| Curricular Requirements | | Syllabus Index (page #) |
|---|---|---|
| CR1 | Students and teachers use a recently published (within the last ten years) college-level chemistry textbook | 2 |
| CR2 | The curse is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework | 4, 5, 6,7 |
| CR3a | The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 1:  Structure of Matter | 7 |
| 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. | 7 |
| CR3c | The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 3:  Chemical Reactions | 7 |
| CR3d | The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 4:  Rates of Chemical Reactions | 7 |
| CR3e | The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 5:  Thermodynamics | 7 |
| CR3f | The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 6:  Equilibrium | 7 |
| 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. | 6 |
| 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. | 2 |
| 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. | 8 |
| 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. | 8 |
| 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. | 2, 3 |

The AP Chemistry course is designed to be the equivalent of the general chemistry course usually taken during the first year of college. This course prepares students for the Advanced Placement Exam, which may allow them to earn college credit while in high school. As a result, this course is a rigorous study of chemistry focused on lab-work and depth of understanding of topics. The coursework is centered about six "Big Ideas" described in the AP Chemistry curriculum framework provided by the College Board. **[CR2]** The laboratory experience includes a combination of seven science practices in conjunction with inquiry. This class meets 85 minutes daily. Students are engaged in hands-on laboratory work, integrated throughout the course, which accounts for 25 percent of the course. **[CR5a]**

**Textbooks, Lab Books, and Resource Materials:**
Zumdahl, Steven S., et. Al., Chemistry, 7$^{th}$ Edition. Boston, New York, Houghton Mifflin Company, 2007. **[CR1]**
The College Board. AP Chemistry Guided Inquiry Experiments: Applying the Science Practices. 2013.
Vonderbrink, Sally. Laboratory Experiments for Advanced Placement Chemistry. Batavia: Flinn Scientific, 2001.
Vonderbrink, Sally. Laboratory Experiments for Advanced Placement Chemistry, 2nd Edition. Batavia: Flinn Scientific, 2005.

**Laboratory Program:**
Besides conducting laboratory investigations, the next most important job of any researcher is to honestly report his or her findings. It is required that you buy and maintain a science notebook for recording and reporting laboratory findings. **[CR7]** A carbonless copy notebook is recommended, but not required. This lab notebook will be especially important if you want to earn college credit for chem. lab. (You are not guaranteed credit, but your college may ask to see your lab book). You should keep an updated Table of Contents on the first page of your notebook. The following format should be used when completing lab reports.

**Laboratory Notebook Components:**
**Title -** The title should be descriptive. "Experiment 3" is not a descriptive title. "Determination of the Molecular Weight of Oxygen from the Decomposition of Potassium Chlorate" is a descriptive title. Please do not simple rely on the titles that may be at the top of lab handouts if they are given. These often have catchy titles instead of descriptive ones. The reader should know exactly what the lab was about when reading the title.
**Date** - This is the date (or dates) that you performed the experiment.
**Introduction -** Provide a short introduction (minimum 5 sentences) on the purpose and background for the experiment. Show the complete chemical equation(s) for all reactions that occur in the procedure.
The second paragraph of the introduction should start off "in this lab we will…" It should describe what you are going to be doing in the lab (minimum 5 sentences).
**Materials -** Include a neat list a chemicals and equipment needed to perform the experiment.

**Procedure -** Record procedures with enough detail so a classmate could understand what you did and reproduce your work if desired. It should be written in a more student friendly manner so that any student in the class could do the experiment. Often the lab instructor will give you changes in the directions, if there are changes in the procedure, these changes must be noted. Use past tense and passive voice (e.g. *100 mL of Solution A was added to the 500 mL beaker).* This should be in numbered list form.
**Data -** Record all your data directly in your lab notebook. Organize your data in a table. Use Excel or Word to create tables. Label all data very clearly. Use correct significant digits, and always include proper units (g, mL, etc.). Space things out—don't try to cram everything into a small space.
**Calculations and Graphs -** You should show *how* calculations are carried out. Give the equation used and show how your values are substituted into it. Give the calculated values, with correct units. If graphs are included, make the graphs an appropriate size. Label all axes and give each graph a title. Graph paper may be stapled, pasted, or taped in your lab book, if used. I am not responsible for the loss of any materials that are turned in "loose" in your lab book. If experiments are not quantitative, this section may be omitted.
**Conclusion -** Paragraph 1: Minimum 5 sentences: Restate the overall purpose of the experiment and how the procedure enabled you to accomplish it. Do not repeat the whole procedure! Paragraph 2: Discuss overall results and draw conclusions from your data. Discuss possible trends in the data/graphs (if applicable). ALL NUMBERS SHOULD BE DISCUSSED HERE!!!!! What did you find? Paragraph 3: Minimum 2 –3 sentences: What are some *specific* sources of error, and how do they influence the data? Do they make the values obtained larger or smaller than they should be? Which measurement was the least precise? Instrumental error and human error exist in all experiments and should not be mentioned as a source of error unless they cause a significant fault. Significant digits and mistakes in calculations are NOT a valid source of error. In writing this section, it is sometimes helpful to ask yourself what you would do differently if you were to repeat the experiment and wanted to obtain better precision. If you can calculate a percent error or percent deviation, do so and include it in this section. Let me reiterate – sources of experimental error are just that: Experimental. Not….Calculations Not….Something unspecific such as "human error" or "the scale was off"
**Questions -** Answer any post lab questions included in the lab.

