AP® Chemistry Sample Syllabus 4

Syllabus 1029721v1

Curricular Requirements		Page(s)
CR1	Students and teachers use a recently published (within the last 10 years) college-level chemistry textbook.	2
CR2	The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.	2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16
CR3a	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 1: Structure of matter.	4, 5
CR3b	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 2: Properties of matter-characteristics, states, and forces of attraction.	6
CR3c	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 3: Chemical reactions.	8, 10
CR3d	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 4: Rates of chemical reactions.	14
CR3e	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 5: Thermodynamics.	11
CR3f	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 6: Equilibrium.	15, 16
CR4	The course provides students with the opportunity to connect their knowledge of chemistry and science to major societal or technological components (e.g., concerns, technological advances, innovations) to help them become scientifically literate citizens.	19
CR5a	Students are provided the opportunity to engage in investigative laboratory work integrated throughout the course for a minimum of 25 percent of instructional time.	1
CR5b	Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.	2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16
CR6	The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.	2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16
CR7	The course provides opportunities for students to develop, record, and maintain evidence of their verbal, written, and graphic communication skills through laboratory reports, summaries of literature or scientific investigations, and oral, written, and graphic presentations.	1

To develop the requisite intellectual and laboratory skills, students have a minimum of 400 minutes (5- 80 Minute Block Sessions) in a five-day cycle, which is adequate classroom and laboratory time. A minimum of 25 percent of instructional time is dedicated to the lab activities. **[CR5a]** In addition, students will have to spend at least five hours a week studying outside of class.

CR5a—Students are provided the opportunity to engage in investigative laboratory work integrated throughout the course for a minimum of 25 percent of instructional time.

Laboratory Program [CR7]

The laboratory activities are comprised of "hands-on" labs so the students can accomplish multiple trials and can use statistical analysis to derive conclusions. Students are required to have a bound student carbonless duplicate lab notebook and three ring binder, which will be used as their lab portfolio. For each lab, students complete a lab report that includes replicated data tables and answers to the post lab discussion. These items are collected and graded as part of their lab grade. These reports are returned and stapled into their lab notebooks.

CR7—The course provides opportunities for students to develop, record, and maintain evidence of their verbal, written, and graphic communication skills through laboratory reports, summaries of literature or scientific investigations, and oral, written, and graphic presentations.

Every lab assignment must have a lab report including the following in order to receive maximum credit:

1. Table of Contents in front of lab report
    - Date experiment performed
    - Title of experiment
    - Page number
    - Minutes of hands-on activity
2. Pages all Numbered
    - Do not skip pages
3. Hand out stapled (two staples) to copy produced from lab manual
4. Report Criteria
    - Title
    - Purpose —State the problem/questions clearly; substantiate the question and explain the reason for the investigation.
    - Theory (Refer to the handout stapled in the book)
    - Procedure (Refer to the handout stapled in the book). Labs must have any procedural changes noted. Give explicit details of methods and give precise quantitative directions. Make sure handout is attached and modifications stated in lab report.
5. Data Table or Pictures
    - Data must have numbers with descriptive units in correct significant figures
    - Data must be recorded *directly into lab book;* hand in data table sheet from hand out
6. Discussion and Conclusion
    - Explain all calculations which produced data in data table

- Answers to questions should be written in complete sentences with question stated in answer (Refer to handout stapled in book)
- Explanation of data and results
- All calculations using data

**Students always work in groups of two.*

Texts

Brown, Theodore L., H. Eugene LeMay, and Bruce Edward Bursten. (2009). *Chemistry: The central science* (11th ed.). New Jersey: Pearson Education. **[CR1]**

CR1—Students and teachers use a recently published (within the last 10 years) college-level chemistry textbook.

Online Reading and Assignments

www.pwista.com/

Laboratory Manuals

Ehrenkranz, David and John J. Mauch. *Chemistry in Microscale*.
Jack Randall, *Advanced Chemistry with Vernier*
College Board, *AP Chemistry Guided-Inquiry Experiments: Applying the Science Practices Teacher Manual*

Demonstration Resources

Shakhashiri, Bassam. *Chemical Demonstrations: A Handbook for Teachers of Chemistry*.

Curriculum Content Map – Early September

Big Idea 2: Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them. **[CR2]**	
Learning Objectives: 2.7, 5.10	
Textbook Chapter(s): 1	
Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**
Introduction to Chemistry 1. Scientific Method 2. Classification of Matter 3. Separation Science, example distillation and chromatography 4. Physical and Chemical Properties 5. Temperature and Density—Demos 6. Meet the Elements 7. Math Review, Significant Figures, and Statistical Techniques 8. Dimensional Analysis and Proportions 9. Units of Measurement	**Guided-Inquiry:** The Scientific Method **SP 6.2** • Students determine the identity of an unknown solution using physical characteristics • Determine alternate method of recording temperature

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

10. Conversion of units 11. Dimensional Analysis 12. Uncertainty in Measurements and Significant Figures 13. Length and Volume 14. Mass and Weight 15. Density and Specific Gravity 16. Temperature and its Measurement	Meet the Elements **SP 6.1** • Students are given the opportunity to make observations on many different elements on the periodic table and based on their physical characteristics, determine periodic tendencies. Students research the properties using the internet. Each lab group member gives a short 5-minute presentation on an element. Resource: www.ptable.com. Laboratory Equipment Technique **SP 3** • Students identify laboratory equipment and watch a demonstration of application. Determination of Bunsen Burner Flame Temperature Using Thermocouple Wire and a Voltage Conversion Chart **SP 3** • Unit conversions • High temperature recording methods • Types of burners • Seebeck effect and thermocouple wire • Voltage concept • Use of voltmeters Separation of Components of a Homogeneous Mixture Using Simple Distillation and Column Chromatography **SP 3** • Use of volumetric glassware • Use of ground glassware • Methods of separation science • Chromatography

Curriculum Content Map - Late September/Early October

<u>Big Idea 1</u>: The chemical elements are fundamental building materials of matter, and all matter can be understood in terms of arrangements of atoms. These atoms retain their identity in chemical reactions. **[CR2]**	
Learning Objectives: 1.5, 1.6, 1.7, 1.8, 1.12, 1.13, 1.14	
Textbook Chapter(s): 2, 6, 21.1-21.6	
Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**
Nuclear and Atomic Structure • Types of Subatomic Particles • The Nucleus • Mass Spectroscopy and Isotopes • Stability of the Nucleus • Atomic Structure • Rutherford Experiment • Cathode Ray Experiments • Atomic Structure Terms • Electromagnetic Radiation • Quantization of Energy • Photoelectric Effect • PES data • Bohr Atom • Spectroscopy • Orbital Model of Atom • Aufbau Diagram • Paramagnetism • Quantum Model	**Guided-Inquiry:** Determination of Paramagnetism Using Electron Configuration and Magnetic Attractions **SP 4.2, 6.2** • Students design method of correlating electron configuration and paramagnetism. Flame Test of Salt Solutions **SP 1.5** • Emission spectroscopy and electronic transition • Predict the color of the flame produced when each of your test solutions is heated in a bunsen burner Spectroscopy of gases using discharge tube **SP 3** • Determine the emission spectrum of various known gases from given gas discharge tubes • Determine what elements are in a fluorescent light bulb • Determine energy of emission
Student Activity - Students observe a demonstration of light emission and the voltage drop for various LED lights, then mathematically and graphically determine Plauk's constant. **LO 1.7 [CR3a]**	

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

CR3a—The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 1: Structure of matter.

Curriculum Map – Late October

Big Idea 1: The chemical elements are fundamental building materials of matter, and all matter can be understood in terms of arrangements of atoms. These atoms retain their identity in chemical reactions. **[CR2]**	
Learning Objectives: 1.9, 1.10, 1.11, 2.14, 2.17, 2.19, 2.20, 2.22, 2.23, 2.24, 2.25, 2.26, 2.27, 2.28	
Textbook Chapter(s): 7, 22, 23, 8.1-8.2	
Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**
Periodicity and Introduction to Bonding 1. Atomic Properties 2. Periodic Law 3. Elemental Properties 4. Types of Bonds 5. Metallic Bonding 6. Properties of Group One 7. Properties of Period Two 8. Metals vs. Non Metals 9. Multiple Oxidation States of Transition Metals 10. Ionic Bonding 11. Ionic Bonding and Potential Energy Diagrams 12. Energy of Formation of Ionic Compounds 13. Lattice energy	**Guided-Inquiry:** Determination of Type of Bonding in Solids **SP 1.1, 1.4, 6.2, 6.4, 7.1**
Student Activity - Students enter data and construct graphs using Microsoft Excel to predict, demonstrate, and identify periodic trends. Students will use graphs and data to justify exceptions to identified trends and present such information in a class discussion. **LO 1.9 [CR3a]**	

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

CR3a—The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 1: Structure of matter.

Curriculum Content Map - Early to Mid November

Big Idea 2: Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them. **[CR2]**

Learning Objectives: 2.11, 2.13, 2.18, 2.20, 2.21, 2.22, 2.29, 2.30, 2.31, 2.32, 5.9

Textbook Chapter(s): 8, 9, 11.7-11.8

Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**

Covalent Bonding and Molecules
1. Types of Covalent Bonds
2. Nonpolar Covalent Bonds
3. Polar Covalent Bonds
4. Coordinate Covalent Bonds - Lewis Acids and Lewis Bases
5. Lewis Structures
6. Resonance
7. Hybridization
8. Molecular Geometry
9. Energy Effects on Molecules
10. Isomerism
11. Functional Groups
12. Interactions of Functional Groups
13. Classification of Molecules
14. Intermolecular Interactions
15. Dipole moments
16. Dielectric Constants
17. Types of Compounds
18. Properties of Metallic, Molecular, Macromolecular and Ionic Compounds
	Molecular Modeling Using Foam Balls and Sticks **SP 1.4**
	• Predict the shapes of molecules by building a model of the molecule with a molecular modeling kit and applying the Valence Shell Electron Pair Repulsion theory.
	Guided-Inquiry: Intermolecular Attractions Lab **SP 6.1, 6.2, 6.4, 7.1**
	• Students will make observations with various solutions to determine the connection between:
	  ◦ molecular structure and polarity
	  ◦ hydrogen bonding and structure
	  ◦ capillary action to polarity
	  ◦ Angle of curvature relationship to IMF
	  ◦ Drop size and IMF
	Guided Inquiry: Molecular Interactions **SP 1.1, 6.2, 6.4, 7.1**
	• Students will make observations with various solutions to determine the connection between:
	  ◦ Random miscibility and solubility of given solutes and solvents
	  ◦ Relationship of structure to solubility
	  ◦ IMF effects, solubility, and extraction

Student Activity - Students are given structures of various compounds and must explain why they differ in physical state at various temperatures; then predict the type(s) of bonding present based on the atom's position on the periodic table. **LO 2.1, 2.13, 2.17, & 2.19 [CR3b]**

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

CR3b—The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 2: Properties of matter-characteristics, states, and forces of attraction.

Curriculum Content Map - End of November

<u>Big Idea 2</u>: Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them. **[CR2]**	
Learning Objectives: 1.15, 1.19, 2.10, 2.11, 3.3, 5.11	
Textbook Chapter(s): 25, 12.6-12.7	
Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**
<u>Organic Chemistry</u> A. Properties and Bonding in Carbon Compounds 1. Introduction to organic chemistry: hydrocarbons and functional groups (structure, nomenclature, chemical properties). Physical and chemical properties of simple organic compounds B. Hydrocarbons 1. Petroleum 2. Fractional Distillation 3. Cracking 4. Alkanes 5. Alkenes 6. Alkynes 7. Benzene Series 8. General Formulas 9. Structural Formulas 10. Saturated/unsaturated Compounds C. Nomenclature 1. Alkyl Groups 2. IUPAC Nomenclature 3. Isomers D. Other Organic Compounds 1. Alcohols • Primary, Secondary, and Tertiary Alcohols • Diols and Triols 2. Aldehydes 3. Ketones 4. Acids	Saponification **SP 3** • Students will use surfactants and develop a procedure to measure surface tension. Esterification (Banana oil and oil of wintergreen) **SP 2** • Students will use a variety of solutions to go through the esterification process and will identify the completion of such a process through macroscopic observations. Polymerization and Polymer Identification **SP 3** • Students will use a variety of solutions to go through the polymerization process and will identify the completion of such a process through macroscopic observations. Aspirin Synthesis and Analysis **SP 2.2, 4.1, 4.2, 5.1, 6.2, 6.4** • Students will perform an esterification synthesis and prove such synthesis with the following procedures and calculations: • Thin layer chromatography • Quantitative analysis • Theoretical yield calculations • Percent yield calculations • IR spectroscopy

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

5. Esters 6. Ethers 7. Amines 8. Polymers • Addition Polymerization • Condensation Polymerization • Natural Polymers E. Organic Reactions	

Curriculum Content Map - Early December

Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons. **[CR2]**	
Learning Objectives: 2.1, 3.1, 3.2, 3.8, 3.9, 3.10, 5.10	
Textbook Chapter(s): 4.3, 16.2, 16.11 Sections 4.2, 4.4, 20.1, 4.4, 8.5, 20.6	
Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**
Predicting Reactions 1. Naming Compounds 2. Balancing Chemical Equations 3. Types of Chemical Equations 4. Types of Chemical Reactions 5. Predicting based on Stability 6. Predicting based on Type 7. Chemical reactivity and products of chemical reactions 8. Reaction types – Organic Functional Group Reactions, Acid-base reactions; concepts of Arrhenius, Brönsted-Lowry, and Lewis; coordination complexes; amphoterism • Precipitation reactions, Oxidation-reduction reactions, Oxidation number, the role of the electron in oxidation-reduction	Chemical Reactions Using Crystal Growth **SP 1.5, 6.1, 6.4, 7.1** • Students will be provided with several solutions to perform several reactions and predict what possible reactions can occur with such solutions. Students will use macroscopic observations to confirm predictions. Solubility Rule Development **SP 1.4, 6.1** • Students will predict double replacement reactions in solutions based on solubility rules. Redox Titration **SP 4.2, 5.1** • Students will perform a redox standardization of H_2O_2 using potassium permanganate.
Student Activity - Students observe a series of chemical reactions using video demonstrations from websites. For each they will: 1. Classify the type of reaction, 2. Write a balanced net ionic chemical equation, 3. Write a brief description for each reaction, and 4. Determine the driving force towards thermodynamic favorability for the reaction. **LO 3.1 & 3.2 [CR3c]**	

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

CR3c—The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 3: Chemical reactions.

Curriculum Content Map- Mid December

Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons. **[CR2]**	
Learning Objectives: 1.1, 1.2, 1.3, 1.4, 1.17, 1.18, 1.19, 3.4, 3.5, 3.6	
Textbook Chapter(s): 4.2, 3.1, 3.6 Section 20.2, 2.6, 3.4, 3.5, 3.7, 10.4	
Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**
Measurement and Stoichiometry 1. Law of Constant Composition and Calculations based on Law 2. Using Moles to find a Quantity 3. Stoichiometry 4. Limiting Reagents 5. Using Density 6. Solution Terms 7. Stoichiometry - Solutions	Percent Oxygen In A Chlorate **SP 2.2, 6.1** • Students will use a prescribed procedure and series of calculations to determine the percent of oxygen in a chlorate. Percent of Water in a Hydrate **SP 2.2, 6.1** • Students will use a prescribed procedure and series of calculations to determine the percent of water and the formula of a hydrate. Empirical Formula **SP 2.2, 5.1, 6.4** • Students will use a prescribed procedure and series of calculations to determine the empirical formula of manganese chloride. Molar Mass of Gas **SP 7.1** • Students will use a prescribed procedure and series of calculations to determine the molecular mass of an unknown gas. Atomic Mass **SP 1.4, 1.5** • Students will use a prescribed procedure and series of calculations to determine the atomic mass of aluminum.

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

	Standardization of an Acid Solution **SP 2.2, 5.1, 6.4** • Students will use a prescribed procedure and series of calculations to prepare solutions of standardized salicylic acid solution.
Student Activity - Students determine optimum hydrocarbon fuel to oxygen ratio to achieve complete combustion in a 60 mL volume. **LO 3.3 & 3.4 [CR3c]**	

CR3c—The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 3: Chemical reactions.

Curriculum Content Map - Early January

Big Idea 5: The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter. **[CR2]**	
Learning Objectives: 3.11, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.12, 5.13, 5.14	
Textbook Chapter(s): Section 5.6, 5.7, 13.1, 19.2, 7.8, 8.4	
Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**
Thermochemistry 1. Introduction to thermodynamics 2. Conservation of energy 3. State Functions 4. Potential Energy 5. Kinetic Energy 6. Calorimetry 7. Heat of Fusion 8. Heat of Vaporization 9. Specific Heat 10. Heat of Dilution 11. Heat of Solution 12. Hess's Law—direct and indirect 13. Bond Dissociation Energies 14. Gibbs Free Energy Equation	Heat of Neutralization **SP 7.1** • Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the heat of neutralization for that reaction. Heat of Dissolution **SP 7.1** • Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the heat of dissolution for that reaction. Heat of a Reaction **SP 1.1, 1.4, 7.2, 1.5, 4.4, 5.1** • Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the heat of a reaction: Mg-HCl. • Relate energy changes associated with a chemical reaction to the enthalpy of the reaction, and relate energy changes to $P\Delta V$ work.

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

	Guided-Inquiry: Stoichiometry Rockets **SP 1.4, 2.2, 2.3, 7.1, 7.2** • Students will relate energy changes associated with a chemical reaction to the enthalpy of the reaction, and relate energy changes to P△V work.
Student Activity - Pre Lab Activity: Students calculate the needed volume of oxygen to react with given volume of gases in a reaction, determine the heat of the reaction, and then determine the amount of work produced using the distance the rocket traveled and heat produced from the reaction. **LO 5.3 & 5.4 [CR3e]**	

CR3e—The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 5: Thermodynamics.

Curriculum Content Map - Late January

<u>Big Idea 2</u>: Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them. **[CR2]**	
Learning Objectives: 2.3, 2.4, 2.5, 2.6, 2.12, 2.16, 2.22, 2.29, 2.31	
Textbook Chapter(s): 10, 11	
Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**
Gas, Liquids and Solids 1. Real Gases versus Ideal Gases 2. Ideal Gas Equation 3. Derivations based on Ideal Gas Equation 4. Gases collected Over Water 5. Kinetic Molecular Theory 6. Van Der Waals Equation 7. Molecular Speeds 8. Diffusion and Effusion 9. Molecular Theory related to Phase 10. Phase Changes 11. Entropy 12. Heating and Cooling Curves 13. Interfaces 14. Pressure 15. Vapor Pressure 16. Boiling Point and Freezing Points 17. Vapor Pressure Curves	Molar Mass of a Gas **SP 1.3, 2.2, 2.3, 5.1, 6.4, 6.5, 7.2** • Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the molecular mass of butane. Freezing Point of a Pure Material **SP 1.4, 6.4** • Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the freezing point of phenyl salicylate.

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

18. Phase Diagrams – Triple point, critical point 19. Energy change during phase changes 20. Viscosity 21. Surface Tension 22. Types of Solids and Crystal Structure	

Curriculum Content Map - Early February

Big Idea 2: Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them. **[CR2]**	
Learning Objectives: 1.16, 2.8, 2.8, 2.9	
Textbook Chapter(s): 13	
Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**
Solutions 1. Types of Solutions 2. Electrolytes 3. Miscibility and Immiscibility 4. Process of Dissolution 5. Dissolution versus Ionization 6. Solubility Terms 7. Solubility Curves 8. Henry's Law 9. Concentration Terms – Molarity, Molality, % , mole fractions 10. Dilution Problems 11. Stoichiometry Problems with Solutions—Review 12. Raoult's Law 13. Freezing and Boiling points of Solutions—Colligative Properties 14. van't Hoff factor 15. Osmosis 16. Deviation from Raoult's Law 17. Colloids	Freezing-point Depression **SP 1.1, 1.2, 1.4, 6.2, 6.4** • Students will use freezing-point depression to find molecular weight of a given substance. Spectrophotometry **SP 4.2, 5.1** • Students will use spectrophotometry and Beer's law to determine the concentration of a given cobalt chloride solution. **Guided-Inquiry:** Spectroscopic Determination of the Percent of Salicylic Acid in Aspirin **SP 4.2, 5.1** • Students prepare standard salicylic acid solutions and use spectroscopy to determine % salicylic acid in expired aspirin tablets. • Given past methods of spectroscopy and preparation of standard solutions, students design an experiment to determine % salicylic acid in expired aspirin tablets.

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

Curriculum Content Map - Late February- Early March

<table>
<tr><td colspan="2"><u>Big Idea 4</u>: Rates of chemical reactions are determined by details of the molecular collisions. [CR2]</td></tr>
<tr><td colspan="2">Learning Objectives: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9</td></tr>
<tr><td colspan="2">Textbook Chapter(s): 14</td></tr>
<tr><td>Unit and Topics</td><td>Lab Activity Title and Science Practice Skills Acquired [CR5b] & [CR6]</td></tr>
<tr><td>Kinetics
1. Rates relationship to collisions
2. Reaction Mechanisms
3. Activation energy
4. Nature of Reactants and Interfacial Surface Area
5. Temperature and Pressure effects on Rates
6. Catalyst—Homogeneous and Heterogeneous
7. Potential Energy Diagrams—Review
8. Activated Complex and Intermediates
9. Arrhenius Equation
10. Maxwell- Boltzman Diagram
11. Average Rate
12. Rates relationship to Stoichiometry
13. Graphical determination of Instantaneous Rate
14. Rate Laws
15. Determination of Rate Laws
16. Determination of Mechanisms
17. Order of Reactions
18. Calculations based on Order</td><td>Kinetics of the Acid Decomposition of Thiosulfate SP 2.1, 2.2, 4.2, 5.1, 6.5, 7.1
• Students will use a prescribed procedure to perform the acid decomposition of thiosulfate and use a series of calculations to determine the rate law of the reaction.
• Students will perform graphical determination of order.
• Students will use differential rate laws to determine order of reaction.
• Students will determine the rate constant from experimental data.
Kinetics of Decomposition of Hydrogen Carbonate SP 1.4, 6.4
• Students will determine the variables that affect reaction rate:
  • Nature of reactants
  • Surface area effects
  • Concentration effects
  • Temperature effects
The Kinetics of Bleach Reaction SP 2.1, 2.2, 4.2, 5.1, 6.5, 7.1
• Students use results to determine the order of the reaction.
  • Consider the bleach to be in excess, write a rate law for the reaction, substitute the appropriate digit for the value of x in the rate law.
  • Calculate a value for the rate constant, k.</td></tr>
</table>

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

	• Determine the rate of the reaction during the first ten seconds. • Determine graphically the initial rate of reaction. • Graphically determine the rate at 15 seconds
Student Activity - Students orally present the solution to a problem given a set of data of the change of concentration versus time to the class, indicating the order of the reaction and the rate constant with appropriate units. **LO 4.2 [CR3d]**	

CR3d—The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 4: Rates of chemical reactions.

Curriculum Content Map - Mid March

Big Idea 6: Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations. **[CR2]**	
Learning Objectives: 5.16, 5.17, 5.18, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.21, 6.22, 6.23, 6.24, 6.25	
Textbook Chapter(s): 15	
Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**
Equilibrium 1. Reversible processes and Reactions 2. Types of systems 3. Kinetics relationship to Equilibrium 4. Equilibrium Expressions 5. Equilibrium Constants 6. LeChatelier's Principle 7. Equilibrium Stresses 8. Equilibrium Calculations 9. Molar Solubility 10. Common Ion Effects 11. Reaction Quotients	Le Chatelier's Principle Using Cobalt Complexes and Chemical Equilibrium Lab **SP 1.4, 6.4** • Students will perform a variety of stresses on a given system in equilibrium to demonstrate Le Chatelier's Principle. Solubility Constant of Calcium Hydroxide **SP 2.1, 2.2, 2.3** • Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the solubility constant of calcium hydroxide using micro-titration techniques.

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

	Determine the Equilibrium Constant **SP 1.3, 2.2, 6.2, 7.2**
	• Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the equilibrium constant for a system at equilibrium:
	  • Combination indicators
	  • Micro-titration
	  • pH measurement
	  • Vernier technology

Student Activity - Students determine the concentration of species at equilibrium given the equilibrium constant and the concentration of other species in the reaction at equilibrium. Students will apply Le Chatelier's Principle quantitatively to equilibrium systems that are altered. **LO 6.8 [CR3f]**	

CR3f—The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 6: Equilibrium.

Curriculum Content Map - End of March- Early April

Big Idea 6: Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations. **[CR2]**	
Learning Objectives: 1.20, 3.7, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16, 6.17, 6.18, 6.19, 6.20	
Textbook Chapter(s): 16	
Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**
Acids, Bases and Salts 1. Dissociation versus Ionization 2. Preparation of Acids, Bases and Salts 3. Classification of Acids and Bases 4. Bronsted-Lowry Theory of Acids and Bases 5. Degree of Ionization 6. Equilibrium Constants for Acids and Bases 7. Weak Acids and Bases 8. Binary acids versus Oxyacids 9. Determination of Acid and Base properties based on structure 10. Ionization of Water 11. pH and pOH	Preparation of Sodium Hydroxide Solution and Standardization Using a Primary Standard **SP 4.2, 5.1** • Micro-titration using syringes Determination of Molecular Weight and K_a of an Unknown Organic Acid **SP 2.2, 5.1, 6.4** • pH probes • Titration curves using data acquisition (Logger Pro) • Determination of Equivalence point using 2^{nd} derivatives • Determination of midpoint to determine pK_a • Vernier technology

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

12. Acid-Base Stoichiometry Problems—Review 13. Ionization calculations of Weak Acids and Bases 14. Henderson-Hasselbalch Equation 15. Titration Calculations 16. Indicators 17. Types of Salts 18. Dissociation of salts and Buffers	Neutralization Reactions **SP 2.2, 2.3, 6.2** • Students will use a prescribed procedure to perform a series of neutralization reactions and use indicators and macroscopic observations to confirm predictions about such reactions. Students will use a prescribed procedure to perform a chemical reaction and use a series of calculations to determine the ionization constant of an indicator **SP 2.3, 5.1, 2.3, 4.2, 6.4** • Calculations using the Hasselbalch equation • Beer's law • Vernier technology
Student Activity - Students determine pH of various buffer solutions and describe the mechanism that would occur within the buffer system upon the addition of an acid or a base. **LO 6.20 [CR3f]**	

CR3f—The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 6: Equilibrium.

CR2—The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.

Curriculum Content Map - Mid April

Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons. **[CR2]**	
Learning Objectives: 3.12, 3.13, 5.14, 5.15, 6.25	
Textbook Chapter(s): 19, 20	
Unit and Topics	Lab Activity Title and Science Practice Skills Acquired **[CR5b] & [CR6]**
Electrochemistry and Thermodynamics 1. Oxidation and Reduction 2. Substances gaining potential 3. Types of electrochemical cells 4. Voltaic cells 5. Cell Potentials 6. Concentration dependence of E 7. Nernst Equation 8. Cell potentials and Equilibrium 9. Metal Electrodes 10. Reference Electrodes 11. Indicator electrodes	Voltaic Cell and Nernst Equation Lab **SP 2.2, 2.3, 5.1, 6.4** • Prepare a list containing all seven metal/metal ion half-reactions as reduction reactions, using a definition of the Ag/AgCl half-reaction as 0.00 volts • List the half-reactions from the most positive reduction potential to the most negative reduction potential • Compare with the order given on chart in your reference tables for chemistry

CR5b—Students are provided the opportunity to engage in a minimum of 16 hands-on laboratory experiments integrated throughout the course while using basic laboratory equipment to support the learning objectives listed within the AP Chemistry Curriculum Framework.

CR6—The laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Chemistry Curriculum Framework. At minimum, six of the required 16 labs are conducted in a guided-inquiry format.

12. Applications of Voltaic Cells
13. Electrolysis
14. Faraday's Law
15. Electrolytic Cells
16. Order of reduction
17. Applications of Electrolytic cells
18. Gibbs Free energy Equation (Free Work)
19. Relationship of Equilibrium and Q
20. Relationship to E
	• Sketch an electrochemical cell for all the cells created. Include each half-cell, the salt bridge, the electrodes and solutions, the voltmeter leads, the voltmeter, and a switch in your drawing.
	Electrolysis of Aqueous Solutions Lab **SP 2.2, 2.3, 5.1, 6.4**
	• Students will use a prescribed procedure to perform a series of redox chemical reactions for galvanic cells
	• Students will use macroscopic observations and calculations to generate a list of all the particles (ions and molecules) present in the U-tube before electrolysis
	  • Write a balanced oxidation half-reaction
	  • Write a balanced reduction half-reaction
	  • Determine the balanced net ionic equation for the chemical reaction
	  • Determine the ions present in the solution are oxidized and which are reduced
	  • Determine which electrode is the anode and which electrode in the cathode
	  • Determine E°
	  • Determine ΔG
	Copper Plating Lab **SP 6.2**
	• Determine the number of faradays, coulombs, and current used to coat a leaf with copper.

<table>
<tr>
<td></td>
<td>Guided-Inquiry: Electrolysis of Sodium Sulfate Using Micro Hoffman Apparatus SP 2.2, 2.3, 5.1, 6.4

Given experimental research using syringes to collect gases over water, atmospheric pressure, and room temperature:

Students collect an unknown volume of gas generated
Determine the system's net ionic equation, moles of gas, moles of electrons used to generate gas
Determine amperes used in the experiment

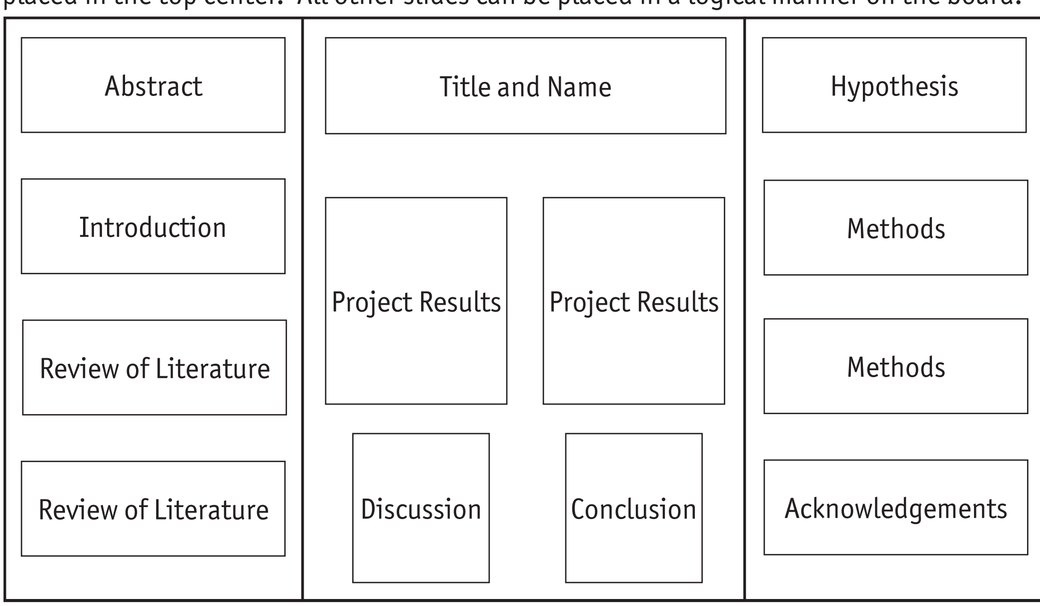
</td>
</tr>
</table>

Final Exit Assessment

AP Chemistry Poster board Guidelines and Lab Binder Portfolio

All students will generate a lab binder portfolio, which will contain a table of contents, all typed lab handouts, and copies of all returned lab reports with dividers separating each lab.

Each designated lab group will perform a 10 minute poster board presentation on the lab of their choice. Poster boards can be the standard Poster board used at most science fair competitions. A 3′x4′ (36″ x 48″) board is acceptable. The boards should securely stand on a table and fold/bend into a 4 foot squared section. The Abstract needs to be placed in the top left corner. The Title, Student's Names and AP period, School Name should be placed in the top center. All other slides can be placed in a logical manner on the board.



Abstract: Summary and Summation of lab

Review of Literature: Provides past research reported in literature and background information. Introduces the topic historically and scientifically. Presented in a logical order, which will lead to the statement of purpose or rationale for the work.

Statement of Purpose/Hypothesis: Identifies a clear prediction or outcome to an event. Identifies the questions that the research seeks to explain.

Methods and Materials: Lists and/or demonstrates the use of equipment and supplies, and describes procedures to be used to execute the experiment.

Results: Because the experiment has not been conducted yet, write the results you anticipate that would support your hypothesis. Data tables and graphs must be included.

Analysis and Discussion: The student explains and interprets the rationale regarding their scientific research area.

Conclusion: States whether or not the results support the hypothesis, suggests future research, and discusses the importance this research has to the scientific community or society.

Applications: How is this experiment related to everyday world applications, major societal or technological components (e.g., concerns, technological advances, innovations) such as how spectroscopy can be used to distinguish real art from fake art? **[CR4]**

CR4—The course provides students with the opportunity to connect their knowledge of chemistry and science to major societal or technological components (e.g., concerns, technological advances, innovations) to help them become scientifically literate citizens.

Each Group will determine the following responsibilities: Lab chosen to present, person designated to purchase the poster board.

Group will determine the Person Responsible for the following responsibilities: Poster Board Layout, Title, Abstract, Review of Literature, Statement of Purpose/Hypothesis, Methods and Materials, Results, Analysis and Discussion, Conclusion, and Application. All slides must be produced using PowerPoint.