Syllabus AP Chemistry 2025-2026

Because of the nature of this course and the amount of new material that will be covered, a strong preparatory background in Chemistry-I is a requirement. If you had me for Pre-AP Chemistry you already have a strong background. The topics that I expect that you already know include:

- atomic structure
- electron configurations
- bonding
- VSEPR theory
- acid-base chemistry
- chemical names and formulas
- chemical reactions (balancing and completing)
- periodicity
- behavior of gases
- mole concept
- mole calculations
- stoichiometry
- making and interpretation of graphs
- thermochemistry
- kinetics
- making observations from laboratory situations

The nature of Chemistry requires the student to know certain basic facts that MUST be committed to memory. Mathematics is an integral part of this class. Problem solving strategies will be stressed through-out the year and this course also requires the student to be able to solve problems, and justify their claim through evidence based reasoning.

The guidelines below about summative assessments are designed to reflect the AP exam in May – each exam will be half of a full AP exam. The exam in May will consist of 60 multiple choice questions, to be completed in 90 minutes. The calculator based free response portion of the exam will be 3 long questions and 4 short questions and will be 105 minutes in length. Each part is 50% of the overall AP score. Your summative exams will consist of two parts: multiple choice and free response. The multiple choice will consist of 30 questions, at least 8, but no more than 15 questions will cover previous materials. The multiple-choice section will be 50% of the overall grade. This reflects Science Practice 5: Mathematical Routines. The free response section will consist of either:

(a) 2 long questions and 1 short question
(b) 1 long question and 3 short questions

The distinction between the two types of questions will be obvious to the students as the school year progresses. The free response section of the test is calculator based. Each part of the exam will be 45 minutes in length and will be 50% of your grade on that exam.

TEXTBOOK:

Chemistry: the Central Science, Brown, LeMay, Bursten, Murphy, Woodward, Stoltzfus (publisher Pearson) copyright 2022

EXAM PREPARATION:

–*Fast Track to a 5 Preparing for the AP Chemistry Examination*, Todd Abronowitz and Kristen Jones (publisher Cengage Learning) © 2018

–*Chemistry: The Central Science Test Prep,* Copyright 2022

STRUCTURE OF THE COURSE:

Science Practice 1: *Models and Representations* Describe models and representations, including across scales.
Science Practice 2: *Question and Method* Determine scientific questions and methods.
Science Practice 3: *Representing Data and Phenomena* Create representations or models of chemical phenomena.
Science Practice 4: *Model Analysis* Analyze and interpret models and representations on a single scale or across multiple scales.
Science Practice 5: *Mathematical Routines* Solve problems using mathematical relationships.
Science Practice 6: *Argumentation* Develop an explanation or scientific argument.

LABORATORY INVESTIGATIONS

The laboratory portion of this class is 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. Some of the laboratory investigations will require the students to spend time in tutorials after school. At a minimum, twenty-five percent of instructional time will be spent in the laboratory.

The laboratory manual that is given to the students is designed to be a complete laboratory experience for the student. It is designed to be "combed bound" and the students write their laboratory reports in the notebook. When the students finish AP Chemistry, they are encouraged to take their laboratory notebook with them to college. The laboratory notebook includes nineteen laboratory investigations. They are all "wet labs" with one being micro-scale. Eight of the labs are student inquiry based.

The school is on a hybrid schedule. M,T, F are seven period days with classes being approximately 52 minutes, and W and Th are on block schedule so class length is approximately 90 minutes, which generally allows enough time for students to complete the laboratory investigation. However, I have my AP Chemistry class first period, so the students know that if a laboratory investigation will require more than 90 minutes that they will be coming in before school starts to begin the investigation.

The laboratory manual has sections on purpose, procedure, equipment needed, data, analysis, questions for the students to answer and conclusion. In the analysis section, the students will be required to answer questions on error analysis, explaining how their answer is either too high or too low from the accepted values. As part of this section, students will complete the calculations for percent error and percent relative deviation to help determine if there were random and systemic errors in their procedure.

