SPRING GROVE AREA SCHOOL DISTRICT

PLANNED COURSE OVERVIEW

Course Title: Advanced Placement Chemistry **Grade Level(s):** 11 - 12 **Units of Credit:** 1.5 **Classification:** Elective	**Length of Course:** Full Year **Periods Per Cycle:** 9 **Length of Period:** 40 Minutes **Total Instructional Time:** 180 Hours

Course Description

This rigorous college level chemistry course is designed to prepare students for success on the AP Chemistry Exam. Course content will deal with intermediate and advanced topics in chemistry as determined by the AP College Board. Major topics include gas laws, reaction kinetics, equilibrium, thermochemistry, and electrochemistry. Good critical thinking and problem-solving skills are essential for success in this class. Throughout the course, students will participate in a mix of hands on and virtual lab activities to explore key content. Prerequisite: Successful completion of Chemistry or Honors Chemistry is required. Minimum 90% in Chemistry or 80% in Honors Chemistry is recommended for success in the class.

Instructional Strategies, Learning Practices, Activities, and Experiences

- Inquiry Based Wet or Dry Lab Activities
- Direct Instruction
- Guided Notes from Videos, Readings, or PowerPoints
- Remedial Videos, Examples, and Practice
- Analogies
- Summarization
- Problem Solving
- Guided Practice
- Homework Assignments
- Graphic Organizers
- Cooperative Learning Activities
- Discovery Learning Activities
- Teacher Demonstration
- Models and Manipulatives
- Review Games
- AP Practice MCQ and FRQ resources

Assessments

Formative Assessments: Student created summaries, Homework Problems, Teacher Questioning, Post Lab Questions, Lesson/Topic Quizzes
Summative Assessments: Written Unit Exams, Lab Reports, Project Reports, Final Exam (Or Midterm/Final Exam Combo).

Materials/Resources

Textbook: Chemistry: The Central Science, Brown, LeMay, Bursten, Murphy, Woodward, and Stoltzfus, 13th Ed. (Pearson, 2015), Teacher Constructed Handouts, Chemistry Laboratory Equipment and Chemicals (determined by staff as needed), Safety Equipment, Technology Equipment and Software, AP Classroom Online Resources

Adopted: 2010
Revised: 5/21/12, 5/22/23

Unit 1: Atomic Structure and Properties	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Moles and Molar Mass Mass Spectroscopy of Elements Elemental Composition of Pure Substances Composition of Mixtures Atomic Structure and Electron Configuration Photoelectron Spectroscopy Periodic Trends Valence Electrons and Ionic Compounds	Objectives 1) I can calculate the molar mass of a chemical compound, or the amount of atoms in a sample mass. 2) I can use mass spectroscopy data to determine the average atomic mass of a compound or identify chemical compounds. 3) I can calculate the percent by mass of any element in a compound theoretically or from data to determine purity. 4) I can use given data to calculate the percent composition of a mixture of chemicals. 5) I can identify the orbitals present in each level of the quantum mechanical model of the atom and create electron configurations or orbital diagrams to depict the arrangement of electrons around the nucleus. 6) I can use a photoelectron spectroscopy graph to identify the likely identity of an element. 7) I can predict the likely shifts in a photoelectron spectroscopy graph if a new element is depicted. 8) I can use the periodic table to predict properties of elements related to electronegativity, ionization energy, and radius, and justify my answers in terms of nuclear shielding vs. electrostatic attraction. 9) I can identify the number of valence electrons present in neutral atoms and predict the likely charges of ions. 10) I can predict the correct formulas of ionic compounds formed from one metal and one non-metal. Standards HS-PS1-1-Matter and its Interactions: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. HS-PS1-2 Matter and its Interactions: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

