Centerville Sr. High School Curriculum Mapping
AP Chemistry
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AP Chemistry Overview

College Board specifies the core, fundamental skills students should learn, master, and apply in order to pass the AP Chemistry Exam. These academic standards serve as the basis to our curriculum in Centerville-Abington Community Schools but do not serve as curriculum alone. These curriculum maps and resources are aligned to the Indiana Academic Standards and provide the tools which are necessary to meet the needs of all learners. As a result, the Centerville-Abington Community Schools' curriculum maps are examined regularly and undergo periodic revisions.

AP Chemistry is a course based on the following core topics: properties and states of matter, atomic structure; bonding; chemical reactions; solution behavior and behavior of gases, acids and bases, and equilibrium reactions. We are using the textbook *Chemistry 13e,* by Raymond Chang, Jason Overby, McGraw Hill, AP Edition (2017) as well as supplemental materials. Students enrolled in AP Chemistry compare, contrast, and synthesize useful models of the structure and properties of matter and the mechanism of reactions.

Unit 1 Theme	**Duration of Unit**	**Essential Question(s)**
Atomic Structure and properties Chapter 2	2 weeks	How can the same element be used in nuclear fuel rods and fake diamonds?

End of Unit 1 Authentic Learning Task

Inquiry-"What makes water hard?" lab-Water samples will be collected from various locations-Some are from municipal water sources, others are from wells. The water will be analyzed for their quantities of water hardness through principles of metal ion precipitation and separation. The samples will then be ranked in order of increasing water hardness.

Assessment-Students will turn in a lab report which is assessed with a rubric for accuracy.

- I can identify safety hazards based on MSDS, and know the first aid for chemicals used in the lab.
- I can follow safety protocol during labs using biohazards.
- I can identify precipitates based on solubility rules.
- I can identify charges of metal ions.
- I can use gravimetric analysis to quantitatively determine mass of products.
- I can write balanced net ionic equations.
- I can use stoichiometry to determine mass percents based on balanced equations.
- I can identify and utilize gravimetric analysis equipment.
- I can properly dispose of biochemical hazards and follow lab safety protocol.

Standards: 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

Pacing: Unit 1
Semester 1, Quarter 1, 5-6 block days, 8-10 school calendar days

Indiana Academic Standards

11-12.LST.2.1, 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.3.2, 11-12.LST.3.3, 11-12.LST.4.1, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.5.1, 11-12.LST.5.2, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

AP Chemistry Big Idea Standards

1.A, 2.A, 4.A, 4.B, 4.C, 5.A, 5.B, 5.D

Academic Vocabulary

moles, molecules, Avogadro's number, Photoelectron spectroscopy, mass spectrum, isotope, pure substance, mixture, Aufbau principle, electron configuration, dimensional analysis, periodicity, electronegativity, electron affinity, ionization energy, first ionization energy, atomic radius

Key Concepts/Learning Targets

- 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 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. 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 difference between trends in the reactivity of elements and periodicity.

Resources/Activities

- Think-Pair-Share (Teacher Led)
- Simulations (Teacher Led)
- Diagramming (Teacher Led)
- Labs (Teacher Files)
- Explore Representations (Teacher Led)
- POGIL (AP Classroom)
- Online Review Activities (Quizizz, Kahoot, Quizlet Live)

Question Stems

- How many Oxygen atoms are in 35 grams of oxygen gas?
- If the natural abundance of Cu-63 is 14.95%, and the natural abundance of Cu-65 is 95.05%, what is the average atomic mass of a sample of pure copper?
- A sample weighing 21.59 grams is found to have 2.05 moles of Fe. What is iron's percent by mass in the original sample?
- What is the electron configuration of Argon?
- What does the height of the peak represent in a PES readout?
- What element does this photoelectron spectrum

	represent? ● What is the binding energy of a valence electron in Phosphorus? ● Why does Chlorine react in a similar way to Fluorine? ● Why does atomic radius decrease as you go from left to right across the periodic table? **Assessment(s)** Bell ringers Exit tickets Quizzes Unit 1 Test Lab Reports

Unit 2 Theme	**Duration of Unit**	**Essential Question(s)**
Molecular and Ionic Compound Structures and Properties Chapter 2, 6, 7, 8, 9	2.5-3 weeks	What is the difference in the strength of bonds in sugar and salt, and how does it determine the properties of these two substances?

End of Unit 2 Authentic Learning Task

What's in that bottle? Lab-Students will determine the type of bonding in unlabeled chemicals using physical and chemical properties of substances containing ionic, molecular, and metallic bonding. Then, given a list of possible substances, the student will try to identify "what's in that bottle."
Assessment-Students will turn in a lab report which is assessed with a rubric for accuracy.
Standards: 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

Pacing: Unit 2, Semester 1, Quarter 1, 6 block days, 12-13 school calendar days	**Key Concepts/Learning Targets**
Indiana Academic Standards 11-12.LST.2.1, 11-12.LST.2.2, 11-12.LST.2.3,	● 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,

11-12.LST.3.2, 11-12.LST.3.3, 11-12.LST.4.1, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.5.1, 11-12.LST.5.2, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

AP Chemistry Big Idea Standards

3.A, 3.B, 4.C, 6.A, 6.C

Academic Vocabulary

chemical bond, cation, anion, ionic bond, ionic compound, crystal lattice, electrolyte, lattice energy, formula unit, monatomic ion, polyatomic ion, oxyanion, electron sea model, delocalized electron, metallic bond, alloy, covalent bond, molecule, Lewis structure, sigma bond, pi bond, bond order, structural formula, resonance, coordinate covalent bond, VSEPR model, hybridization, polar covalent bond, bond angle,

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.
- 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, I can: a. Explain structural properties of molecules. b. Explain electron properties of molecules.