Students must turn in completed laboratory write-ups for each lab. Each student will be required to report their results once per semester using a method of their choice (PowerPoint, Poster, Article, etc.)

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 chromebook for data analysis. 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 manual.

Laboratory Investigation Sequence

First Nine Weeks

MSDS and laboratory safety

- Students will read and understand MSDS (and GHS compliant SDS).
- Students will demonstrate safe laboratory practices for various laboratory situations.

Empirical formula of hydrate (SP 1, 2, 3, 5, 6)

- 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.

Empirical formula by direct combination (SP 1, 2, 4, 5, 6)

- Student Inquiry Lab – students will not be given any procedures to determine the empirical formula – they will have to develop them on their own. Student Inquiry lab
- 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 (SP 1, 2, 3, 5, 6)

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

Redox Titration of Bleach (SP 1, 2, 3, 5, 6)

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

"Four bottle problem" (SP 1, 2, 3, 4, 6) Student inquiry lab.

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

How much zinc is in a penny (SP 1, 2, 3, 4, 5, 6) Student inquiry lab.

Second Nine Weeks

Molecular Geometry Lab (SP 1, 3, 4, 6)

- Students will draw Lewis Dot Diagrams and then build the models that correspond to the Lewis Dot Diagrams. They will not be given any guidance on how the model kit works, this part is student inquiry. Student inquiry lab.

Separation by paper chromatography (SP 1, 2, 3, 4, 6) – student inquiry part will be to translate the technique to thin-layer or column chromatography (students will choose which extension to do) Student inquiry lab.

- To separate food colors into their different compounds
- To investigate the various techniques of chromatography
- To represent the various interactions that are occurring at the particle level with labeled diagrams.

Kinetic study of thiosulfate in acid solution (student inquiry lab; SP 1, 2, 3, 4, 5, 6)

- To study the kinetic reaction of the thiosulfate ion and hydrochloric acid
- To graph laboratory data and to determine the order of the reaction.
    - After students have investigated the order for thiosulfate, they are tasked with making procedural changes to the lab to determine the order for hydrochloric acid. They record their procedures and then conduct the second part of the lab. Student inquiry lab.
    - Students will be tasked to determine how raising/lowering the temperature, make predictions on the effects on the rate of the reaction and then conduct their revised experiment. Student inquiry lab.

Chemical kinetics: Iodine Clock reaction (SP 1, 2, 3, 5, 6)

- 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, 3, 5, 6)

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

Calculation of the Ideal Gas Constant, *R* (SP 1, 2, 3, 5, 6)

- 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, 3, 5, 6)

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

Third Nine Weeks

Thermochemistry: Enthalpy and specific heat (SP 1, 2, 3, 4, 5, 6)

- To determine the specific heat of an unknown solution
- To determine the ΔH_{rxn}

Chemical Equilibria

- To determine the equilibrium constant of a reaction
- To use the equilibrium constant to determine the concentrations of reactants and products
- To determine the molar solubility of a salt

Acid-Base Reactions

- Determine the pH of a strong and weak acid/base
- Determine the equivalence point for an acid base reaction
- Using the pH to determine the hydronium ions in a solution

Fourth nine Weeks

Acid-base titration part I (SP 1, 2, 3, 4, 5, 6) Student Inquiry Lab – students will not be given any procedures for this lab – they will have to develop them on their own. Student inquiry lab.

- To prepare an unknown 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.

Acid-base titration part II (SP 1, 2, 3, 4, 5, 6) Student Inquiry Lab – students will not be given any procedures for this lab – they will have to develop them on their own. Student inquiry lab.

- To use 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

Acid-base titration part III: pKa of a weak acid (SP 1, 2, 3, 4, 5, 6)

- To determine the K_a of acetic acid from an acid-base titration curve
- To determine the K_a of an unknown acid using (non-titration curve) half-equivalence point
- To determine the K_a of BTB using a spectrophotometer

Construction of an Electrochemical Cell (SP 1, 2, 3, 4, 5, 6)

- To determine the various voltages of different cells.
- To determine the products of an electrolytic cell and write the balance equation.

