AP Chemistry Syllabus

	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
CR3a	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 1: Structure of matter.	5, 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.	5, 7, 8
CR3c	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 3: Chemical Reactions.	5, 6, 9
CR3d	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 4: Rates of Chemical reactions.	8
CR3e	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 5: Thermodynamics	6, 7, 9
CR3f	The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 6: Equilibrium	8, 9
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, 9, 10
CR5a	Students are provided the opportunity to engage in investigative laboratory work integrated throughout the course for a minimum of 25 percent 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 in the AP Chemistry Curriculum Framework.	2, 5, 6, 7, 8, 9
CR6	The laboratory investigations used throughout the course allow the students to apply the seven science practices defined in the AP Chemistry Curriculum Framework.	2, 5, 6, 7, 8, 9
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 AP Chemistry course is designed to be the equivalent of two semesters of a general chemistry course taken during the first year of college, covering topics of: measurement, atomic theory, atomic structure, stoichiometry, chemical reactions, thermochemistry, electronic structure, periodicity, states of matter and intermolecular forces, solutions, kinetics, equilibrium, acids and bases, thermodynamics, redox and electrochemistry, nuclear chemistry and organic chemistry. This course is structured around the Six Big Ideas articulated in the AP Chemistry curriculum framework provided by the College Board. **[CR2]** A special emphasis will be placed on the seven science practices, which capture important aspects of the work that scientists engage in, with learning objectives that combine content with inquiry and reasoning skills. Class meets for an 80-minute block period every other day. An additional 80-minute block (once every 4 days) is dedicated to hands-on laboratory work. AP Chemistry is open to all students who wish to take part in a rigorous and academically challenging course.

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

Textbooks, Lab Books and Review Books

Chang, Raymond. Chemistry, Ninth Edition, New York: McGraw-Hill, 2007. **[CR1]**

The College Board. AP Chemistry Guided-Inquiry Experiments: Applying the Science Practices. New York: The College Board, 2013. **[CR5b] & [CR6]**

Flinn Scientific. AP Chemistry Advanced Inquiry Labs **[CR5b] & [CR6]**

Randall, Jack. Advanced Chemistry with Vernier, Second Edition, Oregon: Vernier Software and Technology, 2007**. [CR5b] & [CR6]**

Jespersen, Neil D. Barron's AP Chemistry Review Book, 7th Edition, New York, Barrons, 2014.

Labs

The labs completed require following or developing processes and procedures, making and recording observations, and data manipulation. Students work in lab groups of 2 or 3 students, communicating and collaborating with each other; however, each student is responsible to write a laboratory report according to the "Parts of a Laboratory Report" listed below in a lab notebook (bound composition notebook) for every lab they perform. A minimum of 25% of student contact time will be spent doing hands-on laboratory work. **[CR5a]**

Parts of a Laboratory Report [CR7]

A specific format will be given to the student for each lab. Students must follow that format and label all sections in their lab notebook clearly. AP Chemistry lab reports are much longer and more in depth than the ones completed in the first year chemistry course. Labs not completed in class must be done after school on the student's own time. Students can see the teacher for extra help after school, if needed.

Pre-lab work – is to be completed in the lab notebook before the lab and will be checked on the day the lab is performed.

Title – should be descriptive for the lab being completed (do not use a title like: Lab #3)

Date – the date the lab is performed

Purpose – a statement summarizing the main focus of the lab

Procedure – a list of generalized steps that is to be followed for non-inquiry labs and for inquiry labs, a full procedure that the student develops should be written out.

Pre-lab questions – students will be given questions that relate to the lab to answer before the lab; they should rewrite the question or incorporate the question into their answer.

Data Tables – students should set up any data tables or charts into their notebook necessary for data collection.

During the lab

Data – students need to record all their data directly into their lab notebook; label all data clearly with proper significant figures and units of measurement.

Post-lab Work –

Calculations and graphs – students should show all work when carrying out calculations and graphs need to be titled, axes labeled, and units shown.

Analysis questions - students will answer the post-lab analysis questions similar to the pre-lab questions.

Conclusions – students will summarize the main focus of the lab, explaining their results and completing an error analysis of their work in the lab.

Technology used in labs – students use Vernier LabPros and probes to collect data. Graphs are produced using Vernier LoggerPro Software or Microsoft Excel.

Quizzes and Tests

Quizzes are given about once a week on one or two particular concepts. A unit test is administered at the conclusion of every one or two chapters. A comprehensive midterm exam is given at the end of the first semester and a final exam at the end of the year.

AP Exam Review

The last week of classes before the AP Chemistry exam is used for exam review and practicing test questions from old AP Chemistry exam materials. In addition, a review class may be held after school or on Saturday mornings for those students who want a more in-depth review.

AP Chemistry Unit Overview [CR2]

Chapters in Chang Chemistry (textbook)	AP Chemistry Topic Covered (Big Ideas)
1. Chemistry: The Study of Change	Scientific method, matter, measurement
2. Atoms, Molecules, and Ions	Atomic Theory & Atomic Structure **(BI 1 & BI 2)**
3. Mass Relationships in Chemical Reactions	Stoichiometry **(BI 3)**
4. Reactions in Aqueous Solutions	Types of reactions and Stoichiometry **(BI 3)**
5. Gases	Gases **(BI 1 & 2)**
6. Thermochemistry	First Law of Thermodynamics and calorimetry **(BI 5)**
7. Quantum Theory and Electronic Structure of Atoms	Atomic theory & Atomic Structure **(BI 1 & BI 2)**
8. Periodic Relationships Among the Elements	Atomic theory & Atomic Structure **(BI 1 & BI 2)**
9. Chemical Bonding I: Basic Concepts	Chemical Bonding **(BI 3)**
10. Chemical Bonding II: Molecular Geometry and Hybridization of Atomic Orbitals	Chemical Bonding **(BI 3)**
11. Intermolecular Forces and Liquids and Solids	Liquids & Solids **(BI 1 & BI 2)**
12. Physical Properties of Solutions	Solutions **(BI 2)**
13. Chemical Kinetics	Kinetics **(BI 4)**
14. Chemical Equilibrium	Equilibrium **(BI 6)**
15. Acids and Bases	Equilibrium **(BI 6)**
16. Acid-Base Equilibria and Solubility Equilibria	Equilibrium **(BI 6)**
17. Chemistry in the Atmosphere	Descriptive Chemistry **(BI 2)**
18. Entropy, Free Energy, and Equilibrium	Thermodynamics **(BI 5)**
19. Electrochemistry	Types of Reactions **(BI 3)**
20. Metallurgy and the Chemistry of Metals	Descriptive Chemistry **(BI 2)**
21. Nonmetallic Elements and their Compounds	Descriptive Chemistry **(BI 2)**
22. Transition Metal Chemistry and Coordination Cmpds	Descriptive Chemistry **(BI 2)**
23. Nuclear Chemistry	Nuclear Chemistry
24. Organic Chemistry	Descriptive Chemistry **(BI 2)**
25. Synthetic and Natural Organic Polymers	Descriptive Chemistry **(BI 2)**

BI 1 = Big Idea 1: Structure of Matter
BI 2 = Big Idea 2: Properties of Matter- characteristics, states, and forces of attraction
BI 3 = Big Idea 3: Chemical Reactions
BI 4 = Big Idea 4: Rates of Chemical Reactions
BI 5 = Big Idea 5: Thermodynamics
BI 6 = Big Idea 6: Equilibrium

Assignments:

[Note: SP= science practices LO= learning objectives]

Chapter 1: Chemistry: The Study of Change (6 classes)

Read: pages 3- 31

Problems: p. 31-33 # 3-36, 38-42 (and additional worksheets)

Labs: Laboratory Safety

General Lab Procedures and Using the Bunsen Burner

Density Lab – students practice measuring mass and volume of various solids and liquids to the precision of the instrument and then determine the identity of an unknown organic liquid based on their calculated density. (SP 1, 2, 3, 5)