Unit 2: Molecular and Ionic Compound Structure and Properties	
CONTENT/KEY CONCEPTS	OBJECTIVES/STANDARDS
Types of Chemical Bonds Intramolecular Force and Potential Energy Structure of Ionic Solids Structure of Metals and Alloys Lewis Diagrams Resonance and Formal Charge VSEPR and Bond Hybridization	Objectives 1) I can classify chemical bonds as ionic, polar covalent, or non-polar covalent, and describe how each type of bond creates different properties in matter. 2) I can describe the process of bonds forming by balancing electrostatic attraction and repulsion as a function of distance. 3) I can describe how the formation of molecular or network solids is influenced by the intramolecular forces present. 4) I can determine the chemical formula of an ionic formula from a crystal cell structure and rank the relative strengths of the lattice energies of ionic compounds. 5) I can determine the percent composition of an alloy using a crystal cell structure. 6) I can create a 2D Lewis structure of a covalent compound when given a formula. 7) I can depict resonance structures of Lewis Models when more than one answer is equally correct. 8) I can use formal charges to decide which out of several possible Lewis structures is likely to be correct. 9) I can create a 3D VSEPR model of a covalent molecule and use it to predict molecular properties. 10) I can use a VSEPR model to correctly predict molecular polarity and identify the orbital hybridization used in the bonding of the molecule. Standards MS-PS1-1 Matter and its Interactions: Develop models to describe the atomic composition of simple molecules and extended structures. HS-PS1-3 Matter and its Interactions: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. HS-PS3-5 Energy: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

Unit 3: Intermolecular Forces and Properties

CONTENT/KEY CONCEPTS	OBJECTIVES/STANDARDS
Intermolecular Forces Properties of Solids Solids, Liquids, and Gasses Ideal Gas Law Kinetic Molecular Theory Deviation from Ideal Gas Law Solutions and Mixtures Representations of Solutions Separation of Solutions and Mixtures Chromatography Solubility Spectroscopy and the Electromagnetic Spectrum Photoelectric Effect Beer-Lambert Law	<u>Objectives</u> 1) I can identify the different types of intermolecular forces present in a chemical from a structure or formula. 2) I can rank the strengths of the intermolecular forces present in molecules and relate them to properties of matter such as boiling point. 3) I can classify solids as ionic, molecular, or network covalent, and justify the properties of each. 4) I can describe the arrangement of atoms, and general physical properties, of solids, liquids, and gasses. 5) I can use the ideal gas law to calculate P,V, n, or T from given data. 6) I can use the kinetic molecular theory to explain individual gas laws. 7) I can determine the characteristics and conditions that make a gas most ideal and explain why using the kinetic molecular theory. 8) I can calculate real pressures using the Van Der Walls Equation. 9) I can classify a solution and describe its component parts. 10) I can calculate and covert between various measures of solution concentration. 11) I can draw total and net ionic equations for substances reacting in solution. 12) I can describe how solutions can be separated based on polarity using chromatography. 13) I can use general solubility rules to determine ionic compound solubility and predict relative solubility in covalent molecules. 14) I can explain the uses of spectroscopy as an analytical technique in chemistry. 15) I can calculate the energy, frequency, or wavelength of a photon of light when given data. 16) I can diagram how the photoelectric effect occurs in atoms and justify why some compounds are better for use in solar cells than others. 17) I can select an appropriate wavelength for use in a spectroscopy inquiry from given data. 18) I can apply the Beer-Lambert law to spectroscopic data to determine the concentration of an unknown. <u>Standards</u> MS-PS4-2 Waves and their Applications in Technologies for Information Transfer: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. HS-PS1-3 Matter and its Interactions: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. HS-PS3-2 Energy: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles. HS-PS3-5 Energy: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