- Draw and label the parts of the cell and explain, with diagrams and at the particle level, the changes occurring at each electrode.

SEQUENCE:

First Nine Weeks			*AP Chemistry Curriculum*	
Chapter	*Topics Covered*	*Activities*	*Units*	*Topic Numbers*

Two: Atoms, Molecules and Ions
 	
Three: Chemical Reactions and Reaction Stoichiometry
 	
Four: Reactions in Aqueous Solution
	• Atomic structure
	• Average atomic mass
	• Isotopes
	• Different models
	• Molar mass of compounds
	• Hydrated compounds
	• Balancing equations
	• Percent composition
	• Quantum view of atom
	• Electron Configurations
	  o Aufbau
	  o Hund's Rule
	  o Pauli Exclusion Principle
	• Periodic Trends
	  o Coulomb's Law
	  o Different trends
	• Double Replacement, single replacement, combustion, decomposition, combination reactions, gas forming
	• Solubility rules
	• Precipitation reactions
	• Acid-base reactions
	• Redox reactions
	• Combustion analysis
	• Review redox reactions
	• Oxidation versus reduction
		Student will use a mass spectrometer printout of the isotopes of the element tin to determine (a) the percentages of the isotopes (by finding the area of each peak and then dividing by the whole area) and (b) the average atomic mass of the element. They then will construct their own mass spectrum of an element of their choosing from a table of natural abundances. They will need to describe the structure of each isotope of their chosen element.
		
		students will watch the video entitled "When Things Go Wrong in the Lab" on YouTube (https://www.youtube.com/watch?v=JZ-cF2PYY70). In the video shows a twenty dollar bill that was soaked in alcohol and water set on fire – the bill was not supposed to combust, but did. The students will develop a testable hypothesis of what went wrong with the experiment. Once they have their testable hypothesis, they will conduct an submit an experimental procedure to the teacher for approval and then the teacher will test their hypothesis to determine if they successfully determined what went wrong in the demonstration.
			1 and 4	• 1.1
				• 1.2
				• 1.3
				• 1.4
				• 1.5
				• 1.6
				• 1.7
				• 1.8
				• 4.2
				• 4.4
				• 4.7
				• 4.8
				• 4.9

Eight: Basic Concepts of Chemical Bonding	• Bonding
	  o Metallic
	  o Ionic
	  o Covalent
		The students will be provided with Potential Energy verses Internuclear Distance graph showing the graphs for hydrogen, oxygen and chlorine. They will be asked to draw the	Unit 2	• 2.1
				• 2.2
				• 2.3
				• 2.4
				• 2.5

Nine: Molecular Geometry and Bonding Theories	• Types of energy associated with different structures:
	  o bond dissociation energy
	  o lattice energy
	• Types of covalent bonds, sigma, pi, resonance structures
	• Lewis Dot Diagrams
	• Formal Charge
	• VSEPR Theory
	• Hybridization
		Lewis structures for H_2, O_2, Cl_2, N_2, F_2 and Br_2. They will then have to draw potential energy verses internuclear distance graphs for N_2, F_2 and Br_2 on the same graph as hydrogen, oxygen and chlorine. They will then need to discuss why they placed the graphs in the locations that they did and the characteristics of their graphs (i.e. bond length and bond energy).		• 2.6
				• 2.7

	• Intermolecular Forces
	  o London
	  o Induced dipole to dipole
	  o Dipole to dipole
	• Bond versus molecular polarity
	• Properties of liquids
	• Structures of solids
	• Properties of liquids
	• Structures of solids
	• Phase Change Diagrams
	• Solution Chemistry
	  o Supersaturated solutions
	  o Saturated solutions
	  o Unsaturated solutions
				• 3.1
				• 3.2
				• 3.3
				• 3.4
				• 3.5
				• 3.6