**Curriculum Map**

The curriculum map that follows is designed to adhere to the AP Chemistry Big Ideas, Enduring Understandings, Science Practices, and Learning Objectives outlined in the AP Chemistry Curriculum Framework. Appropriate alignment with each component is provided as appropriate. "Class Periods" in the curriculum map are referred to as a 100 minute block period. Listing of appropriate laboratory components follows the curriculum map. Connections to biological systems will be implemented throughout all units of study as appropriate. Particulate-level modeling and qualitative explanations/descriptions will be stressed in addition the necessary quantitative analysis for each component of the course.

AP Chemistry: Six Big Ideas **[CR 2]**

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.
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.
3) Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.
4) Rates of chemical reactions are determined by details of the molecular collisions.
5) The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
6) Any bond or intermolecular attraction that can be formed can be broken. These two processes are in dynamic competition, sensitive to external conditions and external perturbations.

LO = Learning Objectives, SP = Science Practices, EKC = Essential Knowledge Connections **[CR 5a]**

| **Unit** | **Content Description** | **Textbook Chapter(s)** | **AP Chemistry Curriculum Framework Alignment** | **Topics** | **Class Periods** |
|---|---|---|---|---|---|
| 1 | Review of Atomic Theory (including Photoelectron Spectroscopy analysis), Nomenclature, Chemical Reactions, (except redox) Stoichiometry | 2, 3, 6, 7 | **LO** 1.1, 1.3, 1.17, 2.1, 3.1, 3.2, 3.4, 3.5, 3.6,<br>**SP** 1.5, 2.1, 2.2 , 4.2, 5.1, 6.1, 6.4 7.1, | History of atomic theory, Isotopes, PES, Atomic Mass, Empirical and Molecular Formulas, Waves, Light, Electronic Structure, Periodicity, Ionic and Covalent Nomenclature including Acids and Hydrated Compounds, Reaction Types and prediction of products, Mole Concept, Limiting and Excess Reagents, Yield | 8 |
| 2 | Solutions and Reactions (molarity, redox, electrochemistry, Free Energy) | 4.1, 4.4, 4.5, 20 | **LO** 1.4, 1.18, 3.1, 3.2, 3.3, 3.8, 3.9, 3.13, 3.12<br>**SP** 1.4, 1.5, 2.2, 2.3, 4.2, 5.1, 6.1, 6.4, 7.1, | Electrolytic Solutions, General Solubility, Redox reactions (including acidic and basic solutions), Hydrogen and Halogen replacement Reactions, Disproportionation reactions | 8 |
| 3 | Energy and Thermodynamics (including foods and fuels) | 5.1-5.6, 5.8, 19 | **LO** 3.11, 5.2, 5.3, 5.4, 5.6, 5.7, 5.8, 5.12, 5.13, 5.14,<br>**SP** 1.1, 1.4, 1.5, 2.2, 2.3, 4.2, 4.4, 5.1, 6.4, 7.1, 7.2, | Enthalpy, Enthalpy of reaction and Solution, Calorimetry, Hess' Law, Bond Energies, Entropy, Gibb's Free Energy | 8 |

