AP Chemistry Pacing Guide

Units	Big Idea	Learning Objectives	Time
Unit 1: Atomic Structure and Properties -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	BIG IDEA 1: SCALE, PROPORTION, AND QUANTITY. BIG IDEA 2: STRUCTURE AND PROPERTIES	I can calculate quantities of a substance or its relative number of particles using dimensional analysis and the mole concept. I can explain the quantitative relationship between the mass spectrum of an element and the masses of the element's isotopes. I can explain the quantitative relationship between the elemental composition by mass and the empirical formula of a pure substance. I can explain the quantitative relationship between the elemental composition by mass and the composition of substances in a mixture. I can represent the electron configuration of an element or ions of an element using the Aufbau principle. I can explain the relationship between the photoelectron spectrum of an atom or ion and: a. The electron configuration of the species.	≅**20 days**

		b. The interactions between the electrons and the nucleus. I can explain the relationship between trends in atomic properties of elements and electronic structure and periodicity. I can explain the relationship between trends in the reactivity of elements and periodicity.	
Unit 2: Molecular and Ionic Compound Structure and Properties 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	BIG IDEA 2: STRUCTURE AND PROPERTIES	I can explain the relationship between the type of bonding and the properties of the elements participating in the bond. I can represent the relationship between potential energy and distance between atoms, based on factors that influence the interaction strength. I can represent an ionic solid with a particulate model that is consistent with Coulomb's law and the properties of the constituent ions. I can represent a metallic solid and/or alloy using a model to show essential characteristics of the structure and interactions present in the substance. I can represent a molecule with a Lewis diagram.	**≅15 days**

		I can represent a molecule with a Lewis diagram that accounts for resonance between equivalent structures or that uses formal charge to select between nonequivalent structures. Based on the relationship between Lewis diagrams, VSEPR theory, bond orders, and bond polarities: a. I can explain the structural properties of molecules. b. I can explain electron properties of molecules.	
Unit 3: Intermolecular Forces and Properties Intermolecular Forces Properties of Solids Solids, Liquids, and Gases Ideal Gas Law Kinetic Molecular Theory Deviation from Ideal Gas Law Solutions and Mixtures Representations of Solutions Separation of Solutions and Mixtures Chromatography	BIG IDEA 1 Scale, Proportion, and Quantity BIG IDEA 2 Structure and Properties	I can explain the relationship between the chemical structures of molecules and the relative strength of their intermolecular forces when: a. The molecules are of the same chemical species. b. The molecules are of two different chemical species. I can explain the relationship among the macroscopic properties of a substance, the particulate-level structure of the substance, and the interactions between these particles I can represent the differences between solid, liquid, and gas phases using a particulate level model.	**≅25 days**

		I can explain the relationship between the macroscopic properties of a sample of gas or mixture of gases using the ideal gas law. I can explain the relationship between the motion of particles and the macroscopic properties of gases with: a. The kinetic molecular theory (KMT). b. A particulate model. c. A graphical representation I can explain the relationship among non-ideal behaviors of gases, interparticle forces, and/or volumes. I can calculate the number of solute particles, volume, or molarity of solutions. Using particulate models for mixtures, I can: a. Represent interactions between components. b. Represent concentrations of components. I can explain the relationship between the solubility of ionic and molecular compounds in aqueous and nonaqueous solvents, and the intermolecular interactions between particles.	

		I can explain the relationship between a region of the electromagnetic spectrum and the types of molecular or electronic transitions associated with that region. I can explain the properties of an absorbed or emitted photon in relationship to an electronic transition in an atom or molecule. I can explain the amount of light absorbed by a solution of molecules or ions in relationship to the = concentration, path length, and molar absorptivity.	
Unit 4: Chemical Reactions Introduction for 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 (Redox) Reactions	BIG IDEA 1 Scale, Proportion, and Quantity BIG IDEA 3 Transformations	I can identify evidence of chemical and physical changes in matter. I can represent changes in matter with a balanced chemical or net ionic equation: a. For physical changes. b. For given information about the identity of the reactants and/or product. c. For ions in a given chemical reaction I can represent a given chemical reaction or physical process with a consistent particulate model.	**≅20 days**

