activities must be labeled with the relevant science practice(s).

CR9

The syllabus must label and provide a **brief description** of at least one assignment or activity requiring students to apply their knowledge of AP Chemistry concepts to understand real-world questions or scenarios.

Second Nine Weeks				
AP Unit (Big Ideas)	**Chapter**	**Topics (Skill)**	**Labs**	**Sample Activities**
5 (TRA, ENE)	12	5.1 Reaction Rates (6.E) 5.2 Introduction to Rate Law (5.C) 5.3 Concentration Changes Over Time (5.B) 5.4 Elementary Reactions (5.E) 5.5 Collision Model (6.E) 5.6 Reaction Energy Profile (3.B) 5.7 Introduction to Reaction Mechanisms (1.B) 5.8 Reaction Mechanism and Rate Law (5.B) 5.9 Steady-State Approximation (5.B) 5.10 Multistep Reaction Energy Profile (3.B) 5.11 Catalysis (6.E)	▪ Rate Law Determination for Decomposition of Crystal Violet (GI) ▪ Determination of the Order, Rate Constant, and Activation Energy for a Clock Reaction	▪ Students use initial rate data to determine the order of a reaction, rate law, and rate constant. **(SP 5)** **CR7**
		Complete Personal Progress Checks (MCQ and FRQ) for Unit 5		
6 (ENE)	6	6.1 Endothermic and Exothermic Processes (6.D) 6.2 Energy Diagrams (3.A) 6.3 Heat Transfer and Thermal Equilibrium (6.E) 6.4 Heat Capacity and Calorimetry (2.D) 6.5 Energy of Phase Changes (1.B) 6.6 Introduction to Enthalpy of Reaction (4.C) 6.7 Bond Enthalpies (5.F) 6.8 Enthalpy of Formation (5.F) 6.9 Hess's Law (5.A)	▪ The Hand Warmer Lab (GI) ▪ Heat of Formation of Magnesium Oxide	▪ Students will create a particulate drawing representing the arrangement of molecules at each area of a heating curve. **(SP 3)** **CR5**
		Complete Personal Progress Checks (MCQ and FRQ) for Unit 6		

Third Nine Weeks				
AP Unit (Big Ideas)	**Chapter**	**Topics (Skill)**	**Labs**	**Sample Activities**
7 (TRA)	13	7.1 Introduction to Equilibrium (6.D) 7.2 Direction of Reversible Reactions (4.D) 7.3 Reaction Quotient and Equilibrium Constant (3.A) 7.4 Calculating the Equilibrium Constant (5.C) 7.5 Magnitude of the Equilibrium Constant (6.D) 7.6 Properties of the Equilibrium Constant (5.A) 7.7 Calculating Equilibrium Concentrations (3.A) 7.8 Representations of Equilibrium (3.C) 7.9 Introduction to Le Châtelier's Principle (6.F) 7.10 Reaction Quotient and Le Châtelier's Principle (5.F)	▪ Le Châtelier's Principle – The Rainbow Lab (GI) ▪ Determination of the Equilibrium Constant of $FeSCN^{2+}$ System	▪ Students examine a series of particulate "freeze frames" of a chemical system approaching equilibrium. In small groups, they decide which picture first captures the system at equilibrium, and they provide reasoning for why that picture represents the first moment of equilibrium. **(SP 6)** **CR8** ▪ Students make a prediction of what a stress will do to the equilibrium position and then use an online simulation to manipulate an equilibrium system. Students support or refute their predictions with data and Le Châtelier's Principle. **(SP 6)** **CR8**
	16	7.11 Introduction to Solubility Equilibria (5.B) 7.12 Common-Ion Effect (2.F) 7.13 pH and Solubility (2.D) 7.14 Free Energy of Dissolution (4.D)	▪ Calculation of the K_{sp} of Calcium Hydroxide	▪ Students generate a particulate representation to explain how the pH of a saturated solution of barium hydroxide does not change when more solid is added to the mixture or water evaporates from the mixture. **(SP 3)** **CR5**
Complete Personal Progress Checks (MCQ and FRQ) for Unit 7				

CR8
The syllabus must include a **brief description** of at least one activity or series of activities **(not including the labs listed in CR10)** in which students develop an explanation or scientific argument. Activities must be labeled with the relevant science practice(s).