Second Nine Weeks			*AP Chemistry Curriculum*	
Chapter	*Topics Covered*	*Activities*	*Units*	*Topic Numbers*
Ten: Gases	• Ideal versus Real • Gas Laws • Kinetic Molecular Theory • Photoelectronic Spectroscopy		3	• 3.7 • 3.8 • 3.9 • 3.10 • 3.11 • 3.12 • 3.13
Fourteen: Chemical Kinetics *Twenty-one*: Nuclear Chemistry	• Reaction rates • Relative rates • Rate law, general form • Determination of rate law • Graphical methods for zero, first, and second order rate laws. • Mechanisms	• Students will be given multiple reaction mechanisms and asked to determine the following: (1) the catalyst (2) the reaction intermediaries (3) the rate law from the mechanism.	5 and 6	• 5.1 • 5.2 • 5.3 • 5.4 • 5.5 • 5.6 • 5.7 • 5.8 • 5.9

		They will need to justify their choices to 1, 2 and 3. They will also need to provide reasoning as to why a given step would be the rate determining step based on the particles present in the reaction (i.e., because two anions will not be attracted, etc.). • The students will do the "candy decay chain" activity (M&Ms decay into Skittles which decay into SweeTarts which decay into Smarties, which are stable). This models nuclear decay – first order kinetics. They will construct four graphs, to show the relationship over time of the four candies and the half-life of the first three "radioactive" candies will be determined.		• 5.10 • 5.11 • 6.2

Third Nine Weeks			*AP Chemistry Curriculum*	
Chapter	*Topics Covered*	*Activities*	*Units*	*Topic Numbers*
Five: Thermochemistry	• Energy • Specific Heat • First Law of Thermodynamics • Enthalpy and calorimetry • Hess's Law		6	• 6.1 • 6.3 • 6.4 • 6.5 • 6.6 • 6.8 • 6.9
Fifteen: Chemical Equilibrium	• Nature of equilibrium • Equilibrium constant • Kc and Kp • Use of ICE tables to solve Kc, Kp • Conversion between Kc, Kp • Le Chatelier's Principal	The students will 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 a RICE table. This activity focuses on the structure of the equilibrium questions.	7	• 7.1 • 7.3 • 7.4 • 7.5 • 7.6 • 7.7 • 7.9 • 7.10
Sixteen: Acid-Base Equilibria	• Concepts of acid and bases Arrhenius o Bronsted-Lowry o Lewis	Students will conduct an investigation into the major components of acid rain and write the reactions that occur between the pollutant and the	4 and 8	• 4.8 • 8.1 • 8.2 • 8.3 • 8.4

	• Strength of acid and bases • pH and pOH • Ka, Kb • Finding pH of strong and weak acids and bases • Auto-ionization of water and Kw • pH of different salts	compounds naturally present (i.e. water, oxygen, carbon dioxide). Students will also calculate the pH of the solution given a variety of molarities of the solutions by looking up the required *K*a values.		• 8.6 •
Fourth Nine Weeks - Review			*AP Chemistry Curriculum*	
Chapter	*Topics Covered*	*Activities*	*Units*	*Topic Numbers*
Seventeen: Aqueous Equilibria: Buffers, Titrations, and Solubility	• Acid-base titration curves • Indications and their roles • Common ion-effect • Buffers • Solubility product constant, Ksp		4, 7 and 8	• 4.7 • 7.10 • 7.11 • 7.12 • 7.13 • 8.5 • 8.7 • 8.8 • 8.9 • 8.10
Nineteen: Chemical Thermodynamics	Relationships • Relating thermodynamics to electrochemistry • Relating electrochemistry to equilibrium via thermodynamics • Spontaneous versus non-spontaneous (thermodynamically favored versus not favored) • Entropy • Free Energy • Three laws of thermodynamics • Concept of equilibrium • Review redox reactions • Oxidation versus reduction • Galvanic and voltaic cells • Electrolysis	• Given a set of conditions the students will determine if the situation is thermodynamically favored or not favored by looking at the signs of entropy and enthalpy their effects on the sign of Gibb's Free Energy. • Students will balance by the half-reaction method • Students will balance by oxidation number change method •	9	• 9.1 • 9.2 • 9.3 • 9.4 • 9.5 • 4.7 • 4.9 • 9.6 • 9.7 • 9.8 • 9.9 • 9.10