		I can explain the relationship between macroscopic characteristics and bond interactions for: a. Chemical processes. b. Physical processes I can explain changes in the amounts of reactants and products based on the balanced reaction equation for a chemical process. I can identify the equivalence point in a titration based on the amounts of the titrant and analyte, assuming the titration reaction goes to completion I can identify a reaction as acid base, oxidation-reduction, or precipitation. I can identify species as BrønstedLowry acids, bases, and/or conjugate acid-base pairs, based on proton-transfer involving those species. I can represent a balanced redox reaction equation using half-reactions.	

Unit 5: Kinetics Reaction Rates Introduction to Rate Law Concentration Changes Over Time Elementary Reactions Collision Model Reaction Energy Profile Introduction to Reaction MechanismsReaction Mechanism and Rate Law Steady-State Approximation Multistep Reaction Energy Profile Catalysis	BIG IDEA 3 Transformations BIG IDEA 4 Energy	I can explain the relationship between the rate of a chemical reaction and experimental parameters. I can represent experimental data with a consistent rate law expression. I can identify the rate law expression of a chemical reaction using data that show how the concentrations of reaction species change over time. I can represent an elementary reaction as a rate law expression using stoichiometry I can explain the relationship between the rate of an elementary reaction and the frequency, energy, and orientation of molecular collisions. I can represent the activation energy and overall energy change in an elementary reaction using a reaction energy profile. I can identify the components of a reaction mechanism. I can identify the rate law for a reaction from a mechanism in which the first step is rate limiting.	≅**20 days**

		I can identify the rate law for a reaction from a mechanism in which the first step is not rate limiting. I can represent the activation energy and overall energy change in a multistep reaction with a reaction energy profile. I can explain the relationship between the effect of a catalyst on a reaction and changes in the reaction mechanism.	
Unit 6: Thermodynamics Endothermic and Exothermic Processes Energy Diagrams Heat Transfer and Thermal Equilibrium Heat Capacity and Calorimetry Energy of Phase Changes Introduction to Enthalpy of Reaction Bond Enthalpies Enthalpy of Formation Hess's Law	BIG IDEA 4 Energy	I can explain the relationship between experimental observations and energy changes associated with a chemical or physical transformation. I can represent a chemical or physical transformation with an energy diagram. I can explain the relationship between the transfer of thermal energy and molecular collisions. I can calculate the heat q absorbed or released by a system undergoing heating/ cooling based on the amount of the substance, the heat capacity, and the change in temperature.	**≅20 days**

		I can explain changes in the heat q absorbed or released by a system undergoing a phase transition based on the amount of the substance in moles and the molar enthalpy of the phase transition. I can calculate the heat q absorbed or released by a system undergoing a chemical reaction in relation to the amount of the reacting substance in moles and the molar enthalpy of reaction. I can calculate the enthalpy change of a reaction based on the average bond energies of bonds broken and formed in the reaction. I can calculate the enthalpy change for a chemical or physical process based on the standard enthalpies of formation. I can explain the relationship between the enthalpy of a chemical or physical process and the sum of the enthalpies of the individual steps.	
Unit 7: Equilibrium Introduction to Equilibrium Direction of Reversible Reactions Reaction Quotient and Equilibrium Constant	BIG IDEA 1 Scale, Proportion, and Quantity BIG IDEA 3	I can explain the relationship between the occurrence of a reversible chemical or physical process, and the establishment of equilibrium, to experimental observations	≅**20 days**