Inquiry Lab: Determining the Density of a Candy Bar (without getting candy bar wet) (LO 1.4) **[CR3b]**

Activities: After observing various changes in matter, students have to classify each as physical or chemical and provide evidence for their decision. Students are then asked to find examples of physical and chemical changes at home and take pictures to share with class. (LO 3.10) **[CR3b]**

Determining the thickness of aluminum foil when given the density of aluminum foil (LO 1.4) **[CR3a]**

Chapter 2: Atoms, Molecules, and Ions (5 classes)

Read: pages 41-69

Problems: p. 70-73 # 13-60 (and additional worksheets)

Labs: Striking It Rich with Chemistry Lab (SP 1, 2, 5, 6, 7) (LO 1.2)

Atomic Mass Lab (SP 1, 2, 5, 6) (LO 1.18)

Activities: Thinking tube: using their observation skills and deductive reasoning, students will try to determine what is inside the tube. (SP1)

Chapter 3: Mass Relationships in Chemical Reactions (10 classes)

Read: pages 77-106

Problems: p. 107 -112 # 12-20, 24,26, 34, 40,42,60, 66, 76, 82, 84 90, 92 (and additional worksheets)

Labs: Mole-Mole Ratio Lab (SP 1, 2, 5, 6) (LO 1.4)

Empirical Formula of a Compound (SP 1, 2, 4, 5, 6) (LO 1.1)

Inquiry Lab: Determining the Percent Copper in Brass (students will design a procedure to analyze the amount of copper in brass using visible spectroscopy). (SP 4, 5, 6) (LO 1.16, 3.4) **[CR5b] & [CR 6]**

Activities: Percent Composition of Sugar in Gum: students are to determine the percent of sugar in a gumball through guided inquiry**.** (LO 1.2) **[CR3b]**

Making S'mores: students are supplied with a limited number of supplies for the recipe; they have to determine the limiting reactant and how much product can be made.

(LO 3.4) **[CR3c]**

Chapter 4: Reactions in Aqueous Solutions (12 classes)

Read: pages 119-156

Problems: p. 157-160 # 1-3, 7-10, 17-24, 26-30, 32-34, 35-38, 43-50, 60-64, 72-74 (and additional worksheets)

Labs: Acid-Base Titration Lab (SP 1, 2, 5, 6) (LO 1.20)

Inquiry Lab: Gravimetric Analysis of Calcium and Hard Water Lab – students will investigate the suitability of gravimetric analysis for determining the amount of water hardness in the form of calcium carbonate in various water samples which will be analyzed to determine the accuracy and sensitivity of gravimetric analysis for water hardness testing. **[CR5b] & [CR6]**

Inquiry Lab: Analysis of Food Dyes in Beverages Lab – students will use spectroscopy and graphical analysis to determine the concentration of dye in a sports drink. (SP 2, 4, 5, 6) (LO 1.1, 1.15) **[CR5b] & [CR 6]**

Activities: Qualitative analysis activity (identifying unknown white powders) – students are given 4 white powders along with water, an acid and a base and are asked to identify each of the 4 unknown white powders based on the observations made while performing microscale reactions. (LO 2.22) **[CR3c]**

Chapter 5: Gases (6 classes)

Read: pages 169-209

Problems: p. 210 -213 # 13-22, 32-38, 52-58, 64-66, 71 (and additional worksheets)

Labs: Micro Mole Rocket Lab (SP 1, 2, 5, 6, 7) (LO 2.5)

Molar Mass of a Volatile Liquid – students use the Dumas method for determination of the molar mass of an unknown volatile liquid. (SP 1, 2, 3, 4, 5, 6) (LO2.A.2)

Activities: Demonstrations of Boyle's and Charles' Law – students will sketch out on the molecular level what is happening to the gas in the container as pressure and temperature are changed.

