AP® Chemistry Sample Syllabus 3

Syllabus 1029719v1

Curricular Requirements		Page(s)
CR1	Students and teachers use a recently published (within the last 10 years) college-level chemistry textbook.	1
CR2	The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.	1, 3
CR3a	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 1: Structure of matter.	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.	5
CR3c	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 3: Chemical reactions.	3
CR3d	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 4: Rates of chemical reactions.	6
CR3e	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 5: Thermodynamics.	4
CR3f	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 6: Equilibrium.	6
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.	3
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.	3, 4, 5, 6, 7
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.	3, 4, 5, 6, 7
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

Course Description:

The purpose of Advanced Placement Chemistry is to provide a college level course in chemistry and to prepare the student to seek credit and/or appropriate placement in college chemistry courses. This course meets five times per week for a double period. A total of 95 minutes per day is spent on AP Chemistry. Laboratory periods average two to three days per week. Little time is spent on lecture since it is my philosophy that learning is active not passive. Students are engaged in hands-on laboratory work, integrated throughout the course that accounts for more than 25% of the class time. **[CR5a]** Emphasis is placed on depth of understanding of a topic, rather than breadth of topics. Two days prior to each test is spent in study groups using old AP Chemistry Free Response questions/Study Guides for review.

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.

Objectives:

Students will:

1. Learn the inquiry process through numerous laboratory investigations.
2. Gain an understanding of the six big ideas as articulated in the AP Chemistry Curriculum Framework. **[CR2]**
3. Apply mathematical and scientific knowledge and skills to solve quantitative, qualitative, spatial, and analytic problems.
4. Apply basic arithmetic, algebraic, and geometric concepts.
5. Formulate strategies for the development and testing of hypotheses.
6. Use basic statistical concepts to draw both inferences and conclusions from data.
7. Identify implications and consequences of drawn conclusions.
8. Use manipulative and technological tools including the Texas Instruments Nspire CAS CX Handhelds, Vernier LabQuests, Vernier Probes, and Vernier's LoggerPro software.
9. Measure, compare, order, scale, locate, and code accurately.
10. Do scientific research and report and display the results of this research.
11. Learn to think critically in order to solve problems.

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

Textbook:

Zumdahl, Steven and Susan Zumdahl. Chemistry, Ninth Edition. Belmont, CA: Cengage Learning, 2014. **[CR1]**

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

Supplementary Materials:

AP Chemistry Manual, 2nd Edition. Charleston, WV: Kanawha County Schools, 2003.

Shakashiri, Bassam and Rodney Schreiner. Workbook for General Chemistry, 3rd Edition. Madison, WI: Stipes Publishing, 2004.

Zumdahl, Stephen and Susan Zumdahl. Fast Track to a Five. Evanston, IL: Houghton Mifflin Company, 2006.

Laboratory Work:

All of the laboratory experiments in this course are hands-on. Students work individually or in a group of two, depending upon the lab. They collect, process, manipulate, and graph data from both qualitative and quantitative observations. Inquiry is emphasized in many of the experiments that students complete. The laboratory work requires students to design, carry out, and analyze data using guided-inquiry principles. For all labs, students are required to report the purpose, procedure, all data, data analysis, error analysis, results, and conclusions in a lab report that is submitted for grading. **[CR7]** All laboratory experiments are intended to be completed in one double period (95 minutes) except the following guided-inquiry labs that require two days of work or two double lab periods:

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. Determination of the Formula of a Compound
2. Finding the Ratio of Moles of Reactants in a Chemical Reaction
3. Progressive Precipitation
4. Hess's Law
5. Relationship Between the Spectrum and Absorbance of Light
6. Conductivity of Solids & Metals
7. Factors that affect reaction rates, and determining reaction rates and reaction mechanisms
8. Equilibrium Position
9. Hydrolysis of Salts
10. Electrochemical Cells

Technology:

Students use Texas Instruments NSpire CAS CX Handhelds in both their class work and laboratory work. Students use Vernier LabPros and probes in laboratory work to gather data. Graphs are produced using Vernier LoggerPro software.

Laboratory Notebook:

A laboratory notebook is required for the course. All completed lab reports documenting all lab experiences must be included in the notebook. The notebook is checked every nine weeks with a final check at the end of the course. **[CR7]**

Tests:

A chapter test is assigned for each chapter. A comprehensive, standardized semester exam is administered at the end of 1st semester and a final exam at the end of the year.

AP Exam Review:

The final ten full class days before the AP Chemistry Exam are used for exam review and practice tests using old AP Chemistry exam materials. Students work in cooperative

groups to solve a packet of free response problems from previous exams. Students practice net ionic equations and are quizzed on their progress. Several practice AP Exams are administered as part of the two-week review prior to the AP Chemistry Exam.

Course Outline: [CR2]

(BI) *refers to Big Ideas. Big Idea 1 – Structure of matter, Big Idea 2 – Properties of matter-characteristics, states and forces of attraction, Big Idea 3 – Chemical reactions, Big Idea 4 – Rates of chemical reactions, Big Idea 5 – Thermodynamics, Big Idea 6 – Equilibrium*.

Unit Topics and Labs:

Unit 1: **Chemical Foundations (10 days) - BI 1**

Labs: Safety/Lab Skills/Lab Preparation
Ion Chromatography (SP 6.1; LO 2.18) **[CR5b] & [CR6]**
Kool Aid Chromatography (SP 1.4, 6.4; LO 2.13) **[CR5b] & [CR6]**
Fractional Distillation (SP 4.2, 5.1, 6.4; LO 2.10) **[CR5b] & [CR6]**

Activity: Based on the Kool Aid Chromatography lab, students write an analysis on the GRAS (generally regarded as safe) requirements, the use of, the chemical structure of, and problems associated with certain food dyes. **[CR4]**

Unit 2: **Atoms, Molecules, and Ions (8 days) [CR2]**

Labs: Determination of Avogadro's Number (SP 2.2, 6.1; LO 3.6) **[CR5b] & [CR6]**

Unit 3: **Stoichiometry (9 days) - BI 3**

Labs: *Guided Inquiry:* Determination of the Formula of a Compound (SP 4.2, 5.1, 6.4; LO 3.5) **[CR5b] & [CR6]**
Guided Inquiry: Finding the Ratio of Moles of Reactants in a Chemical Reaction (SP 2.1, 2.2, 4.2, 5.1, 6.4; LO 3.3, 3.5) **[CR5b] & [CR6]**
Chemical Reactions of Copper and Percent Yield (SP 1.4, 2.1, 2.2, 4.2, 5.1, 6.1, 6.4; LO 1.19, 3.2, 3.3, 3.4, 3.10)

Activity: **LO 3.6:** Use data from synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.

The students present problems to the class in which they demonstrate how to find the empirical formula of a compound from data on the percent composition by mass. **[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.

C4—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.

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

Unit 4: **Types of Chemical Reactions and Solution Stoichiometry (11 days) - BI 3**

Labs:
- Use of a Primary Standard — $KHC_8H_4O_4$ **[CR5b] & [CR6]**
- Reduction of Permanganate (SP 4.2, 5.1, 6.4; LO 1.20, 3.3) **[CR5b] & [CR6]**
- *Guided Inquiry:* Progressive Precipitation (SP 1.5, 2.2, 4.2, 5.1, 6.4; LO 1.19, 2.10, 3.2, 3.3) **[CR5b] & [CR6]**

Unit 5: **Gases (9 days) - BI 1 & 2**

Labs:
- Investigating Graham's Law (SP 2.2, 2.3; LO 2.6) **[CR5b] & [CR6]**
- Ideal Gas Law (SP 2.2, 2.3; LO 2.6) **[CR5b] & [CR6]**
- The Determination of the Molar Mass of a Volatile Liquid (SP 1.3, 1.4, 6.4, 7.2; LO 2.4, 2.5) **[CR5b] & [CR6]**

Unit 6: **Thermochemistry (10 days) - BI 5**

Labs:
- *Guided Inquiry:* Hess's Law (SP 4.2, 5.1, 6.4; LO 5.6, 5.7) **[CR5b] & [CR6]**
- Heat of Combustion of Magnesium (SP 4.2, 5.1, 6.4; LO 5.6, 5.7) **[CR5b] & [CR6]**

Activity:
- **LO 5.2:** Students relate temperature to the motions of particles, either via particulate representations, such as drawings of particles with arrows indicating velocities, and/or via representations of average kinetic energy and distribution of kinetic energies of the particles, such as plots of the Maxwell-Boltzmann distribution. **[CR3e]**

Students are accountable for answering homework questions about particle motions and kinetic energies of a sample at different temperatures while viewing a Podcast. The podcast begins with particulate animations and the narrator interprets the animations to show how kinetic energy distributions can explain the effect of temperature on the rate of a chemical reaction. The questions lead to the interpretation of activation energy on the distribution curve and eventually the refining of collision theory.

Unit 7: **Atomic Structure and Periodicity (10 days) - BI 1 & 2**

Labs:
- *Guided Inquiry:* Relationship Between the Spectrum and Absorbance of Light (SP 4.1; LO 1.15) **[CR5b] & [CR6]**
- Poison in the Kool Aid-A Spectroscopic Inquiry (SP 4.1, 4.2, 5.1, 6.4; LO 1.15, 1.16) **[CR5b] & [CR6]**

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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.

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

Beer's Law (SP 4.2, 5.1; LO 3.4) **[CR5b] & [CR6]**

Activity: **LO 1.10:** Justify with evidence the arrangement of the periodic table and apply periodic properties to chemical reactivity.

Students are given several elements pairing them by families or by period and are asked to rationalize the change in electronegativity of each group based on the electronic structure of the atom **[CR3a]**

Unit 8: **Bonding: General Concepts (9 days) - BI 1 & 2**

Lab: Molecular Geometry (SP 1.4; LO 2.21) **[CR5b] & [CR6]**

Guided Inquiry: Conductivity of Solids & Metals (SP 4.2, 6.4; LO 2.22) **[CR5b] & [CR6]**

Activity: **LO 2.21:** Use Lewis diagrams and VSEPR to predict the geometry of molecules, identify hybridization, and make predictions about polarity.

Students construct balloon models of the arrangement of pairs of electrons around a central atom. They then draw 2D pictures of these arrangements and apply these to predicting the shapes of molecules. **[CR3b]**

Unit 9: **Covalent Bonding: Orbitals (9 days) - BI 1 & 2**

Lab: Determination of the Formula of a Hydrate (SP 2.1, 4.2, 6.4; LO 3.5) **[CR5b] & [CR6]**

Unit 10: **Liquids and Solids (8 days) - BI 1 & 2**

Labs: The Structure of Crystals (SP 1.1, 1.4, 7.1; LO 2.19, 2.23, 2.24) **[CR5b] & [CR6]**

Enthalpy of Vaporization of Water (SP 6.4, 7.1; LO 2.3) **[CR5b] & [CR6]**

Unit 11: **Properties of Solutions (8 days) - BI 2**

Lab: Freezing Point Depression (SP 1.1, 1.2, 6.4; LO 2.8) **[CR5b] & [CR6]**

Winter of Tomis (SP 1.1, 1.2, 6.4; LO 2.8) **[CR5b] & [CR6]**

http://chem.lapeer.org/Chem2Docs/APChem2Manual.html#tomis

Unit 12: **Chemical Kinetics (12 days) - BI 4**

Labs: Reaction Rates (SP 4.2, 6.4; LO 4.1, 4.2) **[CR5b] & [CR6]**

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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.

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.

Rate Law Determination: Crystal Violet Reaction (SP 5.1, 6.4; LO 4.1, 4.2, 4.4) **[CR5b] & [CR6]**
Guided Inquiry: Factors that affect reaction rates and determining reaction rates and reaction mechanisms (SP 6.2, 7.2; LO 4.5, 4.9) **[CR5b] & [CR6]**

Activity: **LO 4.8:** Translate among reaction energy profile representations, particulate representations, and symbolic representations (chemical equations) of a chemical reaction occurring in the presence and absence of a catalyst.

Students create energy diagrams to explain why catalysts and raising the temperature can increase the rate of a chemical reaction. **[CR3d]**

Unit 13: Chemical Equilibrium (11 days) - BI 6

Labs: *Guided Inquiry:* Equilibrium Position (SP 4.2; LO 6.9) **[CR5b] & [CR6]**
Equilibrium Constant Determination (SP 4.2; LO 6.9) **[CR5b] & [CR6]**
Equilibrium of Ethyl Acetate (SP 4.2; LO 6.9) **[CR5b] & [CR6]**

Activity: **LO 6.1:** Given a set of experimental observations regarding physical, chemical, biological, or environmental processes that are reversible, the student is able to construct an explanation that connects the observations to the reversibility of the underlying chemical reactions or processes.

Students view the NO_2/N_2O_4 Equilibrium simulation available on the General Equilibria Animations Index page at Iowa State University and verbally report and discuss their answers to teacher supplied questions regarding the number of reactant and product molecules present at a particular point in the equilibrium process, the breaking and forming of bonds during the process, and how the reactant and product molecules are changing in order to illustrate the dynamic nature of equilibrium. **[CR3f]**

Unit 14: Acids and Bases (11 days) - BI 6

Labs: K_a Prelab
Determination of Dissociation Constant of Weak Acids (SP 1.1, 1.4, 2.3; LO 6.11) **[CR5b] & [CR6]**
Guided Inquiry: Hydrolysis of Salts (SP 6.4; LO 6.20) **[CR5b] & [CR6]**
Determination of Vitamin C and Aspirin Content (SP 4.2, 5.1, 6.4; LO 1.20) **[CR5b] & [CR6]**

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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.

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

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

Unit 15: **Applications of Aqueous Equilibria (16 days) - BI 6**

Labs:
- Acid-Base Titration (SP 4.2, 5.1, 6.4; LO 1.20) **[CR5b] & [CR6]**
- Titration of a Diprotic Acid (SP 5.1, 6.4; LO 3.2, 6.13) **[CR5b] & [CR6]**
- Titration Curves of Strong and Weak Acids and Bases (SP 1.4, 6.2, 6.4; LO 1.18, 6.12) **[CR5b] & [CR6]**
- Determination of a Solubility Product Constant (SP 2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 4.1, 5.1; LO 1.4, 3.3, 6.12, 6.20) **[CR5b] & [CR6]**
- Buffered Solutions (SP 2.3, 4.2, 6.4; LO 1.4, 6.18, 6.20) **[CR5b] & [CR6]**

Unit 16: **Spontaneity, Entropy, and Free Energy (10 days) - BI 5**

Labs:
- Determination of Soluble Chloride (SP 1.4, 2.2, 2.3, 5.1, 6.4, 7.1; LO 6.22, 6.23, 6.24) **[CR5b] & [CR6]**
- Percentage Calcium in Calcium Supplements (SP 4.2, 5.1, 6.4; LO 1.19) **[CR5b] & [CR6]**

Unit 17: **Electrochemistry (11 days) - BI 3**

Labs:
- A Chemical Activity Series (SP 3.1, 3.2, 3.3, 4.2, 4.3, 4.4, 5.1; LO 3.3) **[CR5b] & [CR6]**
- Corrosion (SP 3.1, 3.2, 3.3, 4.2, 4.3, 4.4, 5.1; LO 3.3) **[CR5b] & [CR6]**
- Electroplating (SP 3.1, 3.2, 3.3, 4.2, 4.3, 4.4, 5.1; LO 3.3) **[CR5b] & [CR6]**
- *Guided Inquiry*: Electrochemical Cells (SP 2.2, 2.3, 5.1, 6.4; LO 3.12, 3.13) **[CR5b] & [CR6]**

Unit 18: **The Representative Elements: Groups 1A Through 4A (8 days) - BI 2**

Lab:
- Using Conductivity to Find an Equivalence Point (SP 1.1, 6.2, 7.1; LO 2.24, 2.32) **[CR5b] & [CR6]**

Unit 19: **The Representative Elements: Groups 5A through 8A (8 days) - BI 2**

Labs:
- Percent Sulfate in a Mixture (SP 6.4, 7.1; LO 2.1) **[CR5b] & [CR6]**

***Refers to Learning Objectives (LO) or Science Practices (SP)**

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.