Calculating the Equilibrium Constant Magnitude of the Equilibrium Constant Properties of the Equilibrium Constant Calculating Equilibrium Concentrations Representations of Equilibrium Introduction to Le Châtelier's Principle Reaction Quotient and Le Châtelier's Principle Introduction to Solubility Equilibria Common-Ion Effect pH and Solubility Free Energy of Dissolution	Transformation	I can explain the relationship between the direction in which a reversible reaction proceeds and the relative rates of the forward and reverse reactions. I can represent the reaction quotient Qc or Qp , for a reversible reaction, and the corresponding equilibrium expressions Kc = Qc or K p = Qp I can calculate Kc or Kp based on experimental observations of concentrations or pressures at equilibrium. I can explain the relationship between very large or very small values of K and the relative concentrations of chemical species at equilibrium. I can represent a multistep process with an overall equilibrium expression, using the constituent K expressions for each individual reaction. I can identify the concentrations or partial pressures of chemical species at equilibrium based on the initial conditions and the equilibrium constant. I can represent a system undergoing a reversible reaction with a particulate model.	

		I can identify the response of a system at equilibrium to an external stress, using Le Châtelier's principle. I can explain the relationships between Q, K, and the direction in which a reversible reaction will proceed to reach equilibrium. I can calculate the solubility of a salt based on the value of Ksp for the salt. I can identify the solubility of a salt, and/or the value of Ksp for the salt, based on the concentration of a common ion already present in solution. I can identify the qualitative effect of changes in pH on the solubility of a salt I can explain the relationship between the solubility of a salt and changes in the enthalpy and entropy that occur in the dissolution process.	
Unit 8: Acids and Bases Introduction to Acids and Bases pH and pOH of Strong Acids and Bases Weak Acid and Base Equilibria Acid-Base Reactions and Buffers	BIG IDEA 2 Structure and Properties	I can calculate the values of pH and pOH, based on Kw and the concentration of all species present in a neutral solution of water.	≅**20 days**

Acid-Base Titrations Molecular Structure of Acids and Bases pH and pKa Properties of Buffers HendersonHasselbalch Equation Buffer Capacity		I can calculate pH and pOH based on concentrations of all species in a solution of a strong acid or a strong base. I can explain the relationship among pH, pOH, and concentrations of all species in a solution of a monoprotic weak acid or weak base. I can explain the relationship among the concentrations of major species in a mixture of weak and strong acids and bases. I can explain results from the titration of a mono- or polyprotic acid or base solution, in relation to the properties of the solution and its components. I can explain the relationship between the strength of an acid or base and the structure of the molecule or ion. I can explain the relationship between the predominant form of a weak acid or base in solution at a given pH and the pKa of the conjugate acid or the pKb of the conjugate base. I can explain the relationship between the ability of a buffer to stabilize pH and the reactions that occur when an acid or a base is	

		added to a buffered solution. I can identify the pH of a buffer solution based on the identity and concentrations of the conjugate acid-base pair used to create the buffer. I can explain the relationship between the buffer capacity of a solution and the relative concentrations of the conjugate acid and conjugate base components of the solution.	
Unit 9: Applications of Thermodynamics Introduction to Entropy Absolute Entropy and Entropy Change Gibbs Free Energy and Thermodynamic Favorability Thermodynamic and Kinetic Control Free Energy and Equilibrium Coupled Reactions Galvanic (Voltaic) and Electrolytic Cells Cell Potential and Free Energy Cell Potential Under Nonstandard Conditions Electrolysis and Faraday's Law	**BIG IDEA 4 Energy**	I can identify the sign and relative magnitude of the entropy change associated with chemical or physical processes. I can explain whether a physical or chemical process is thermodynamically favored based on an evaluation of ΔG°. I can explain, in terms of kinetics, why a thermodynamically favored reaction might not occur at a measurable rate I can explain whether a process is thermodynamically favored using the relationships between K, ΔG°, and T. I can explain the relationship between external sources of energy or coupled reactions and their	**≅15 days**

		ability to drive thermodynamically unfavorable processes. I can explain the relationship between the physical components of an electrochemical cell and the overall operational principles of the cell. I can explain whether an electrochemical cell is thermodynamically favored, based on its standard cell potential and the constituent half-reactions within the cell. I can explain the relationship between deviations from standard cell conditions and changes in the cell potential. I can calculate the amount of charge flow based on changes in the amounts of reactants and products in an electrochemical cell.	