AP Chemistry Syllabus 25-26

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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. 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.

Textbook:
Zumdahl, Steven S., Susan A. Zumdahl, and Donald J. DeCoste. *Chemistry (AP Edition).* 10th Edition. National Geographic Learning/Cengage Learning, 2018.

- Students can check out a textbook or test resource to take home. Textbooks and resources must be returned undamaged to avoid a $122 charge on their student account.

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

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

- Students must bring their own bound notebook to complete labs.

Lesson Delivery and Homework:
This course is taught using a blend of traditionally structured classroom teaching and a flipped classroom model. Videos or readings covering all the topics in the curriculum are available on google classroom or the AP board website. It is highly suggested that students use these resources to supplement the in-class lecture, notes, and practice problems. Additionally, the students will reference their textbook for clarification of topics and additional problems. The students are assigned problems sets at the conclusion of each section. Throughout each unit, Topic Questions will be available on AP Board 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 on AP Board 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 must make arraignments to attend tutoring with the instructor. Because this class is taught at the AP level, it is expected that students take advantage of all available resources independently and manage their own learning.

Laboratory work:
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. 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 (bound composition notebook), 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.

The labs are completed during two 50-minute periods with some extended time for the inquiry-based activities. Hands-on guided inquiry labs are marked with "(GI)."

1. Percentage of Water in an Unknown Hydrate (GI)
2. Determination of the Percentage of NaHCO3 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)
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 FeSCN2+ 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. Micro-voltaic Cells
22. Redox Titration of Hydrogen Peroxide

Tests:
At the completion of each unit's video/reading, problem sets, labs, and quizzes, a unit test is given. Like the AP Exam, the unit test consists of two parts: multiple choice and free response. A cumulative semester exam is also given. All tests will be curved with a square-root curve–similar to AP test grading. Students have two school days to turn-in test corrections–earning up to half of the missed points of the curved grade.

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 Policies:

- **Grading:**
  Assignments (daily, homework, labs) = 40%
  Assessments (quizzes, tests, projects) = 60%
  *labs are weighted more than assignments, and tests/projects are weighted more than quizzes

- **Late Work:**
  Assignments will be counted 20 points off per day late—unless excused.
- **Absences:**
  All excused absences must be approved by the front office. Always check Google Classroom, the work folder, and/or the instructor for missed assignments. Quizzes and labs are expected to be made up the next school day unless excused. If you miss a test, you must make it up within one week.
- **Tutoring:**
  Tutoring is available before school by appointment. Student must meet basic classroom criteria before tutoring is available—students must be present in class and taking advantage of class time to qualify for tutoring.
- **Extra Credit:**
  One extra credit opportunity will be given at the end of the 1st and 2nd semester–the sole purpose of this is to bump students on the edge (1 pt away) from their desired grade. For example, a student with a semester average of 89.3 may complete the extra credit to receive a grade of 90.0.

AP College Board Classroom:
AP college board classroom is a great resource that all students will be required to access and complete reviews and assessments. It will also be used independently by students to self-monitor progress and target preparation for the AP exam and course exams.

Course Outline:
Units will incorporate the AP college board "big ideas" into the curriculum—a description of these is found here:

Big Idea 1: SCALE, PROPORTION, AND QUANTITY **(SPQ)** Quantities in chemistry are expressed at both the macroscopic and atomic scale. Explanations, predictions, and other forms of argumentation in chemistry require understanding the meaning of these quantities, and the relationship between quantities at the same scale and across scales.

Big Idea 2: STRUCTURE AND PROPERTIES **(SAP)** Properties of substances observable at the macroscopic scale emerge from the structures of atoms and molecules and the interactions between them. Chemical reasoning moves in both directions across these scales. Properties are predicted from known aspects of the structures and interactions at the atomic scale. Observed properties are used to infer aspects of the structures and interactions.

Big Idea 3: TRANSFORMATIONS **(TRA)** At its heart, chemistry is about the rearrangement of matter. Understanding the details of these transformations requires reasoning at many levels as one must quantify what is occurring both macroscopically and at the atomic level during the process. This reasoning can be as simple as monitoring amounts of products made or as complex as visualizing the intermolecular forces among the species in a mixture. The rate of a transformation is also of interest, as particles must move and collide to initiate reaction events.

Big Idea 4: ENERGY **(ENE)** Energy has two important roles in characterizing and controlling chemical systems. The first is accounting for the distribution of energy among the components of a system and the ways that heat exchanges, chemical reactions, and phase transitions redistribute this energy. The second is in considering the enthalpic and entropic driving forces for a chemical process. These are closely related to the dynamic equilibrium present in many chemical systems and the ways in which changes in experimental conditions alter the positions of these equilibria.

First 9 Weeks:

AP Unit (Big Idea)	Chapter	Topics	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)
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) • 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)
Complete Personal Progress Checks (MCQ and FRQ) for Unit 1				
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) • Students research the actual bond angles and explain any differences between actual values and their predictions. (SP 4)
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)
3 (SPQ, SAP)	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)
3 (SPQ, SAP)	11, 7	• 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 Rf values to determine if solvent distance affects the separation of components proportionately. (SP 5)
Complete Personal Progress Checks (MCQ and FRQ) for Unit 3				

Second 9 Weeks:

AP Unit (Big Idea)	Chapter	Topics	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)	• 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) • Students balance redox reactions from provided half-reactions. (SP 5)

		• 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)		
Complete Personal Progress Checks (MCQ and FRQ) for Unit 4				
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)
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)
Complete Personal Progress Checks (MCQ and FRQ) for Unit 6				

Third 9 Weeks:

AP Unit (Big Idea)	Chapter	Topics	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)	• Le Châtelier's Principle – The Rainbow Lab (GI) • Determination of the Equilibrium Constant of	• 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)

		• 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	FeSCN2+ System	• 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)
7 (TRA)	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)
Complete Personal Progress Checks (MCQ and FRQ) for Unit 7				
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) • 8.4 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 8.3 Weak Acid and Base Equilibria (5.C) • 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) • **Real World Application:** Students are given acid-base titration data from acidic rain from their closest urban area. After background reading, students will then calculate the concentration of pollutants and research and present the sources of those pollutants and the current technologies to abate them.
Complete Personal Progress Checks (MCQ and FRQ) for Unit 8				

Fourth 9 Weeks:

AP Unit (Big Idea)	Chapter	Topics	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)		• Students solve problems determining the values and signs of ΔH, ΔS, and ΔG. (SP 5)

		• 9.4 Thermodynamic and Kinetic Control (6.E) • 9.5 Free Energy and Equilibrium (6.D) • 9.6 Coupled Reactions (4.D)		
9 (SPQ, SAP, ENE)	18	• 9.7 Galvanic (Voltaic) and Electrolytic Cells (2.F) • 9.8 Cell Potential and Hydrogen Peroxide Free Energy (5.F) • 9.9 Cell Potential Under Nonstandard Conditions (6.D) • 9.10 Electrolysis and Faraday's Law (5.B)	• Micro-voltaic 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) **Real World Application:** of each of the metals identified—students will research and present findings of which metals would have the least environmental impact to dispose of in a landfill as battery technologies are more and more prevalent. • Students then explain how the change in electrode would alter the cell potential recorded by a voltmeter. (SP 2)
Complete Personal Progress Checks (MCQ and FRQ) for Unit 9				
Review and AP Exam				
	19	• Radioactive Decay • Half-Life of Isotopes • Medical Applications • Radioisotopic Dating		
	20-21	• Transition Metals • Group Properties		
	22	• Hydrocarbons • Derivatives • Polymerization		