| | | | | | |
|---|---|---|---|---|---|
| | | | **EKC** 5.B.1, 5B.2, 5.E.2, 5.E.3 | | |
| 4 | Atomic and Molecular Structure: Chemical Bonding and Molecular Geometry | 8, 9.1-9.7 | **LO** 1.6, 1.9, 1.10 1.11, 1.12, 1.13, 2.17, 2.18, 2.19, 2.20, 2.23, 2.24, 2.25, 2.26, 2.27, 2.28, 3.1<br>**SP** 1.1, 1.4, 1.5, 3.1, 5.1, 5.3, 6.1, 6.2, 6.3, 6.4, 7.1, 7.2<br>**EKC** 2.D.1, 2.D.2 | Ionization Process and Ionic Bonding, Covalent Compounds and Lewis Structures, Expanded Octets and Electron Deficient Molecules, Resonance Structures and Coordinate Covalent Bonds, Molecular Geometry and the VSEPR Theory, Polar Bonds and Molecules, Hybridization, | 8 |
| 5 | Intermolecular Forces and Gases | 11, 10 | **LO** 2.1, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.16, 3.4, 5.2, 5.5, 5.9, 5.11,<br>**SP** 1.1, 1.2, 1.3, 1.4, 2.2, 2.3, 4.2, 5.1, 6.2, 6.4, 6.5, 7.1, 7.2<br>**EKC** 5B.1, 5.B.2, 2.A.2 | Determination of the Types of Intermolecular Forces and relationship to Primary States of Matter, Pressure, Ideal Gas Behaviors, Partial Pressures, Mole Fractions of Mixtures, Energy of Gas Particles, Effusion and Diffusion, Non-Ideal Gas Behaviors | 8 |
| 6 | Kinetics | 14 | **LO** 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9<br>**SP** 2.1, 1.4, 1.5, 2.2, 4.2, 5.1, 6.2, 6.4, 6.5, 7.1, 7.2<br>**EKC** 4.A.3, 4.B.2 | Reaction Rates, Reaction Order, Rate Laws, Integrated Rate Laws, Activation Energies and Factors Affecting Reaction Rates, Reaction Mechanisms, Catalysis | 8 |
| 7 | General Equilibrium | 15 | **LO** 6.6, 6.8, 6.10, 6.25<br>**SP** 1.4, 2.2, 2.3, 6.4, 7.2 | Equilibrium Constants and Expressions, Equilibrium Concentrations and Pressures, Manipulating the Equilibrium Constant, The Reaction Quotient, Le | 8 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Chatelier's Principle, Gibb's Free Energy and Equilibrium Relationship | |
| 8 | Solution Analysis, Solubility Equilibria, Qualitative Analysis | 13.1-13.3, 17.4- 17.7 | **LO** 6.6, 6.8, 6.10, 6.21, 6.22, 6.23, 6.24, 6.25<br>**SP** 1.4, 2.2, 2.3, 5.1, 6.4, 7.1, 7.2<br>**EKC** 5.E.2, 5.E.3, 6.A.2, 6.B.1, 6.D.1 | Types of Solutions, Molecular Structure and Solubility Relationships, Solubility of Gases, Solubility Product Constant, Particulate Descriptions of Colligative Properties in Ideal and Non-Ideal Situations | 8 |
| 9 | Acids and Bases (including equilibria of weak acids and bases, common ions, and buffers) | 16.1-16.10, 17.1-17.3 | **LO** 6.11, 6.12, 6.13, 6.14, 6.15, 6.16, 6.17, 6.18, 6.19, 6.20<br>**SP** 1.1, 1.4, 2.2, 2.3, 4.2, 5.1, 6.2, 6.4<br>**EKC** 1.E.2 | Bronsted-Lowery and Arhenius Theories of Acids and Bases, Strengths of Acids and Bases, Auto-ionization of Water, $K_a$ and $K_b$, pH, pOH, Monoprotic vs. Polyprotic Acids, Acid Base Reactions in Solution and Gas Phases, Review of Common Ion Effect and Buffers, Complex Ion Formation, indicators and $pK_a$ $pK_b$ (half-ionization to determine $K_a$ $K_b$), Neutralization Reactions and Acid Base Titrations. | 8 |
| 10 | Year-End Review, Continuation of Laboratory Program | Comprehensive | Comprehensive | Comprehensive | 8 |
| -- | AP Testing Period | -- | -- | Students are allowed to use class time following the AP Chemistry Exam to study for their additional upcoming AP Exams. Students without additional AP Exams will use this time to study for their regular classes. | 8 |
| 11 | Nuclear Chemistry | 25 | Comprehensive | Types of radiation, properties of various radiation, writing nuclear reactions, fission versus fusion, half life. Students will debate the pros and cons of nuclear power **[CR 4]** | 8 |

**Big Idea Activities:** At a minimum the following activities will be performed by the students either individually or in groups. Although only one activity is listed for each Big Idea, it should be understood that multiple activities for each of the six Big Ideas will be performed throughout the school year to enhance student instruction and learning of the concepts therein. Descriptions of each Big Idea can be found with the Curriculum map section of this syllabus. <u>While some of these activities may relate to laboratory experiences, they are not a specific component of any laboratory exercises; they are to be conducted outside the laboratory environment in the regularly scheduled instructional component of the course and do not use any laboratory resources or materials</u>.**[CR 3a-f]**

| Big Idea | Activity Name, Brief Description, and Resources |
|---|---|
| 1 | *Essential and Applied Inquiry 10-2, 10-3: Empirical Formulas and Molecular Formulas.* Students work in POGIL groups to investigate method for determining empirical and molecular formulas from experimental data. Advanced application of this activity includes researching the methods of collection of pertinent required data. All resources are teacher generated and published. |
| 2 | Provided pertinent information (PV=nRT and n = mass/molar mass, students will derive the equation necessary to calculate the molar mass of an unknown gas. Students will describe the measurements that must be taken in order appropriately calculate this descriptor of a gas. No special resources are needed for this inquiry activity. |
| 3 | *Limiting and Excess Reactants: Is there enough of each chemical reactant to make a desired amount of product?* Students will be provided a certain number of "parts" to build model cars. Students will determine the limiting and excess reagents in their model car kits (Trout, Laura, 2012. P. 175). |
| 4 | Provided appropriate data, students will analyze reaction rates in relationship to the concentration of the reactants in two reactant systems. Students will use this data to determine if presented chemical reactions are zero, first, or second order in terms of individual reactants and the overall. Sample and Practice Exercises 14.6 (Brown and Lemay, 2009. Pp584-585). |
| 5 | *Bond Energy: What makes a reaction endothermic or exothermic?* In POGIL groups, students will investigate the energy required to break and assemble bonds during a chemical reaction. The data provided in the activity allow the students to calculate Change in Enthalpy of specific chemical reactions. Further analysis allows students to connect concepts with Potential Energy Diagrams, and to develop their own definition of bond energy (Trout, Laura, 2012. P. 225). |
| 6 | *Equilibrium: At what point is a reversible reaction "completed"?* Students will describe the changes in a system as it reaches equilibrium, as well as develop an understanding that the product/reactant ratio of a system at equilibrium is independent of the initial conditions, but related to the rates of the forward and reverse reactions (Trout, Laura, 2012. P. 235). |

The laboratory component of the AP Chemistry class is based on the *AP Chemistry Guided-Inquiry: Applying the Science Practices Lab* Manual. It is intended that no less than ten of these hands-on laboratory investigations will be conducted in a guided or open-inquiry format with others being modified to a more traditional format. The laboratory is stocked with all appropriate equipment, lab-wares, and reagents necessary to provide for a college-level laboratory experience. The appropriate curriculum alignment (CR, BI, LO, EK, EU, SP) can be found within the College Board Published manual. Many of the labs provide students with the opportunity to connect their knowledge of chemistry and science to major societal or technological components. These labs will account for 25% of the instructional component of the class. **[CR 2, CR 4, CR 5a, CR 5b, CR 6]**

* Indicates, at minimum, those labs that will be conducted in guided or open-inquiry format. Lab titles not marked with an * *may* be modified from the College Board inquiry model to a more traditional format in a manner designed to maintain the integrity of the investigations underlying concepts. **[CR 6]**

**Laboratory Titles from *AP Chemistry Guided-Inquiry: Applying the Science Practices***

1) *What is the Relationship Between the Concentration of a Solution and the Amount of Transmitted Light Through the Solution?
2) How Can Color Be Used to Determine the Mass Percent of Copper in Brass?
3) What Makes Water Hard?
4) How Much Acid Is in Fruit Juices and Soft Drinks?
5) Sticky Question: How do You Separate Molecules That are Attracted to One Another?
6) *What's in That Bottle?
7) Using the Principle That Each Substance Has Unique Properties to Purify a Mixture: An Experiment Applying Green Chemistry to Purification
8) *How Can We Determine the Actual Percentage of $H_2O_2$ is a Drugstore Bottle of Hydrogen Peroxide?
9) Can the Individual Components of Quick Ache Relief Be Used to Resolve Consumer Complaints?
10) *How Long Will That Marble Statue Last?
11) What is the Rate Law of the Fading Crystal Violet Using Beer's Law?
12) *The Hand Warmer Design Challenge: Where Does the Heat Come From?
13) *Can We Make the Colors of the Rainbow? An Application of Le Chatelier's Principle.
14) How Do the Structure and the Initial Concentration of an Acid and a Base Influence pH of the Resultant Solution During Titration?
15) To What Extent Do Common Household Products Have Buffering Activity?

16) The Preparation and Testing of and Effective Buffer:  How Do Components Influence a Buffer's pH and Capacity?