Unit 4: Chemical Reactions	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Introduction to Reactions Net Ionic Equations Representations of Reactions Physical and Chemical Changes Stoichiometry Introduction to Titration Types of Chemical Reactions Introduction to Acid-Base Reactions Oxidation-Reduction Reactions	Objectives 1) I can classify changes in matter as physical or chemical changes. 2) I can write total and net ionic equations for reactions in aqueous solution. 3) I can use multiple models to quantitatively represent chemical reactions. 4) I can classify chemical reactions as one of several major types. 5) I can predict reactants or products of the major types of reactions. 6) I can carry out stoichiometric calculations to determine the theoretical yield of a reactions. 7) I can carry out stoichiometric calculations to determine the limiting reactant of a chemical reaction. 8) I can conduct a titration to accurately determine the concentration of an unknown. 9) I can write neutralization reactions and accurately identify acids and bases. 10) I can divide Oxidation-Reduction reactions into accurate half reactions. 11) I can balance Oxidation-Reduction reactions in acidic solution. 12) I can balance Oxidation-Reduction reactions in basic solution. Standards HS-PS1-2 Matter and its Interactions: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS1-7 Matter and its Interactions: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Unit 5: Kinetics	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Reactions Rates Rate Laws Concentration Changes Over Time Elementary Reactions Collision Model Reaction Energy Profile Reaction Mechanisms Mechanism Relationships to Rate Laws Steady State Approximation Multistep Reaction Energy Profile Catalysis	<u>Objectives</u> 1) I can define the rate of change of a reaction with appropriate units or interpret one from a graph. 2) I can use stoichiometry to infer rates of change in reactants or products from one given rate. 3) I can calculate average or instantaneous rates from given data. 4) I can write a generic rate law for a reaction. 5) I can use Method of Initial Rates data to determine rate orders of reactants, and solve rate laws k. 6) I can use graphical data to determine the rate order of a reaction and use the slope to find k. 7) I can use integrated rate law equations to solve for initial concentrations, final concentration, or time. 8) I can use half-life equations or data to find k, half-life time, or initial concentrations. 9) I can determine the molecularity and individual rate laws of elementary reactions. 10) I can use the tenets of the collision model to justify qualitative changes in rates of reaction based on temperature, concentration, molecular geometry, or presence of a catalyst. 11) I can use the Arrhenius equation to calculate changes in k, activation energy, or temperature from given data. 12) I can read a reaction energy profile to classify the reaction as endo or exothermic, identify transition states and intermediates, and identify activation energy. 13) I can evaluate proposed reaction mechanisms for realism based on molecularity, number of steps, and whether the chemicals add up to the overall reaction. 14) I can evaluate proposed rate mechanisms to decide if they are supported by experimental evidence. 15) I can use Steady State Approximation to determine the experimental rate law that should be observed based on a proposed mechanism with several steps of similar speed. 16) I can read a multistep reaction energy profile to classify the reaction as endo or exothermic, identify transition states and intermediates, identify activation energy, and label mechanism steps. 17) I can use collision theory to explain how catalysts increase reaction speeds. 18) I can classify different types of catalysts and describe what aspect of the catalyst limits their impacts on rate. 19) I can sketch or interpret reaction energy profiles of catalyzed or non-catalyzed reactions. <u>Standards</u> HS-PS1-5 Matter and its Interactions: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS3-2 Energy: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles.

Unit 6: Thermodynamics	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Endothermic vs. Exothermic Processes Energy Diagrams Heat Transfer and Thermal Equilibrium Heat Capacity and Calorimetry Energy of Phase Changes Enthalpy of Reactions Bond Enthalpies Enthalpy of Formation Hess's Law	Objectives 1) I can classify processes as endo or exothermic based on energy flow between system and surroundings. 2) I can apply the First Law of thermodynamics to calculate E, q, and w for the energy change of a system. 3) I can use an energy diagram to classify a reaction as endo or exothermic based on the bond strength in reactant and products. 4) I can explain heat transfer from high energy to low energy areas through kinetic energy transferred during collisions until all particles are moving the same average speed. 5) I can define the heat capacity of common materials as a measure of the heat needed for the material to change temperature. 6) I can calculate final temperatures of Constant Pressure and Constant Volume calorimetry given necessary data. 7) I can use calorimetry data to calculate enthalpy changes for a process. 8) I can describe what impacts energy is having on material particles during phase changes that does not result in temperature change. 9) I can calculate the energy needed to heat or cool a substance through various temperature ranges using a phase diagram. 10) I can define reaction enthalpy as the change in heat of a chemical process at constant pressure. 11) I can estimate reaction enthalpy using standard bond enthalpies. 12) I can write formation reactions for chemical compounds. 13) I can use standard enthalpies of formation to calculate the change in enthalpy for chemical processes. 14) I can apply Hess's Law to calculate the overall enthalpy change of a process from several component steps. Standards HS-PS1-4 Matter and its Interactions: Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. HS-PS3-2 Energy: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles. HS-PS3-4 Energy: Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system.