Chapter 6: Thermochemistry (6 classes)

Read: pages 223-254

Problems: p. 255 # 16-20, 25-28, 34-38, 46-42 (and additional worksheets)

Labs: Specific Heat of a Metal – using a Styrofoam calorimeter, students determine the specific heat of two metals and check their results with the accepted values.(SP 1, 2, 3, 4, 5, 6) (LO 5.2, 5.3, 5.7)

Inquiry Lab: Designing a Hand Warmer Lab- students will design an effective hand warmer that is inexpensive, nontoxic, and safe for the environment. (SP 1, 2, 4, 5) (LO 2.8, 3.11, 5.6) **[CR5b] & [CR 6]**

Activities: Alternative Energy Source research project and presentation – students are assigned an alternative energy source (such as solar energy, wind energy, hydrogen fuel cell energy, geothermal energy, etc.) to research and present their findings to class. **[CR4]**

Heat of solution and heat of dilution – students will monitor the temperature of a solution as two substances (one endothermic, one exothermic) are dissolved in it. **[CR3e]**

Chapter 7: **Quantum Theory and the Electronic Structure of Atoms (3 classes)**

Read: pages 267 – 302

Problems: p. 303 #7-10, 16-20, 26-28, 30-34, 56-64, 76-78, 88-92 (and additional worksheets)

Labs: Flame Tests of Metallic Ions Lab (SP 1, 5, 6) (LO 1.14)

Activities: Spectrum and Spectroscope Lab – using hand-held spectroscopes to look at the emission spectra of different elements, students will determine what the element is by the spectral lines seen and comparing to a given set of spectral lines. (SP 1, 4, 5, 6, 7) (LO 1.15)

Chapter 8: **Periodic Relationships Among the Elements (2 classes)**

Read: pages 315-347

Problems: p. 348 # 3-16, 20-24, 27-30, 38-44, 52-56, 62-64, 68-72 (and additional worksheets)

Activities: Trends of the Periodic Table – students graph various trends (electronegativity, ionization energy, electron affinity, and atomic radius) for both groups and periods of elements and analyze the graphs to draw conclusions on the trends. (LO 1.9) **[CR3a]**

Chapter 9: **Chemical Bonding I: Basic Concepts (4 classes)**

Read: pages 357-390

Problems: p. 390 # 3-5, 16-18, 23-26, 30-32, 36-40, 43-46, 52-54, 62-64, 69-72 (and additional worksheets)

Labs: **Inquiry lab:** Qualitative Analysis and Chemical Bonding Lab – students will design a procedure to identify twelve unknown solids based on systematic testing of their physical and chemical properties. (SP 1, 4, 5, 6, 7) (LO 2.22, 2.24, 2.28, 2.32) **[CR5b] & [CR 6]**

Chapter 10: **Chemical Bonding II: Molecular Geometry & Hydridization of Atomic Orbitals (4 classes)**

Read: pages 399-442

Problems: p. 442 # 1-4, 7-14, 19-22, 28-30, 34-38 (and additional worksheets)

Labs: **Inquiry Lab:** Green Chemistry Analysis of a Mixture Lab – students will design and carry out a green chemistry experiment that can quantitatively measure the mass percent of one compound in in a mixture of two compounds. (SP 1, 2, 4, 5, 6) (LO 1.18, 3.3, 3.5) **[CR5b] & [CR 6]**

Activities: Molecular Models Activity – students are asked to predict the molecular geometry of various molecules and then use the molecular model kits to build the models to confirm their predictions. (LO 2.13) **[CR3b]**

Chapter 11: Intermolecular Forces and Liquids and Solids (4 classes)

Read: pages 451-493

Problems: p. 494 # 1, 3-6, 8-14, 16-18, 31-32, 52-56, 59-72, 78-86, 89-94 (and additional worksheets)

Labs: **Inquiry Lab:** Separation of a Dye Mixture Using Chromatography Lab – students will investigate the factors that influence the separation of food dyes using paper chromatography. (SP 1, 4, 5, 6) (LO 2.7, 2.10, 2.13) **[CR5b] & [CR6]**

Activities: Heating Curves online simulation and tutorial – students work through an online simulation and tutorial observing the changes that occur in a beaker of ice as the temperature is increased and how the changes correlate to heating curves and phase change diagrams. (LO 5.3) **[CR3e]**

Demonstration of evaporation of liquids – using the temperature probes, students will observe the temperature curves of various liquids and students must deduce the differences based on intermolecular forces. (SP 1,3,4,5,6,) (LO 2.11)

Chapter 12: Physical Properties of Solutions (6 classes)

Read: pages 503-534

Problems: p. 535 # 9-12, 13, 15-18, 27-29, 30-34, 36-38, 39-44, 69-72 (and additional worksheets)

Labs: **Inquiry Lab:** Separating a Synthetic Pain Relief Mixture Lab – students will separate a mixture that represents a pain reliever, containing binder, acetaminophen, and acetylsalicyclic acid in varying amounts. (SP 1, 4, 6) (LO 3.10) **[CR5b] & [CR6]**

Activities: Making Ice Cream activity (Freezing Point Depression) – students make ice cream in a plastic bag by using a solution of rock salt and water to demonstrate freezing point depression of the solution. (LO 2.8) **[CR3b]**

Chapter 13: Chemical Kinetics (5 classes)

Read: pages 545-588

Problems: p. 589 # 5-8, 11-14, 16-18, 20-22, 28-30, 35, 38-42, 45-47, 52-54, 61-62 (and additional worksheets)

Labs: **Inquiry Lab**: Rate of Decomposition of Calcium Carbonate Lab – students will learn how reaction rates are measured and design a kinetics experiment for the heterogeneous reaction of calcium carbonate with hydrochloric acid. (SP 4, 5, 6) (LO 4.1, 4.2) **[CR 5b] & [CR 6]**

Inquiry Lab: Kinetics of Crystal Violet Fading Lab – students will use spectroscopy and graphical analysis to determine the rate law for the color-fading reaction of crystal violet with sodium hydroxide. (SP 1, 2, 4, 5, 6) (LO 4.1, 4.2) **[CR5b] & [CR6]**

Activities: The Effect of Temperature on the Reaction Rate of Glow Sticks – students are provided with several glow sticks and asked to design an activity that shows how temperature affects reaction rate. (LO 4.1) **[CR 3d]**

Demonstration of the effect of concentration on reaction rate – students will observe the decomposition of 3% and 30% hydrogen peroxide and be able to explain the difference in reaction rate. (LO 4.1) **[CR3d]**

Chapter 14: **Chemical Equilibrium (8 classes)**

Read: pages 601-632

Problems: p. 633 # 6-9, 13-16, 18-22, 28-32, 35-36, 40-44, 54-58 (and additional worksheets)

Labs: Cobalt Complex Equilibrium Lab (SP1, 4, 5, 6) (LO 5.16)

Inquiry Lab: Applications of LeChatelier's Principle Lab – students will investigate six equilibrium systems to gain a deeper understanding of equilibrium and LeChatelier's Principle. (SP 1, 4, 5, 6, 7) (LO 3.11, 6.3, 6.8, 6.9) **[CR5b] & [CR6]**

Activities: LeChatelier's Principle Virtual Lab Activity –students predict the color changes that will occur on various equilibrium systems based on stresses placed on those systems (changes in concentration, temperature, pressure**).** (LO 5.16) **[CR 3f]**

Chapter 15: **Acids and Bases (5 classes)**

Read: pages 645-686

Problems: p. 686 #3-6, 12, 14, 16-20, 33-36, 44-48, 54-56, 62-64, 78-82, 86-88 (and additional worksheets)

Labs: **Inquiry Lab:** Acid-Base Titrations Lab – students will conduct a series of acid-base titrations to determine the concentration of two unknowns. (SP 1, 2, 4, 5, 6) (LO 1.18, 1.20, 3.3, 3.4, 6.12, 6.13, 6.14, 6.15, 6.16, 6.17) **[CR5b] & [CR6]**

Chapter 16: **Acid-Base Equilibria and Solubility Equilibria (7 classes)**

Read: pages 697- 739

Problems: p. 740 # 5-8, 10-16, 24-30, 36-38, 46-54, 60-62, 64-68 (and additional worksheets)

Labs: **Inquiry lab:** Acidity of Beverages Lab – students will conduct acid-base titrations and determine the concentration of acid in common beverages such as orange juice or pineapple juice. (SP 2, 3, 4, 5, 6, 7) (LO 1.20, 3.3) **[CR5b] & [CR6]**

Inquiry lab: Buffers in Household Products Lab – students will investigate the buffering capacity and buffer components of various consumer products containing buffering chemicals such as citric acid, sodium carbonate, sodium benzoate and phosphates or phosphoric acid. (SP 2, 4, 5, 6, 7) (LO 3.4, 3.7, 6.12, 6.16, 6.19, 6.20) **[CR5b] & [CR6]**

Activities: Analyzing titration data activity – students are provided with several graphs of titration data and are asked to analyze and identify monoprotic acids and polyprotic acids as well as strong acid/strong base, strong acid/weak base, weak acid/strong base and weak acid/weak base situations and explain why they think the data represents that combination. (LO 6.13) **[CR3f]**

Chapter 17: **Chemistry in the Atmosphere (2 classes)**

Read: pages 751-776

Activities: In groups, students will research then present reports on the nitrogen cycle, oxygen/carbon dioxide cycle, depletion of ozone, greenhouse effect, smog and indoor pollution (ex. Radon). (SP 1, 6, 7) **[CR4]**

Chapter 18: **Entropy, Free Energy and Equilibrium (2 classes)**

Read: pages 783-809

Problems: p. 810 # 2-5, 10-14, 18-20, 24-30 (and additional worksheets)

Activities: Entropy activity – students create their own model of an entropy situation from every day experiences to show understanding of sign and magnitude of entropy. (LO 5.12) **[CR3e]**

Chapter 19: **Electrochemistry (3 classes)**

Read: pages 819-854

Problems: p. 855 # 2, 12-16, 22-26, 30-34, 38, 26-50 (and additional worksheets)

Labs: **Inquiry lab:** Analysis of Hydrogen Peroxide Lab – students will determine the percent composition of a common drug store bottle of hydrogen peroxide through an oxidation-reduction titration with potassium permanganate. (SP 2, 4, 5) (LO 1.20, 3.3, 3.9) **[CR5b] & [CR6]**

Activities: Electrochemical cell data analysis – students are given various electrochemical cell data (galvanic and electrolytic) and are asked to predict potentials based on half-cell reactions. (LO 3.12) **[CR3c]**

Chapter 20: **Metallurgy and the Chemistry of Metals**

Read: pages 867-888

Chapter 21: **Nonmetallic Elements and Their Compounds**

Read: pages 895-928

Chapter 22: **Transition Metal Chemistry and Coordination Compounds**

Read: pages 935-960

Activities: For the information in the above three chapters (20, 21, and 22) the students, working in small groups, will each investigate a topic (alloys, ferromagnetic metals, amalgams, making steel, making iron, purification of metals, conductivity of metals, hydrogen, carbon, nitrogen, phosphorus, oxygen, sulfur, halogens, iron, copper, and coordination compounds) and report their information by a power point presentation to the class. **[CR4]**

Chapter 23: **Nuclear Chemistry (2 classes)**

Read: pages 9667-994

Problems: p. 995 # 1-6, 14-16, 23-28, 33-36, 37, 42, 43, 46, 48-50 (and additional worksheets)

Chapter 24: **Organic Chemistry (2 classes)**

Read: pages 1003-1029

Problems: p. 1029 # 2, 3, 13-18, 31-32, 34-38 (and additional worksheets)

Labs: Esterification Lab (SP 1, 5, 6)

Chapter 25: **Synthetic and Natural Organic Polymers**

Read: pages 1039 -1058

Activities: Making a polymer with glue and borax (SP 1, 3, 7)