

Grade: 11-12

Course Title: AP Chemistry

Topic/Concept: Atomic Structure & Properties

Time Allotment: 10 days

Unit Sequence: 1

Major Concepts to be learned:

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| <ul style="list-style-type: none">• Moles and Molar Mass• Mass Spectra of Elements• Elemental Composition | <ul style="list-style-type: none">• 4. Atomic Structure• 5. Photoelectron Spec• 6. Periodic Trends | <ul style="list-style-type: none">• 7. Valence Electrons• 8. Ionic Compounds |
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Expected Skills to be demonstrated:

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| <ul style="list-style-type: none">• Calculate quantities of a substance or its relative number of particles using dimensional analysis and the mole concept.• Explain the quantitative relationship between the mass spectrum of an element and the masses of the element's isotope.• Explain the quantitative relationship between the elemental composition by mass and the empirical formula of a pure substance.• Explain the quantitative relationship between the elemental composition by mass and the composition of substances in a mixture.• Represent the ground-state electron configuration of an atom of an element or its ions using the Aufbau principle.• Explain the relationship between the photoelectron spectrum of an atom or ion and: ground-state electron configuration of the species and the interactions between the electrons and the nucleus.• Explain the relationship between trends in atomic properties of elements and electronic structure and periodicity.• Compare and construct the relationship between trends in the reactivity of elements and periodicity |
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PA Standard/NGSS:

SEP/DCI/CCC:

3.2.9-12.B
3.2.9-12.D
HS-PS1-2

SEP: Developing and Using Models, Planning and Carrying Out Investigations, Using Mathematics and Computational Thinking
DCI: PS1:A, PS1.B, PS2:B,
CCC: Patterns, Energy and Matter

Instructional Strategies:

Assessments:

Cooperative groups
Problem solving activities
Lecture
Written work
Hands-on activity
Graphic organizers
Evaluating

Group discussion
Note Taking
Charting
Summarizing
Outlining
Graphic Calculators

Investigation: What Makes Hard Water Hard?
Exploring Atomic Structure Using PES
Section Quizzes
Unit Exam

Grade: 11-12

Course Title: AP Chemistry

Topic/Concept: Compound Structure & Properties

Time Allotment: 15 days

Unit Sequence: 2

Major Concepts to be learned:

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| <ul style="list-style-type: none">• Types of Chemical Bonds• Structure of Metals and Alloys• VSEPR theory | <ul style="list-style-type: none">• Intramolecular Force and PE• Lewis Diagrams• Hybridization | <ul style="list-style-type: none">• Structure of Ionic Solids• Resonance and Formal Charge |
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Expected Skills to be demonstrated:

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| <ul style="list-style-type: none">• Explain the relationship between the chemical structures of molecules and the relative strength of their intermolecular forces when the molecules are of the same chemical species and when the molecules are of two different chemical species.• Explain the relationship among the macroscopic properties of a substance, the particulate-level structure of the substance, and the interactions between these particles.• Represent the differences between solid, liquid, and gas phases using a particulate level model.• Apply the relationship between the macroscopic properties of a sample of gas or mixture of gases using the ideal gas law.• Explain the relationship between the motion of particles and the macroscopic properties of gases with: i. The kinetic molecular theory (KMT). ii. A particulate model. iii. A graphical representation.• Explain the relationship among non-ideal behaviors of gases, interparticle forces, and/or volumes.• Calculate the number of solute particles, volume, or molarity of solutions.• Interpret the results of a separation experiment based on intermolecular interactions.• Explain the relationship between the solubility of ionic and molecular compounds in aqueous and nonaqueous solvents, and the intermolecular interactions between particles. |
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PA Standard/NGSS:

SEP/DCI/CCC:

3.2.9-12.B
3.2.9-12.D
HS-PS1-2

SEP: Developing and Using Models, Planning and Carrying Out Investigations, Using Mathematics and Computational Thinking
DCI: PS1:A, PS1:B, PS2:B,
CCC: Patterns, Energy and Matter

Instructional Strategies:

Assessments:

Cooperative groups Problem solving activities Lecture Written work Hands-on activity Graphic organizers Evaluating	Group discussion Note Taking Charting Summarizing Outlining Graphic Calculators
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Lab Investigation: What's in That Botte?
Lab Investigation: How Do You Separate Molecules That Are Attracted to One Another?
Lewis Structures Lab
Section Quizzes
Unit Exams

Grade: 11-12

Course Title: AP Chemistry

Topic/Concept: Properties of Substances and Mixtures

Time Allotment: 18 days

Unit Sequence: 3

Major Concepts to be learned:

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| <ul style="list-style-type: none">• IMF and IPF• Ideal Gas Laws• Solutions and Mixtures | <ul style="list-style-type: none">• Properties of Solids• Kinetic Molecular Theory• Solubility | <ul style="list-style-type: none">• Solids, Liquids, and Gases• Gases• Spectroscopy and the EM | <ul style="list-style-type: none">• Properties of Photons• Beer-Lambert Law |
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Expected Skills to be demonstrated:

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| <ul style="list-style-type: none">• Explain the relationship between the type of bonding and the properties of the elements participating in the bond.• Represent the relationship between potential energy and distance between atoms, based on factors that influence the interaction strength.• Represent an ionic solid with a particulate model that is consistent with Coulomb's law and the properties of the constituent ions.• Represent a metallic solid and/or alloy using a model to show essential characteristics of the structure and interactions present in the substance.• Represent a metallic solid and/or alloy using a model to show essential characteristics of the structure and interactions present in the substance.• Represent a molecule with a Lewis diagram.• 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: VSEPR theory uses the Coulombic repulsion between electrons as a basis for predicting the arrangement of electron pairs around a central atom.• Explain structural properties of molecules.• Explain electron properties of molecules. |
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PA Standard/NGSS:

SEP/DCI/CCC:

3.2.9-12.B
3.2.9-12.D
HS-PS1-2

SEP: Developing and Using Models, Planning and Carrying Out Investigations, Using Mathematics and Computational Thinking
DCI: PS1:A, PS1:B, PS2:B,
CCC: Patterns, Energy and Matter

Instructional Strategies:

Assessments:

Cooperative groups Problem solving activities Lecture Written work Hands-on activity Graphic organizers Evaluating	Group discussion Note Taking Charting Summarizing Outlining Graphic Calculators
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Lab 7: Purifying a Mixture: Green Chemistry
Beers-Lambert Law Lab
Section Quizzes
Unit Exam

Grade: 11-12

Course Title: AP Chemistry

Topic/Concept: Chemical Reaction

Time Allotment: 15 days

Unit Sequence: 4

Major Concepts to be learned:

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| <ul style="list-style-type: none">• Net Ionic Equations• Intro to Titrations | <ul style="list-style-type: none">• Particle Diagrams• Types of Reactions | <ul style="list-style-type: none">• Physical and Chemical Changes• Acid-Base Reaction | <ul style="list-style-type: none">• Stoichiometry• Redox Reactions |
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Expected Skills to be demonstrated:

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| <ul style="list-style-type: none">• Represent changes in matter with a balanced chemical or net ionic equation: For physical changes given information about the identity of the reactants and/or product and for ions in a given chemical reaction.• Represent a given chemical reaction or physical process with a consistent particulate model.• Explain the relationship between macroscopic characteristics and bond interactions for chemical and physical processes.• Apply and understand the changes in the amounts of reactants and products based on the balanced reaction equation for a chemical process.• Identify the equivalence point in a titration based on the amounts of the titrant and analyte, assuming the titration reaction goes to completion.• Identify a reaction as acid-base, oxidation-reduction or precipitation.• Identify species as a Brønsted-Lowry acids, bases and/or conjugate acid-base pairs, based on proton-transfer involving those species.• Predict the products of a balanced redox reaction equation using half-reactions. |
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PA Standard/NGSS:

SEP/DCI/CCC:

3.2.9-12.A
3.2.9-12.C
HS-PS1-1
HS-PS1-2

3.2.9-12.H
3.2.9-12.G
HS-PS1-5

SEP: Developing and Using Models, Asking questions, Using mathematics and computational thinking, Obtaining, evaluating and communicating information
DCI: PS1:C, PS1:B, PS2:B,
CCC: Patterns, Energy and Matter, Cause and Effect, Systems and System Models

Instructional Strategies:

Assessments:

Cooperative groups
Problem solving activities
Lecture
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Lab Activity: Standardization of NaOH
Lab Investigation: How Much Acid is in Fruit Juice?
Section Quizzes
Unit Exams

Grade: 11-12

Course Title: AP Chemistry

Topic/Concept: Kinetics

Time Allotment: 14 days

Unit Sequence: 5

Major Concepts to be learned:

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| <ul style="list-style-type: none">• Reactions Rates• Reaction Energy Profile• Multistep Reactions | <ul style="list-style-type: none">• Changes Over Time• Reaction Mechanism• Catalysis | <ul style="list-style-type: none">• Elementary Reactions• Rate Laws | <ul style="list-style-type: none">• Collision Model• Pre-Equilibrium App |
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Expected Skills to be demonstrated:

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| <ul style="list-style-type: none">• Explain the relationship between the rate of a chemical reaction and experimental parameters.• Represent experimental data with a consistent rate law expression.• Identify the rate law expression of a chemical reaction using data that show how the concentrations of reaction species change over time.• Represent an elementary reaction as a rate law expression using stoichiometry.• Explain the relationship between the rate of an elementary reaction and the frequency, energy, and orientation of particle collision.• Represent the activation energy and overall energy change in an elementary reaction using a reaction energy profile.• Identify the components of a reaction mechanism.• Calculate the rate law for a reaction from a mechanism in which the first step is rate limiting.• Calculate the rate law for a reaction from a mechanism in which the first step is not rate limiting.• Represent the activation energy and overall energy change in a multistep reaction with a reaction energy profile.• Explain the relationship between the effect of a catalyst on a reaction and changes in the reaction mechanism. |
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PA Standard/NGSS:

SEP/DCI/CCC:

3.2.9-12.B
3.2.9-12.C
HS-PS1-1
HS-PS1-3

3.2.9-12.D
3.2.9-12.F
HS-PS1-6

SEP: Developing and Using Models, Asking questions, Using mathematics and computational thinking, Obtaining, evaluating and communicating information
DCI: PS1:C, PS1.B, PS2:B,
CCC: Patterns, Energy and Matter, Cause and Effect, Systems and System Models

Instructional Strategies:

Assessments:

Cooperative groups
Problem solving activities
Lecture
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Graphic organizers
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Graphic Calculators

Lab Investigation: How Long Will That Marble Statue Last?
Lab Investigation: What Is the Rate Law of the Fading of Crystal Violet Using Beer's Law?
Section Quizzes
Unit Exam

Grade: 11-12

Course Title: AP Chemistry

Topic/Concept: Thermochemistry

Time Allotment: 11 days

Unit Sequence: 6

Major Concepts to be learned:

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| <ul style="list-style-type: none">• Endo and Exo Processes• Energy of Phase Changes• Hess's Law | <ul style="list-style-type: none">• Energy Diagrams• Enthalpy of Reaction | <ul style="list-style-type: none">• Heat Transfer• Bond Enthalpies | <ul style="list-style-type: none">• Heat Capacity and Calorimetry• Enthalpy of Formation |
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Expected Skills to be demonstrated:

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| <ul style="list-style-type: none">• Explain the relationship between experimental observations and energy changes associated with a chemical or physical transformation.• Represent a chemical or physical transformation with an energy diagram.• Explain the relationship between the transfer of thermal energy and molecular collisions.• 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.• 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.• Calculate the heat q absorbed or released by a system undergoing a chemical reaction in relationship to the amount of the reacting substance in moles and the molar enthalpy of reaction.• Calculate the enthalpy change of a reaction based on the average bond energies of bonds broken and formed in the reaction.• Calculate the enthalpy change for a chemical or physical process based on the standard enthalpies of formation.• Explain the relationship between the enthalpy of a chemical or physical process and the sum of the enthalpies of the individual steps.• Represent a chemical or physical process as a sequence of steps. |
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PA Standard/NGSS:

SEP/DCI/CCC:

3.2.9-12.A
3.2.9-12.C
HS-PS1-2
HS-PS1-6

3.2.9-12.H
3.2.9-12.G
HS-PS1-7

SEP: Constructing Explanations and Designing Solutions, Using mathematics and computational thinking, Obtaining, evaluating and communicating information
DCI: PS1.B, PS2.B,
CCC: Stability and Change, Systems and System Models

Instructional Strategies:

Assessments:

Cooperative groups
Problem solving activities
Lecture
Written work
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Graphic organizers
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Lab Investigation: The Hand Warmer Challenge
Section Quizzes
Unit Exam

Grade: 11-12

Course Title: AP Chemistry

Topic/Concept: Equilibrium

Time Allotment: 15 days

Unit Sequence: 7

Major Concepts to be learned:

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| <ul style="list-style-type: none">• Intro to Equilibrium• Magnitude of the K_{Equ}• LeChatelier's Principle | <ul style="list-style-type: none">• Reversible Reactions• Properties of K_{Equ} | <ul style="list-style-type: none">• Reaction Quotient• Calculating the K_{Equ} | <ul style="list-style-type: none">• Equilibrium Constant• Representation of Equ |
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Expected Skills to be demonstrated:

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| <ul style="list-style-type: none">• Explain the relationship between the occurrence of a reversible chemical or physical process, and the establishment of equilibrium, to experimental observations.• Explain the relationship between the direction in which a reversible reaction proceeds and the relative rates of the forward and reverse reactions.• Represent the reaction quotient Q_c or Q_p, for a reversible reaction, and the corresponding equilibrium expressions $K_c = Q_c$ or $K_p = Q_p$.• Calculate K_c or K_p based on experimental observations of concentrations or pressures at equilibrium.• Explain the relationship between very large or very small values of K and the relative concentrations of chemical species at equilibrium.• Represent a multistep process with an overall equilibrium expression, using the constituent K expressions for each individual reaction.• Identify the concentrations or partial pressures of chemical species at equilibrium based on the initial conditions and the equilibrium constant.• Represent a system undergoing a reversible reaction with a particulate model.• Identify the response of a system at equilibrium to an external stress, using Le Châtelier's principle.• Explain the relationships between Q, K, and the direction in which a reversible reaction will proceed to reach equilibrium.• Calculate the solubility of a salt based on the value of K_{sp} for the salt. |
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PA Standard/NGSS:

SEP/DCI/CCC:

3.2.9-12.A
3.2.9-12.C
HS-PS1-7

SEP: Developing and using models, Using mathematics and computational thinking, Obtaining, evaluating and communicating information
DCI: PS1.A, PS2:B,
CCC: Energy and matter, Patterns

Instructional Strategies:

Assessments:

Cooperative groups Problem solving activities Lecture Written work Hands-on activity Graphic organizers Evaluating	Group discussion Note Taking Charting Summarizing Outlining Graphic Calculators
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Lab Investigation: How Many Colors of the Rainbow Can You Make?
Section Quizzes

Unit Exam

Grade: 11-12

Course Title: AP Chemistry

Topic/Concept: Acids and Bases

Time Allotment: 18 days

Unit Sequence: 8

Major Concepts to be learned:

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|---|---|---|---|
| <ul style="list-style-type: none">• Intro to Acids and Bases• Acid-Base Titrations• Henderson-Hasselbalch | <ul style="list-style-type: none">• pH and pOH of Strong Acids• Molecular Structure of Acids• Buffer Capacity | <ul style="list-style-type: none">• Weak Acids and Bases• pH and pKa• pH and Solubility | <ul style="list-style-type: none">• Buffers• Properties of Buffers |
|---|---|---|---|

Expected Skills to be demonstrated:

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| <ul style="list-style-type: none">• Calculate the values of pH and pOH, based on K_w and the concentration of all species present in a neutral solution of water.• Calculate pH and pOH based on concentrations of all species in a solution of a strong acid or a strong base.• Explain the relationship among pH, pOH, and concentrations of all species in a solution of a monoprotic weak acid or weak base.• Explain the relationship among the concentrations of major species in a mixture of weak and strong acids and bases.• 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. |
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PA Standard/NGSS:

SEP/DCI/CCC:

3.2.9-12.B
3.2.9-12.D
HS-PS1-2

SEP: Developing and Using Models, Planning and Carrying Out Investigations, Using Mathematics and Computational Thinking
DCI: PS1:A, PS1.B, PS2:B,
CCC: Patterns, Energy and Matter

Instructional Strategies:

Assessments:

Coooperative groups
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Graphic Calculators

Lab: How Do the Structure and the Initial Concentration of an Acid and a Base Influence the pH of a Solution?
Lab Investigation: To What Extent Do Common Household Products Have Buffering Activity?
Section Quizzes
Unit Exam