Unit 7: Equilibrium	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Introduction to Equilibrium Direction of Reversible Reactions Reaction Quotient and Equilibrium Constant Calculating the Equilibrium Constant Magnitude of the Equilibrium Constant Properties of the Equilibrium Constant Calculating Equilibrium Concentrations Representations of Equilibrium Le Chatelier's Principle Solubility Equilibria Common-Ion Effect pH and Solubility Free Energy of Dissolution	Objectives 1) I can identify notation used to describe reversible reactions and characteristics of reversible reactions. 2) I can write equilibrium expressions for chemical reactions. 3) I can solve equilibrium expressions for Q or K. 4) I can compare Q and K to predict the direction a reversible reaction will move. 5) I can compare equilibrium constants from several reactions and draw conclusions about how much products or reactants are favored. 6) I can use equilibrium expressions to determine the concentrations of reactants and products at equilibrium. 7) I can use Le Chatelier's principle to make predictions about how changes to a system at equilibrium would result in responses by the system to reach a new equilibrium. 8) I can apply the concept of equilibrium to establish the concentrations in solution of partially soluble ionic compounds. 9) I can apply the common ion effect to make predictions about the addition of identical ionic species to chemical systems. 10) I can apply knowledge of equilibrium to make predictions about how the pH of a solution will impact solubility. 11) I can make inferences about the forces between solute and solvent based on Free Energy of Dissolution. Standards HS-PS1-6 Matter and its Interactions: Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. HS-PS3-2 Energy: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles.

Unit 8: Acids and Bases	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Defining Acids and Bases pH and pOH of Strong Acids and Bases Weak Acid and Base Equilibria Acid-Base Reactions and Buffers Acid-Base Titrations Molecular Structure of Acids and Bases pH and pKa Properties of Buffers Henderson-Hasselbalch Equation Buffer Capacity	Objectives 1) I can apply various accepted definitions in chemistry to classify acidic or basic substances. 2) I can calculate the pH or pOH of a strong acid or base from given data. 3) I can write reversible reactions depicting equilibrium conditions for weak acids and bases. 4) I can calculate the pH or pOH of weak acid or base solutions. 5) I can evaluate chemical structures to draw conclusions about the acidic or basic properties of molecules. 6) I can carry out stoichiometric calculations to solve for unknowns involving titration reactions. 7) I can identify a buffered solution based on presence or absence of required ions. 8) I can write chemical reactions depicting how buffered systems isolate solutions from harsh pH swings. 9) I can evaluate ways to increase or decrease the buffering capacity of a solution. 10) I can use the Henderson-Hasselbalch Equation to predict the pH of buffer solutions. Standards HS-PS1-2 Matter and its Interactions: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS1-6 Matter and its Interactions: Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

Unit 9: Applications of Thermodynamics	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Entropy Absolute Entropy and Change in Entropy Gibbs Free Energy and Thermodynamic Favorability Thermodynamic and Kinetic Control Free Energy and Equilibrium Coupled Reactions Galvanic (Voltaic) ad Electrolytic Cells Cell Potential and Free Energy Cell Potential Under Non-Standard Conditions Electrolysis and Faraday's Law	Objectives 1) I can define entropy and provide examples of system microstates. 2) I can use the Third Law of thermodynamics to define absolute entropy. 3) I can calculate the change in entropy of a process from various given data. 4) I can apply the Second Law of thermodynamics to predicting reaction favorability. 5) I can use Gibbs Free Energy to predict if a reaction will be spontaneous at a given temperature. 6) I can apply data from a given reaction to predict if the reaction is under Kinetic control or Thermodynamic control, and how changes to reaction conditions could impact reaction progress. 7) I can define a system at equilibrium as having no Free Energy. 8) I can calculate the free energy of a chemical system under non-standard conditions. 9) I can describe how coupled reactions allow non-spontaneous processes to occur by being paired to spontaneous ones. 10) I can diagram a galvanic or electrolytic cell and label correct relevant vocabulary and parts of the cell. 11) I can relate cell potential to free energy and how electrical systems can be used to do work. 12) I can use standard reaction potentials to calculate the voltage of a galvanic cell at standard conditions. 13) I can use the Nernst equation to calculate the standard potential of a cell under non-standard conditions. 14) I can use Faraday's Law to solve for the time a cell must be run, or amount of product produced over time, from given data. Standards HS-PS1-4 Matter and its Interactions: Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. HS-PS1-5 Matter and its Interactions: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS1-6 Matter and its Interactions: Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. HS-PS3-2 Energy: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles.