AP Chemistry Syllabus

2016-2017

**Course Design:**

Advanced Placement Chemistry is designed by the College Board and their standards on a freshman level chemistry course; General Chemistry. Students will have to opportunity to take the AP Chemistry Examination in May and based on their results may receive college credit for General Chemistry or place out of General Chemistry and opt to go straight into Organic Chemistry while spending more time and focus on undergraduate research. The school schedule allows for 44 minutes of Advanced Placement Chemistry each day, with a 79 minute block of time strictly devoted to laboratory work every other Wednesday and a 79 minute block of time strictly devoted to laboratory work each Friday. The High School is able to devote a minimum of 25% of scheduled instructional time to hands-on laboratory experiences integrated throughout the course. Prerequisites for the course are successful completion, grade of “B” or better, in two previous years of math and science with one of those science courses being a first year chemistry course. Pre-laboratory assignments for the week are provided on the preceding Friday. Students must answer and turn in all pre-lab questions prior to entering the laboratory. All labs consist of a formal laboratory report that is due on Fridays.

In the two semesters of AP Chemistry, students will explore, investigate and problem solve. In addition, it is expected of students to spend at least an additional four to five hours each week outside of class studying and applying their chemistry content knowledge to problem sets and laboratory reports. The content in this course can be achieved with great work-ethic and motivation resulting in preparation for the AP Chemistry Examination and future success in college science courses.

**Textbook:**

Theodore K. Brown, H. Eugene Lemay, Bruce Edward Bursten, Catherine Murphy, and Patrick Woodward. 2011. *Chemistry: The Central Science*, 12th edition. New Jersey: Prentice Hall. **[CR 1]**

**Laboratory Resources:**

Vonderbrink, Sally, *Laboratory Experiments for Advanced Placement Chemistry*, 2nd edition, Flinn Scientific, Inc., 2006

AP Chemistry Guided Inquiry Experiments: *Applying the Science Practices*. College Board, 2013

**Kits:** Obtained from Flinn Scientific

**Miscellaneous Resources:**

*Journal of Chemical Education*

**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. 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 of 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]**

*(Subject to change)*

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| **Unit** | **Content Description** | **Textbook**  **Chapter(s)** | **AP Chemistry Curriculum Framework Alignment** | **Topics** |
| 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  ----------------------  **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 |
| 2 | 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  **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  **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, and  Hybridization. |
| 3 | 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,  **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  **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 |
| 4 | Energy and Thermodynamics (including foods and fuels) | 5.1-5.6, 5.8, 19 | **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,  ----------------------  **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  ----------------------  **EKC** 2.D.1, 2.D.2 | Enthalpy, Enthalpy of reaction and Solution, Calorimetry, Hess’ Law, Bond Energies, Entropy, Gibb’s Free Energy |
| 5 | Solutoins 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  ----------------------  **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 |
| 6 | Kinetics | 14 | **LO** 4.1, 4.2, 4.3,  4.4, 4.5, 4.6, 4.7,  4.8, 4.9  **SP** 2.1, 1.4, 1.5,  2.2, 4.2, 5.1, 6.2,  6.4, 6.5, 7.1, 7.2  **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 |
| 7 | General Equilibrium | 15 | **LO** 6.6, 6.8, 6.10,  6.25  **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  Chatelier’s Principle, Gibb’s Free  Energy and Equilibrium  Relationship |
| 8 | 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  **SP** 1.1, 1.4, 2.2,  2.3, 4.2, 5.1, 6.2,  6.4  **EKC** 1.E.2 | Bronsted-Lowery and Arhenius  Theories of Acids and Bases,  Strengths of Acids and Bases, Autoionization  of Water, Ka and Kb, 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 pKa pKb (half-ionization to  determine Ka Kb), Neutralization  Reactions and Acid Base Titrations. |
| 9 | 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  **SP** 1.4, 2.2, 2.3,  5.1, 6.4, 7.1, 7.2  **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 |
| 10 | Year-End Review, Continuation of Laboratory Program | Comprehensive | Comprehensive | Comprehensive |
| -- | 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 |
| 11 | Food Safety and Chemical  Interactions in the  Gastronomical Sciences | 25 | Comprehensive | Focused analysis of biological  concerns with processing, handling,  and cross-contamination of food  stuffs. Biological metabolism and  nutrition analysis combined with  structure and interaction of common  compounds found in foods;  particularly lipids, proteins, starches  and sugars, and aromatics. **[CR 4]** |

**Big Idea Activities:**

At a minimum the following activities will be performed by the students either individually or in *Process Oriented Guided Inquiry Learning* (POGIL) groups. Although only one activity is listed for each Big Idea, it should be understand 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. 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 of materials. Bibliographic information can be found in the *Textbook*, and *Miscellaneous Resources* section of this syllabus. **[CR 3a-f]**

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| --- | --- |
| **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 to 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. Some 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. Pp 584-585). |
| 5 | Bond Energy: What makes a reaction endothermic and 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 tht 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). |

In addition to the above specific activities, students are also required to read and report, in written format, a minimum of three articles from the *Journal of Chemical and Engineering News* and/or *The Journal of Chemical Education*. Journal articles from the previous year are available to the students in the regular classroom. The report must specify how the article relates to societal or technological issues, in addition to building a correlation to the content that has been studied within the course. If a student chooses an article from *The Journal of Chemical Education*, the report must specify the results of research that exemplifies how the content of the article has been shown, or desires to show, the increased understanding of the chemical concepts discussed. These three article analyses are expected to be completed during the second semester of the course after a good deal of the class content has been articulated. **[CR 4] [CR 7]**

**Assessments:**

1. Tests are given at the conclusion of each unit. In the School District, teachers must have a minimum of fifteen grades per marking period, with a minimum of one grade per week. Each major unit test will consist of multiple choice and Free Response Questions that are appropriate for that particular unit. Essay questions, graphing analysis, and equations may also appear on the test. For review purposes, three old exams will be given with the AP Exam format. We will hold a discussion after each unit exam in preparation for the AP Exam.
2. Students are quizzed once each week. Quizzes are timed and designed to take no more than 10 to 15 minutes. Quizzes are prepared from the assigned homework and are considered formative.
3. Homework: Homework problems are assigned throughout the week. Although homework is not checked on a daily basis, it is checked through the use of weekly quizzes. (See number two above). The majority of the homework will be from the student textbook, however some questions may come from old AP Chemistry Examination questions. In the case event that our class does not meet for a day, (due to standardized testing, pep-rally, etc.) students are still required to follow the homework policy.
4. Lab Notebook: Labs are essential to understanding Chemistry. Goggles must be worn at all times. No open toed shoes are allowed during lab. Laboratory experiments will be completed either on Wednesday or Fridays with all qualitative and quantitative data recorded in a graphical composition book. All lab books are submitted for grading on Friday. Cheating or plagiarism (from a classmate or cited document) is not tolerated and will immediately result in a failing grade. See attachment A for the ‘Format for Documenting Laboratory Participation’ and Attachment B for ‘Formal Lab Report’.

**Laboratory Program Framework and Requirements**

All students are required to maintain a bound composition notebook to organize all of their laboratory investigations including the pre-lab discussion notes, procedural designs and pertinent handouts, as well as the completed laboratory report for each investigation performed. The laboratory reports will constitute 25% of the overall student grade in alignment with the 25% requirement regarding total instructional time. The lab notebook is designed for the students to present to appropriate staff when enrolled in the college or university of their choice. The laboratory is architecturally designed to be conducive to a college-level chemistry laboratory program. The laboratory is stocked with all necessary glassware, reagents, and equipment necessary for students to complete all required labs in groups of two. **[CR 5a][CR7]**

Students will work in groups of two per station; all students will turn in their own independent laboratory report. [**CR 7]**

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 modifiedto 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 a minimum of 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 H2O2 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 LeChâtelier’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

**Attachment A**

**Format for Documenting Laboratory Participation**

**Advanced Placement Chemistry**

The AP Chemistry Course requires the completion of a laboratory component comparable to college level chemistry laboratories.

The laboratory notebook should be neat and organized. It should also be written in a scientific manner, meaning that the writing is objective and uses the past tense. All entries into the notebook are to be hand written (no cutting and pasting of computer print outs). Keep a running table of contents with page numbers on the very first page of your notebook.

* **Title/Source/Partner/Date**\*: Record the title and lab notebook page number in the table of contents as well.
* **Purpose**\*: Write one or two sentences that describe the reasons or objectives for completing the lab.
* **Chemical reactions\***: List the balanced chemical reactions involves in the experiment, if applicable.
* **List of Materials\***: Include a list of materials needed to complete the experiment.
* **Safety considerations\***: List applicable safety rules to consider in this experiment. Include special handling and disposal instructions.
* **Procedure\***: In your own words, write the directions for the experiment in a numbered step-by-step list. For CBL labs, the numbered step-by-step procedure from the lab handout may be substituted and DOES NOT have to be rewritten. Write the procedures with enough detail that experiments could be reproduced from what is written. The text may have a sequence that is not suitable for the lab, so you may have to write the steps in a different order than presented in the literature. For instance, towards the end of a procedure, you may be told to pour boiling water over a substance. When you write the procedure in you notebook, you may want to make an earlier step directing you to begin heating the water so that it is ready by the time you need it.
* **Data Table(s)\***: Create a blank data table to record data collected during the experiment (completed for prelab assignment). Record the information from the experiment in the table while conducting the lab. Include units for all measurements. Do not erase when recording data; simply draw a single line through a mistake and record the new value next to it.
* **Observations\***: Create a blank table to record observations collected during the experiment (completed for prelab assignment). Include anything you do, see, smell, hear, etc.
* **Calculations/Results:** Include all pertinent calculations. For all calculations, the equation must be expressed in words first before numbers are used in the equation. Show work for calculations, express all answers to the correct number of significant digits and include units. For repetitive problems, provide one sample calculation (with appropriate units) for each type of calculation. Percent error should be calculated in this section.

For example:

Mass of substance = mass of substance and beaker – mass of beaker

24 g = 63 g – 39 g

Volume of object = Volume of water and object – volume of water only

2.0 mL = 14.3 mL – 12.3 mL

Density = Mass/Volume

24 g/2.0 mL = 12 g/mL

* **Graphs:** Data should be graphed with maximum use of the paper, labels on both axes with units, a title, and a best fit line or curve through the data. Write the equation expressing the relationship between the variables. Graphs will be created using a computer. Tape graphs into the notebook. Not all activities will require a graph.

**\* Items that must be prepared before lab is to be completed.**

**Attachment B**

**Formal Lab Report**

**Advanced Placement Chemistry**

Scientific papers are written in an objective, technical form using the passive past tense. This report should be typed.

* **Title/Partner Name/Date**
* **Abstract**: Write three to four sentences briefly summarizing the purpose and procedure of the experiment, including a brief description of the results. The procedure may be different from what was originally written in the lab notebook depending on what actually happened in lab (what you intend to do is sometimes not what happens).
* **Results and Discussion**: State the results of the experiment and list any results from evaluation methods used (i.e. chromatography Rf values). Compare the results with standard values and list the percent error. State whether the results were too high or too low. Suggest two sources of error related to the data you collected that would have influenced these experimental results. Hypothesize why errors occurred, the directionality of errors (cause an increase or decrease in measured values) and what might be changed to avoid these errors.
* **Answers to Questions**: Rewrite the analysis/conclusion questions from the lab sheet and then answer each question. This assures the thought-process and your analysis is complete.
* **References**: Cite reference material, if applicable. If it’s a handout from your teacher, simply list it as a handout from the instructor.

Grading Notes to be aware of:

- Make note of items to be done for Prelab (also prelab questions due day lab is to be completed)

- Title, source (given) partner name, date

- Data table

- Observations: cheap, easy points but commonly forgotten!!!

- Calculations: show equation in words first, for repetitive problems - do one!

- Graphs: remember titles, equation!

- Analysis questions: rewrite question—easier and faster to grade

- Conclusion: one of most important parts of report!!! Spend time! Follow directions provided carefully!