CR5
The syllabus must include a **brief description** of an activity or series of activities **(not including the labs listed in CR10)** in which students create representations or models of chemical phenomena. Activities must be labeled with the relevant science practice(s).

Third Nine Weeks				
AP Unit (Big Ideas)	**Chapter**	**Topics (Skill)**	**Labs**	**Sample Activities**
8 (SAP)	14–15	8.1 Introduction to Acids and Bases (5.B) 8.2 pH and pOH of Strong Acids and Bases (5.B) 8.3 Weak Acid and Base Equilibria (5.C) 8.4 Acid-Base Reactions and Buffers (5.F) 8.5 Acid-Base Titrations (5.D) 8.6 Molecular Structure of Acids and Bases (6.C) 8.7 pH and pK_a (2.D) 8.8 Properties of Buffers (6.D) 8.9 Henderson-Hasselbalch Equation (5.F) 8.10 Buffer Capacity (6.G)	▪ Preparation and Examination of Buffers (GI) ▪ Determination of K_a by Half-Titration Method ▪ Examination of the Titration Curves for Weak and Strong Acids and Bases ▪ Comparison of Acid Strength and Salt Hydrolysis Using Indicators	▪ Students are given the data from an acid-base titration. The students calculate the molarity of the acid used in the titration to be 0.15 *M*. The teacher tells them the actual concentration of the acid is 0.33 *M*. In small groups, students brainstorm possible experimental errors that would lead to the incorrect acid concentration. **(SP 2)** **CR4**
Complete Personal Progress Checks (MCQ and FRQ) for Unit 8				

CR4

The syllabus must include a **brief description** of an activity or series of activities **(not including the labs listed in CR10)** in which students determine scientific questions and methods. Activities must be labeled with the relevant science practice(s).

Fourth Nine Weeks				
AP Unit (Big Ideas)	**Chapter**	**Topics (Skill)**	**Labs**	**Sample Activities**
9 (SPQ, SAP, ENE)	17	9.1 Introduction to Entropy (6.C) 9.2 Absolute Entropy and Entropy Change (5.F) 9.3 Gibb's Free Energy and Thermodynamic Favorability (6.E) 9.4 Thermodynamic and Kinetic Control (6.E) 9.5 Free Energy and Equilibrium (6.D) 9.6 Coupled Reactions (4.D)		▪ Students solve problems determining the values and signs of ΔH, ΔS, and ΔG. **(SP 5)** **CR7**
	18	9.7 Galvanic (Voltaic) and Electrolytic Cells (2.F) 9.8 Cell Potential and Free Energy (5.F) 9.9 Cell Potential Under Nonstandard Conditions (6.D) 9.10 Electrolysis and Faraday's Law (5.B)	▪ Microvoltaic Cells ▪ Redox Titration of Hydrogen Peroxide	▪ Given a sketch of an operational Galvanic cell and a standard reduction potential table, students identify metals and solutions that could be substituted for either the anode or the cathode and still operate as a Galvanic cell. **(SP 1)** **CR3** Students then explain how the change in electrode would alter the cell potential recorded by a voltmeter. **(SP 2)** **CR4**
Complete Personal Progress Checks (MCQ and FRQ) for Unit 9				
Review and AP Exam				
n/a post-exam	19	▪ Radioactive Decay ▪ Half-Life of Isotopes ▪ Medical Applications ▪ Radioisotopic Dating		
n/a post-exam	20–21	▪ Transition Metals ▪ Group Properties		
n/a post-exam	22	▪ Hydrocarbons ▪ Derivatives ▪ Polymerization		