Resources/Activities

- Modeling electron motion (Teacher Led, videos)
- Diagramming formation of ions (Teacher Files)
- Videos on Electron Diagramming (Various)
- Electron-Dot Structures (In Class Demonstration)
- Atomic Lewis Structure modeling (Teacher Files)
- Formal Charge Practice (Teacher Files)
- Lewis Structure modeling (Teacher Led)
- Drawing Resonance Structures (Teacher Files)
- Resonance Video (Various)
- Molecular Model Lab (Teacher Files)
- Labeling Chemicals Lab (Teacher Files)

Question Stems

- If this substance is unable to conduct electricity after being dissolved in water, what type of substance is it?
- In a potential energy diagram, which peak should we look at to determine the bond length?
- What is wrong with this particulate model of sodium chloride? What should be drawn differently?
- If this drawing is an interstitial alloy, where should I draw the other particles?
- What does the Lewis structure of C_2H_3O look like?
- What do the resonance structures of Carbonate look like, and what is the bond order of the oxygen bonds?
- Why is the bond angle in water smaller than the bond angle in ammonia?
- Why does water have a molecular geometry that is bent,

	but methane has a molecular geometry that is tetrahedral? **Assessment(s)** Bell ringers Exit tickets Quizzes Chapter Tests Lab Reports

Unit 3 Theme	**Duration of Unit**	**Essential Question(s)**
Chemical Reactions and Quantities Chapters 4, 8, 10, 11	4 weeks	How do interactions between particles influence mixtures?

End of Unit 3 Authentic Learning Task

Concentration of Blue Food Coloring in Gatorade Lab-Students are given a solution of blue food coloring, and make 5 dilutions. They then use a spectrophotometer to determine the absorbance of these solutions at known concentrations. Using this, they make a calibration curve. They then test the sample of gatorade, and comparing it to the data they have already collected, they are able to calculate the concentration of blue food coloring in a sample of gatorade.

Assessment-Students will turn in a lab report which is assessed with a rubric for accuracy.

- I can determine proper safety equipment to use in the presence of unknown substances.
- I can create dilutions using a standard solution provided, and calculate the new concentrations using the $V_1M_1 = V_2M_2$ equation.
- I can identify the proper labware to make dilutions.
- I can perfect the analytical chemical techniques in order to precisely dilute a substance
- I can choose the correct wavelength for the spectrophotometer settings.
- I can accurately use and read a spectrophotometer.
- I can use Beer's law (A = abc) to determine the concentration of an unknown given the absorbance read by the spectrophotometer.
- I can relate concentration of a substance to absorbance by a spectrophotometer, and explain what each part of Beer's law means.
- I can predict the outcome of common laboratory errors and identify errors on a standard curve.
- I can use a standard curve to predict the concentration based on absorbance.

Standards: 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

Pacing: Unit 3	**Key Concepts/Learning Targets**

Semester 1, Quarter 1, 10 block days, 20 school calendar days

Indiana Academic Standards

11-12.LST.2.1, 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.3.2, 11-12.LST.3.3, 11-12.LST.4.1, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.5.1, 11-12.LST.5.2, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

AP Chemistry Big Idea Standards

2.C, 2.E, 3.C, 4.A, 4.C, 4.D, 5.C, 5.F, 6.E

Academic Vocabulary

aqueous solution, solute, solvent, intermolecular forces, hydrogen bonding, dipole-dipole interactions, London dispersion forces, ideal gas law, solubility, aqueous, nonaqueous, electromagnetic spectrum, photon, Beer's law, molar absorptivity, concentration, molarity, molecular vibration, molecular rotation, electron transition, wavelength, speed of light, frequency

- 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.
- 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.
- Explain the relationship between the macroscopic properties of a sample of gas or mixture of gases using the ideal gas law.
- 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.
- Using particulate models for mixtures: a. Represent interactions between components. b. Represent concentrations of components.
- Explain the relationship between the solubility of ionic and molecular compounds in aqueous and nonaqueous solvents, and the intermolecular interactions between particles.
- Explain the relationship between the solubility of ionic and molecular compounds in aqueous and nonaqueous solvents, and the intermolecular interactions between particles.
- Explain the relationship between a region of the electromagnetic spectrum and the types of molecular or electronic transitions associated with that region.
- Explain the properties of an absorbed or emitted photon in relationship to an electronic transition in an atom or molecule.
- Explain the amount of light absorbed by a solution of molecules or ions in relationship to the concentration, path length, and molar absorptivity.

Resources/Activities

Demo with Q & A (Teacher led)
Exploring Representations (student created, teacher led)
Which gas is your classmate? (student created, teacher led)
Collection of Gas over water lab (teacher files)
Post lab discussion (teacher led)

Question Stems

- Will ethanol or water have stronger intermolecular forces?
- Will ethanol or water have a higher boiling point?
- What is the difference on a particle level between a liquid and a gas? How would you draw that?
- What is the pressure of a 3.15 moles of oxygen gas at

Predict and Confirm (teacher files) Online Trivia Games (quizizz, kahoot, quizlet) Education videos (various) Beer's law lab (teacher files) Unit videos (AP classroom) Unit Multiple Choice Progress Check (AP Classroom) Unit Free Response Progress Check (Teacher files)	25℃ in a rigid container with a volume of 2.0L? ● When is a gas going to behave least like an ideal gas? ● What is the concentration of a solution made with 3.5 grams of sodium chloride in 500 mL of water? ● If the concentration of this drawing were doubled, how would you need to change the drawing? ● Why is iodine soluble in hexane but not in water? ● What type of motion will be caused by x-ray radiation waves? ● What type of radiation causes electrons to transfer to an excited state? ● What is the process of using a spectrophotometer to determine the concentration of an unknown? **Assessment(s)** Bell ringers Exit tickets Quizzes Chapter Tests Lab Reports

Unit 4 Theme	**Duration of Unit**	**Essential Question(s)**
Chemical Reactions Chapter 3, 4, 9, 12, 14	3-4 weeks	What makes fireworks explode?

End of Unit 4 Authentic Learning Task

"How much acid is in fruit drinks?" Lab-Students will experiment to determine the total acidity of orange, lemon, grapefruit, white grape and lime juice. Students will properly dilute each solution, then using titration, will quantitatively determine the original concentration of acid in each juice.

Assessment-Students will turn in a lab report which is assessed with a rubric for accuracy.

- I can determine proper safety equipment to use in the presence of acids and bases.
- I can find the health warnings and first aid information on MSDS.
- I can draw the Lewis structure of citric acid.

- I can identify and label the ionizable hydrogens for each acid group.
- I can identify chemical properties of acids (sourness) and relate the intensity of those properties to the concentration of the acid.
- I can identify, name, and set up titration analysis equipment.
- I can write a balanced reaction of the titration of citric acid with NaOH.
- I can determine the end point of the reaction based on color change.
- I can identify the correct indicator based on the expected pH at the endpoint.
- I can perform a dilution using the correct laboratory glassware.

Standards: 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

Pacing: Unit 4, Chapter 6
Semester 1, Quarter 2, 8 block days, 16 school calendar days

Indiana Academic Standards

11-12.LST.2.1, 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.3.2, 11-12.LST.3.3, 11-12.LST.4.1, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.5.1, 11-12.LST.5.2, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

AP Chem Big Idea Standards

1.B, 2.B, 3.A, 3.B, 5.C, 5.E, 6.B

Academic Vocabulary

balanced, coefficient, physical change, chemical change, precipitate, net ionic equation, spectator ion, equivalence point, titration, titrant, pH, indicator, end point, Bronsted Lowry acid, base, conjugate acid-base pair, oxidation, reduction

Key Concepts/Learning Targets

- 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.
- I can represent a given chemical reaction or physical process with a consistent particulate model.
- I can explain the relationship between macroscopic characteristics and bond interactions for chemical and 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.

Resources/Activities

- AP Classroom videos (AP Classroom)
- Explore Representations (teacher files)
- Videos (various)

Question Stems

- Do the bubbles seen indicate a physical or chemical change?
- Which of these species are spectator ions?

• Animations, (various) • Simulations (student led) • Particulate Drawing Models (teacher files) • Think-Pair-Share (student led) • Titration lab (teacher files) • pH indicator lab (teacher files) • Critique reasoning (student led) • Demonstrations (teacher led)	• How many particles should be represented in the product drawing? • If the reaction proceeds, are we breaking bonds? Or are we breaking intermolecular forces? • If you use 2 moles of methane, how many moles of carbon dioxide will you produce? • What will the Erlenmeyer flask look like when you have reached the end point? • Is this reaction an acid/base reaction, a redox reaction, or a precipitate reaction? • Which of these chemicals is an acid? • What is the redox half reaction for this balanced equation? **Assessment(s)** Bell ringers Exit tickets Quizzes Chapter Tests Lab Reports

Unit 5 Theme	**Duration of Unit**	**Essential Question(s)**
Kinetics Chapter 13	4 weeks	Why are some reactions faster than others?

End of Unit 5 Authentic Learning Task

Investigation-How Long Will That Marble Statue Last?-Lab Students will observe and measure the evolution of carbon dioxide gas from the decomposition of calcium carbonate when mixed with an acid. Students will also create experiments to determine the rate of reaction with different concentrations of hydrochloric acid.

Assessment-Students will turn in a lab report which is assessed with a rubric for accuracy.

- I can determine and follow proper safety protocol when handling strong acids.
- I can develop an experiment to determine the initial rate law of a reaction.
- I can analyze data to determine the rate constant of a reaction.

- 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.

Standards: 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

Pacing: Unit 5, Chapter 13
Semester 1, Quarter 2, 10 block days, 20 school calendar days

Indiana Academic Standards

11-12.LST.2.1, 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.3.2, 11-12.LST.3.3, 11-12.LST.4.1, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.5.1, 11-12.LST.5.2, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

AP Chemistry Big Idea Standards

1.B, 3.B, 5.B, 5.C, 5.E, 6.E

Academic Vocabulary

activated complex, activation energy, biomolecular reaction, catalyst, chemical kinetics, elementary steps, enzyme, first-order reaction, half-life, intermediate, molecularity of a reaction, rate constant, rate-determining step, rate law, reaction mechanism, reaction order, reaction rate, second-order reaction, termolecular reaction, transition state, unimolecular reaction

Key Concepts/Learning Targets

- 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.
- 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.

Resources/Activities

- videos (Teacher Led)
- animations (Various)
- rate law manipulations (Teacher Files)
- elementary step practice (Teacher files)
- Post-Lab Discussion (Student Led)

Question Stems

- According to the experimental data, what is the rate of this reaction?
- What is the rate law for this reaction?
- What is the concentration of the product after 30 seconds?

• Critique Reasoning (Student Led) • Supplemental problems (Teacher Files) • Manipulatives (Teacher Files)	• What is the rate law for the elementary step? • What is the relationship between the rate of an elementary reaction and the frequency, energy, and orientation of molecular collisions? • What does the peak of the reaction energy profile mean? • Where should the reactants and products be on the energy profile? • What is the energy change for the reaction shown in this energy profile? • How does adding a catalyst change the energy profile? **Assessment(s)** Bell ringers Exit tickets Quizzes Chapter Tests Lab Reports

Unit 6 Theme	**Duration of Unit**	**Essential Question(s)**
Thermodynamics Chapter 6	3 weeks	Why is energy released when water becomes an ice cube?

End of Unit 6 Authentic Learning Task

"How much chemical energy is in my food?" Lab-Students learn how scientists determine the amount of calories in the foods they eat, and how to read packaging labels from a chemistry perspective. Students will perform a calorimetry experiment, where they measure the temperature of the water, add a large piece of hot iron to the water, and take the final temperature of the water. They will calculate how much heat was transferred from the metal into the water, and then relate this to how much energy is released when their favorite granola bar is burned-this amount is how much energy our body gains when we eat the granola bar.

Assessment-Students will turn in a lab report which is assessed with a rubric for accuracy.

- I can determine proper safety equipment to use in the presence of a bunsen burner.
- I can determine where the energy has moved within the system.
- I can calculate the enthalpy change in the reaction for the water and the metal.
- I can identify calorimetry equipment, and know when and how this equipment should be used.
- I understand that energy is not created or destroyed, only transferred, and can use this knowledge to explain thermochemical equations.

- I can use the calorimetry equation (M=CΔT) to calculate the amount of energy found in my favorite granola bar.
- I understand that Joules and Calories are units of energy, and can convert from one to the other.

Standards: 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

Pacing: Unit 6, Chapter
Semester 2, Quarter 3, 8 block days, 16 school calendar days

Indiana Academic Standards

11-12.LST.2.1, 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.3.2, 11-12.LST.3.3, 11-12.LST.4.1, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.5.1, 11-12.LST.5.2, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

Academic Vocabulary

calorimetry, chemical energy, closed system, endothermic process, energy, enthalpy, enthalpy of reaction, enthalpy of solution, exothermic process, first law of thermodynamics, heat, heat capacity, heat of dilution, heat of hydration, heat of solution, Hess's law, Isolated system, lattice energy, Law of Conservation of Energy, Open system, potential energy, radiant energy, specific heat, standard enthalpy of formation, standard enthalpy of reaction, standard state, state function, state of a system, surroundings, system, thermal energy, thermochemical equation, thermochemistry, thermodynamics, work

Key Concepts/Learning Targets

- 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.
- 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 represent a chemical or physical process as a sequence of steps.
- I can explain the relationship between the enthalpy of a chemical or physical process and the sum of the enthalpies of the individual steps.

Resources/Activities

- Energy Diagrams (Teacher Files)
- Hess's Law puzzles (Teacher Files)
- Videos (Variety)

Question Stems

- How do these experimental observations relate to the energy change?
- Will the products be higher or lower than the reactants in

• Calorimetry Mini Lab (Teacher Files) • Hand Warmer Lab (AP Classroom) • Enthalpy of Formation Calculations (Teacher Files) • Bond energy Diagramming (Teacher Files) • Chemical reaction Calorimetry mini lab (Teacher Files) • Think-Pair-Share Exo & Endothermic (Discussion) • POGIL-boiling points (AP Classroom) • Progress Check (AP Classroom) • Chemical Mystery (Teacher files)	the energy diagram? • What is the relationship between the transfer of thermal energy and molecular collisions? • What is the heat absorbed during this reaction? • What is the amount of heat absorbed during freezing? • What is the heat released during this chemical change? • Using the bond energy chart, what is the amount of energy you should expect to be released during this reaction? • Based on the enthalpy of formation, how much energy should be released during this reaction? • What are the series of steps in this chemical reaction? • What is the total amount of energy needed to boil 32.00grams of ice? **Assessment(s)** Bell ringers Exit tickets Quizzes Chapter Tests Lab Reports

Unit 7 Theme	**Duration of Unit**	**Essential Question(s)**
Equilibrium Chapters 14, 16 & 17	4 weeks	How can reactions occur in more than one direction?

End of Unit 7 Authentic Learning Task

Investigation: "Can we make the colors of the Rainbow?" Lab The central challenge is to investigate Le Châtelier's principle by testing several systems at equilibrium and then selecting specific ones to produce the colors of the rainbow based on specific applications of Le Châtelier's principle. An additional challenge involves selecting which reaction system to use for which color in producing the rainbow while trying to only use a given "stress" once. Students will use their knowledge of acids and bases to create a rainbow of color in test tubes.

Assessment-Students will turn in a lab report which is assessed with a rubric for accuracy.

- I can determine proper safety equipment to use in the presence of acids and bases.

- I can use Le Châtelier's principle to design a set of conditions that will optimize a desired outcome, such as product yield.
- I can determine the results of a stressor on a system.
- I can neutralize an acid or base to make it safe for disposal.
- I can predict what the products of a neutralization reaction will be.

Standards: 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

Pacing: Unit 7, Chapter 14, 16 & 17
Semester 2, Quarter 3, 10 block days, 20 school calendar days

Indiana Academic Standards

11-12.LST.2.1, 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.3.2, 11-12.LST.3.3, 11-12.LST.4.1, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.5.1, 11-12.LST.5.2, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

AP Chemistry Big Ideas

3.A, 3.C, 4.D, 5.A, 5.C, 5.F, 6.D, 6.F

Academic Vocabulary

chemical equilibrium, concentration, equilibrium constant, equilibrium expression, heterogeneous equilibrium, homogeneous equilibrium, Law of mass action, Le Châtelier's principle, soluble, miscible, insoluble, immiscible, precipitate, molarity, mole fraction, solvation, heat of solution, unsaturated solution, saturated, reaction quotient, K_{sp}, solubility, common ion effect, pH, entropy

Key Concepts/Learning Targets

- I can explain the relationship between the occurrence of a reversible chemical or physical process, and the establishment of equilibrium, to experimental observations.
- 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.

Resources/Activities	**Question Stems**

- Factors affecting Solvation lab (Teacher Files)
- Determining concentration activity (Teacher Files)
- K vs. Q Diagramming (Teacher Files)
- Videos (Various)
- Ksp determination practice (Teacher Files)
- Solubility Lab (Teacher Files)
- Demo with Q & A (Teacher Led)
- Identify Subtasks (Student Led)
- Manipulatives (Teacher Files)
- Post-Lab Discussion (Student Led)

- What is the relationship between the occurrence of a reversible chemical or physical process, and the establishment of equilibrium, to experimental observations?
- Why does this reaction proceed in the forward direction?
- What is the reaction quotient for this reaction?
- What is the K_p value after this change has occurred?
- If the value of K is very large, what does that mean about the solubility?
- What is the final equilibrium expression after all the changes have been made?
- What are the concentrations of the products at equilibrium?
- If this reaction is reversible, how would you represent the reactants in a particulate model?
- If you decrease the volume of this container, will this cause more products or more reactants to form?
- If a change occurs and K > Q, how will the concentration of reactants change?
- Given the Ksp, what is the solubility of Barium Chloride?
- Given the Ksp, what is the solubility of Barium Chloride if sodium chloride is already present in the solution?
- If Barium chloride is being dissolved in a 0.5*M* solution of Hydrochloric acid, how does this affect its solubility?
- Does dissolving a salt increase or decrease the entropy of the solution?

Assessment(s)

Bell ringers
Exit tickets
Quizzes
Chapter Tests
Lab Reports

Unit 8 Theme	**Duration of Unit**	**Essential Question(s)**
Acids and Bases Chapter 15, 16, & 17	4 weeks	How does your body maintain a pH balance?

End of Unit 8 Authentic Learning Task

Buffering Capacity of Common Household Products-Lab Many household products contain buffering chemicals such as citric acid, sodium carbonate, sodium benzoate, and phosphates or phosphoric acid. Students will begin with an introductory activity-generating a titration curve for citric acid-to identify the buffering regions in the neutralization of a polyprotic weak acid. Students will then complete a guided-inquiry design in order to conduct various neutralization reactions to investigate the buffering capacity and buffer components of various consumer products. Students may recommend additional consumer products for further inquiry.

Assessment-Students will turn in a lab report which is assessed with a rubric for accuracy.

- I can determine proper safety equipment to use in the presence of acids and bases.
- I can set up titration equipment and know the names of the laboratory equipment.
- I can qualitatively identify the end point of a titration analysis.
- I can determine the best indicator to use in a titration analysis.
- I can calculate the concentration of a substance based on quantitative data collected during a titration.
- I can neutralize an acid or base to make it safe for disposal.
- I can predict what the products of a neutralization reaction will be.
- I can create a titration curve.
- I can calculate the pK_a value of a weak acid.
- I can analyze the buffer capacity and composition.

Standards: 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

Pacing: Unit 8, Chapter 15, 16, & 17
Semester 2, Quarter 3, 10 block days, 20 school calendar days

Indiana Academic Standards

11-12.LST.2.1, 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.3.2, 11-12.LST.3.3, 11-12.LST.4.1, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.5.1, 11-12.LST.5.2, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

Academic Vocabulary

Key Concepts/Learning Targets

- I can read and comprehend science and technical texts within a range of complexity appropriate for grade 9-10 independently and proficiently by the end of grade 10.
- I can write routinely over a variety of time frames for a range of discipline-specific tasks, purposes, and audiences.
- I can cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
- I can determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate, objective summary of the text.

acidic solution, basic solution, Arrhenius model, Bronsted-Lowry model, conjugate acid, conjugate base, conjugate acid-base pair, amphoteric, Lewis model, strong acid, weak acid, acid ionization constant, strong base, weak base, ion product constant for water, pH, pOH, neutralization reaction, salt, titration, titrant, equivalence point, acid-base indicator, end point, salt hydrolysis, buffering capacity, Henderson Hasselbalch,	• I can follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. • I can analyze the structure of the relationships among concepts in a text, including relationships among key terms. • I can analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address. • I can translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words. • I can assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. • I can compare and contrast findings presented in a text to those from other sources, noting when the findings support or contradict previous explanations or accounts. • I can write arguments focused on discipline-specific content. • I can write informative texts, including scientific procedures/experiments or technical processes that include precise descriptions and conclusions drawn from data and research. • I can plan and develop; draft; revise using appropriate reference materials; rewrite; try a new approach, focusing on addressing what is most significant for a specific purpose and audience; and edit to produce and strengthen writing that is clear and coherent. • I can use technology to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. • I can conduct short as well as more sustained research assignments and tasks to answer a question. • I can gather relevant information from multiple authoritative sources, using advanced searches effectively. • I can draw evidence from informational texts to support analysis, reflection , and research. • 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. • 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.

Resources/Activities	**Question Stems**
• Factors affecting Solvation lab (Teacher Files) • Determining concentration activity (Teacher Files) • Molarity conversion practice (Teacher Files) • Aquarium Analysis (Teacher Led) • Household product pH mini lab (Teacher Files) • Indicator solution lab (Teacher Files) • Titration curve diagramming (Teacher Led) • Titration curve matching (Student Led) • Particulate diagram models (Teacher Led) • Videos (Various) • pH and pOH calculation practice (Teacher Files) • Titration practice (Teacher Files) • Titration Lab (College Board Guided Inquiry)	• Where can you find that in the text? • How would you write this if you were speaking to another scientist? • Can you cite specific textual evidence to support your answer? • Can you summarize what the author is saying? • What is the next step in the procedures? • What is the name of the element that has the atomic symbol "C"? • What is the relationship between the position on the periodic table and the electronegativity? • Why do you think the author explained this to us? • What does this graph tell us? • Does this evidence support the author's claim? • Does the scientific journal support the claim from the textbook? • How could you write this so it could be understood by other scientists? • Is there another way you could describe this that would

	be more clear to a general audience? ● Is there a way you could link your findings to this document? ● How could you test this hypothesis? ● Is this source authoritative and accurate? ● What evidence can you draw from the text to support your analysis? ● What is the pH, based on Kw and the concentration of all species present in a neutral solution of water? ● What is the pH at this point in a strong base titration? ● If the pH is a 3.4 in a monoprotic acid, what is the pOH? ● What are the major species in the beaker in a mixture of a weak acid and a strong base? ● At this point in a titration, what is the concentration of acid in the beaker? ● What causes HCl to be a strong acid, but HF is not? ● What is the relationship between the predominant form of a weak acid in solution at a given pH and the pKb of the conjugate base? ● In a strong buffer solution, what will happen if you add more acid? ● What is the pH of the buffer solution at this point in the titration? **Assessment(s)** Bell ringers Exit tickets Quizzes Chapter Tests Lab Reports

Unit 9 Theme	**Duration of Unit**	**Essential Question(s)**
Applications of Thermodynamics Chapter 17	4 weeks	How is electrical energy generated using chemical reactions?

End of Unit 9 Authentic Learning Task

Can you make a battery?-Lab Students will create an electrolyte solution and form a rudimentary battery using chemicals. They will then set up an electric current to test the voltage with a voltmeter, and they will test to see if they can turn on an LED light bulb with their battery.
Assessment-Students will turn in a lab report which is assessed with a rubric for accuracy.

- I can determine proper safety equipment to use in the presence of acids and bases.
- I can identify the parts of a galvanic and electrolytic cell, and explain the purpose of each.
- I can identify the reducing agent and the oxidizing agent, and determine which will have a greater mass at the end of the experiment.
- I can qualitatively analyze the voltage of the electrolytic cell based on reduction potential.
- I can identify the number of electrons transferred.
- I can use Faraday's laws to determine the stoichiometry occurring in the electrochemical cell with respect to the charge of ionic species.

Standards: 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

Pacing: Unit 9, Chapter 17 & 18
Semester 2, Quarter 4, 10 block days, 20 school calendar days

Indiana Academic Standards

11-12.LST.2.1, 11-12.LST.2.2, 11-12.LST.2.3, 11-12.LST.3.2, 11-12.LST.3.3, 11-12.LST.4.1, 11-12.LST.4.2, 11-12.LST.4.3, 11-12.LST.5.1, 11-12.LST.5.2, 11-12.LST.7.1, 11-12.LST.7.2, 11-12.LST.7.3

AP Chemistry Big Ideas

2.F, 4.D, 5.B, 5.F, 6.C, 6.D, 6.E

Academic Vocabulary

Anode, Battery, Cathode, Cell Voltage, Corrosion, Electrochemistry, Electrolysis, Electrolytic Cell, Electromotive force, Entropy, Faraday constant, Free energy, Fuel Cell, Galvanic Cell, Gibbs free energy, Half-cell reaction, Nernst Equation, Overvoltage, Second law of thermodynamics, Standard entropy of reaction, Standard free-energy of formation, Standard free-energy of reaction, Standard reduction potential, Third law of

Key Concepts/Learning Targets

- I can identify the sign and relative magnitude of the entropy change associated with chemical or physical processes.
- I can calculate the entropy change for a chemical or physical process based on the absolute entropies of the species involved in the process.
- I can explain whether a physical or chemical process is thermodynamically favored based on an evaluation of ΔG^{o} .
- 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^{o}, and T.
- I can explain the relationship between external sources of energy or coupled reactions and their 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.

thermodynamics	

Resources/Activities

- Think-Pair-Share (Student Led)
- Demo with Q & A (Teacher Led)
- Critique Reasoning (Student Led)
- Modeling Electrochemistry (Teacher Led)
- Create a battery Lab (Teacher Files)
- Electrochemical Potential (Teacher Files)
- Videos (Various)
- Trivia Games (Quizlet, Quizizz, Kahoot)

Question Stems

- Is ΔG positive or negative? How do you know?
- What is the entropy change for this chemical reaction?
- If ΔG^o is 4.36, is this process thermodynamically favored?
- If this is thermodynamically favorable, why is this reaction not occurring at a measurable rate?
- If we add outside energy, could this process become thermodynamically favorable?
- If I used a copper electrode instead of zinc, how would that change the operational principles of this cell?
- If I replaced the copper electrode with a zinc electrode, would it be thermodynamically favorable?
- What is the relationship between deviations from standard cell conditions and changes in the cell potential?
- What is the charge flow based on if you double the concentration of the reactants?

Assessment(s)

Bell ringers
Exit tickets
Quizzes
Chapter Tests
Lab Reports

Indiana Academic Standards Addressed and Assessed Each Term
Chemistry
(A=assessed; I=introduced; P=practiced; R=reviewed)
(Green=high priority; Yellow=moderate priority; Blue=low priority)

Standard	Standard Statement	Term 1	Term 2	Term 3	Term 4
Unit 1: Atomic Structure and Properties 7-9%					

1.1 Moles and Molar Mass	5.B	PRA	PRA	PRA	PRA
1.2 Mass Spectroscopy of Elements	5.D	IPRA	PRA	PRA	PRA
1.3 Elemental Composition of Pure Substances	2.A		IPRA	PRA	PRA
1.4 Composition of Mixtures	5.A		IPRA	PRA	PRA
1.5 Atomic Structure and electron Configuration	1.A			IPRA	PRA
1.6 Photoelectron Spectroscopy	4.B	IPRA	PRA	PRA	PRA
1.7 Periodic Trends	4.A	IPRA	PRA	PRA	PRA
1.8 Valence Electrons and Ionic Compounds	4.C	IPRA	PRA	PRA	PRA
Molecular and Ionic Compound Structure and Properties 7-9%					
2.1 Types of Chemical Bonds	6.A	PRA	PRA	PRA	PRA

2.2 Intramolecular Force and Potential Energy	3.A	IPRA	PRA	PRA	PRA
2.3 Structure of Ionic Solids	4.C	PRA	PRA	PRA	PRA
2.4 Structure of Metals and Alloys	4.C	IPRA	PRA	PRA	PRA
2.5 Lewis Diagrams	3.B	PRA	PR	PRA	PRA
2.6 Resonance and Formal Charge	6.C	PRA	PR	PR	PR
2.7 VSEPR and Bond Hybridization	6.C	PRA	PR	PR	PR
Intermolecular Forces and Properties 18-22%					
3.1 Intermolecular Forces	4.D	PRA	PRA	PRA	PRA
3.2 Properties of Solids	4.C	PRA	PRA	PRA	PRA
3.3 Solids, Liquids, and Gases	3.C	PRA	PRA	PRA	PRA
3.4 Ideal Gas	5.C	PRA	PRA	PRA	PRA

Law					
3.5 Kinetic Molecular Theory	4.A	PRA	PRA	PRA	PRA
3.6 Deviation from Ideal Gas Law	6.E		IPRA	PR	PR
3.7 Solutions and Mixtures	5.F		IPRA	PRA	PRA
3.8 Representations of Solutions	3.C		IPRA	PRA	PRA
3.9 Separation of Solutions and Mixtures Chromatography	2.C		PRA	PR	PR
3.10 Solubility	4.D		IPRA	PRA	PRA
3.11 Spectroscopy and the Electromagnetic Spectrum	4.A		IPRA	PRA	PRA
3.12 Photoelectric Effect	5.F		IPRA	PR	PR
3.13 Beer-Lambert Law	2.E	IPRA	PR	PR	PR

Chemical Reactions 7-9%					
4.1 Introduction for Reactions	2.B		PRA	PRA	PRA
4.2 Net Ionic Equations	5.E		PRA	PR	PR
4.3 Representation of Reactions	3.B		PRA	PR	PR
4.4 Physical and Chemical Changes	6.B		PRA	PR	PR
4.5 Stoichiometry	5.C	PRA	PRA	PRA	PRA
4.6 Introduction to Titration	3.A		IPRA	PRA	PRA
4.7 Types of Chemical Reactions	1.B		PRA	PRA	PRA
4.8 Introduction to Acid-Base Reactions	1.B		IPRA	PR	PRA
4.9 Redox Reactions	5.E		IPRA	PR	PRA
Kinetics 7-9%					

5.1 Reaction Rates	6.E		IPRA	PR	PR
5.2 Introduction to Rate Law	5.C		IPRA	PR	PR
5.3 Concentration Changes over Time	5.B		IPRA	PR	PR
5.4 Elementary Reactions	5.E		IPRA	PR	PR
5.5 Collision Model	6.E		IPRA	PR	PR
5.6 Reaction Energy Profile	3.B		IPRA	PR	PR
5.7 Introduction to Reaction Mechanisms	1.B		IPRA	PR	PR
5.8 Reaction Mechanism and Rate Law	5.B		IPRA	PR	PR
5.9 Steady-State Approximation	5.B		IPRA	PR	PR
5.10 Multistep Reaction Energy Profile	3.B		IPRA	PR	PR

5.11 Catalysis	6.E		IPRA	PR	PR
Thermodynamics 7-9%					
6.1 Endothermic and Exothermic Processes	6.D			PRA	PRA
6.2 Energy Diagrams	3.A			IPRA	PRA
6.3 Heat Transfer and Thermal Equilibrium	6.E			IPRA	PRA
6.4 Heat Capacity and Calorimetry	2.D			PRA	PRA
6.5 Energy of Phase Changes	1.B			PRA	PRA
6.6 Introduction to Enthalpy of Reaction	4.C			IPRA	PRA
6.7 Bond Enthalpies	5.F			IPRA	PRA
6.8 Enthalpy of Formation	5.F			IPRA	PRA
6.9 Hess's Law	5.A			PRA	PRA

Equilibrium 7-9%					
7.1 Introduction to Equilibrium	6.D			IPRA	PRA
7.2 Direction of Reversible Reactions	4.D			IPRA	PRA
7.3 Reaction Quotient and Equilibrium Constant	3.A			IPRA	PRA
7.4 Calculating the Equilibrium Constant	5.C			IPRA	PRA
7.5 Magnitude of the Equilibrium Constant	6.D			IPRA	PRA
7.6 Properties of the Equilibrium Constant	5.A			IPRA	PRA
7.7 Calculating Equilibrium Concentrations	3.A			IPRA	PRA
7.8 Representations of Equilibrium	3.C			IPRA	PRA

7.9 Introduction to Le Chatelier's Principle	6.F			IPRA	PRA
7.10 Reaction Quotient and le Chatelier's Principle	5.F			IPRA	PRA
7.11 Introduction to Solubility Equilibria	5.B			IPRA	PRA
7.12 Common-Ion Effect	2.F			IPRA	PRA
7.13 pH and Solubility	2.D			IPRA	PRA
7.14 Free energy of Dissolution	4.D			IPRA	PRA
Acids and Bases 11-15%					
8.1 Introduction to Acids and Bases	5.B				IPRA
8.2 pH and pOH of Strong Acids and Bases	5.B				IPRA

8.3 Weak Acid and Base Equilibria	5.C				IPRA
8.4 Acid-Base Reactions and Buffers	5.F				IPRA
8.5 Acid-Base Titrations	5.D				IPRA
8.6 Molecular Structure of Acids and Bases	6.C				IPRA
8.7 pH and pKa	2.D				IPRA
8.8 Properties of Buffers	6.D				IPRA
8.9 Henderson-Hasselbalch Equation	5.F				IPRA
8.10 Buffer Capacity	6.G				IPRA
Applications of Thermodynamics					
9.1 Introduction to Entropy	6.C				IPRA
9.2 Absolute Entropy and	5.F				IPRA

Entropy Change					
9.3 Gibbs Free Energy and Thermodynamic Favorability	6.E				IPRA
9.4 Thermodynamic and Kinetic Control	6.E				IPRA
9.5 Free Energy and Equilibrium	6.D				IPRA
9.6 Coupled Reactions	4.D				IPRA
9.7 Galvanic (Voltaic) and Electrolytic Cells	2.F				IPRA
9.8 Cell Potential and Free Energy	5.F				IPRA
9.9 Cell Potential under Nonstandard Conditions	6.D				IPRA
9.10 Electrolysis and Faraday's Law	5.B				IPRA

Literacy in Science & Technical Subjects					
11-12.LST.2.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.	I, P, A	P, R, A	P, R, A	P, R, A
11-12.LST.2.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.	P	P, R, A	P, R, A	P, R, A
11-12.LST.2.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.	P, A	P, R, A	P, R, A	P, R, A
11-12.LST.3.1	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.	P, R, A	P, R, A	P, R, A	P, R, A
11-12.LST.3.2	Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.	P	P	P	P, R
11-12.LST.3.3	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.	P	P	P	P, R
11-12.LST.4.1	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.	P	P	P	P
11-12.LST.4.2	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.	P	P	P	P

11-12.LST.4.3	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.	P, R	P, R	P, R	P, R
11-12.LST.5.1	Write arguments focused on discipline-specific content.	P	P	P	P
11-12.LST.5.2	Write informative texts, including scientific procedures/experiments or technical processes that include precise descriptions and conclusions drawn from data and research.	P	P	P	P
11-12.LST.6.1	Plan and develop; draft; revise using appropriate reference materials; rewrite; try a new approach, focusing on addressing what is most significant for a specific purpose and audience; and edit to produce and strengthen writing that is clear and coherent.	P	P	P	P
11-12.LST.6.2	Use technology to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.	P			
11-12.LST.7.1	Conduct short as well as more sustained research assignments and tasks to answer a question (including a self-generated question), test a hypothesis, or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.	P	P	P	P
11-12.LST.7.2	Gather relevant information from multiple types of authoritative sources, using advanced searches effectively; annotate sources; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; synthesize and integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and over reliance on any one source and following a standard format for citation (e.g., APA or CSE).	P	P	P	P
11-12.LST.7.3	Draw evidence from informational texts to support analysis, reflection, and research.	P	P	P	P