## AP Chemistry Syllabus
### 2017-18

<table>
<thead>
<tr>
<th>Curricular Requirements</th>
<th>Pages</th>
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<tr>
<td>CR1 Students and teachers use a recently published (within the last 10 years) college-level chemistry textbook.</td>
<td>2</td>
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<tr>
<td>CR2 The course is structured around the enduring understandings within the big ideas as described in the AP Chemistry Curriculum Framework.</td>
<td>1, 3, 4</td>
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<tr>
<td>CR3a The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 1: Structure of matter.</td>
<td>6</td>
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<td>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.</td>
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<td>CR3c The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 3: Chemical reactions.</td>
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<td>CR3d The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 4: Rates of chemical reactions.</td>
<td>7</td>
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<td>CR3e The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 5: Thermodynamics.</td>
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<tr>
<td>CR3f The course provides students with opportunities outside the laboratory environment to meet the learning objectives within Big Idea 6: Equilibrium.</td>
<td>7</td>
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<tr>
<td>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.</td>
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<td>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.</td>
<td>1, 3</td>
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<tr>
<td>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.</td>
<td>5, 6, 7, 8</td>
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<tr>
<td>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.</td>
<td>1, 5, 6, 7, 8</td>
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<tr>
<td>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.</td>
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Course Description:
AP Chemistry is open to all highly motivated students who have completed a year of chemistry and algebra who wish to engage in a rigorous academic challenge. This course is highly recommended for students interested in pursuing science, medical or engineering careers including, but not limited to pre-medical, pre-dental, pre-pharmacy and pre-veterinary majors in college.

The course meets 55 minutes each day or 90 minutes every other day. Students engage in hands-on lab work for more than 25% of class time, and additional laboratory time is offered an average of 2 -3 hours per week to complete labs as needed. [CR5a]

This AP Chemistry course is designed to be the equivalent of the general chemistry course usually taken during the first year of college. Students will gain an understanding of the six big ideas articulated in the AP Chemistry Curriculum Framework provided by the College Board. [CR5] A special emphasis will be placed on the seven science practices [CR6], which capture important aspects of the work in which scientists often engage, with learning objectives that combine content with inquiry and reasoning skills. AP Chemistry contributes to the development of the student’s abilities to solve chemical problems as well as clearly and logically express ideas.

Course Structure:
AP Chemistry is built on six big ideas and seven science practices.

The six big ideas (BI) are:
- **Big Idea 1:** Structure and 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

The seven science practices (SP) are:
- **Science Practice 1:** The student can use representations and models to communicate scientific phenomena and solve scientific problems.
- **Science Practice 2:** The student can use mathematics appropriately.
- **Science Practice 3:** The student can engage in scientific questioning to extend thinking or to guide investigations within the context of AP Chemistry.
- **Science Practice 4:** The student can plan and implement data collection strategies in relation to a particular scientific question.
- **Science Practice 5:** The student can perform data analysis and evaluation of evidence.
- **Science Practice 6:** The student can work with scientific explanations and theories.
- **Science Practice 7:** The student is able to connect and relate knowledge across various
Textbook:

Additional books used in addition to the textbook include the following:
Brown, Carol. Saint Mary’s Hall Chemistry I Honors Workbook and Laboratory Manual. San Antonio, TX.
**Laboratory Procedures:**
Labs require students to follow or develop processes and procedures, record observations, interpret data and draw conclusions. [CR7] Students communicate and collaborate in lab groups, but each student writes his/her own lab reports in a lab notebook. A minimum of 25% of student classroom time will be spent in the laboratory experiencing hands-on lab activities. [CR5a]

A laboratory notebook is required for the course. The lab notebook will have all the pages numbered with a table of contents containing the following information in the front pages of the notebook:
- Title of the Experiment
- Date of the Experiment
- Page Number of the Experiment

All data is recorded directly in the bound lab notebook during the experiment. [CR7] Only the front sides of the pages in the notebook are used. The following components are in the lab notebook for each experiment:
- Descriptive Title
- Date
- Purpose
- Background
- Procedure Outline
- Pre-Lab Questions
- Data and Observations
- Calculations and Graphs
- Error Analysis
- Conclusion: Discussion or explanation of experimental results

**Course Outline:**

<table>
<thead>
<tr>
<th>Unit of Study</th>
<th>Chapters in Tro Chemistry: A Molecular Approach</th>
<th>AP Chemistry Big Ideas (BI) Covered</th>
<th>AP Chemistry Learning Objectives (LO) Covered</th>
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<tbody>
<tr>
<td><strong>Unit 1:</strong> Chemical Foundations</td>
<td>1. Matter, Measurement, and Problem Solving</td>
<td>BI 2 &amp; 3</td>
<td>LO 2.7, LO 2.10, LO 3.10</td>
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<td></td>
<td>2. Atoms and Elements</td>
<td>BI 1, 2, &amp; 4</td>
<td>LO 1.1, LO 1.17, LO 2.17, LO 3.5, LO 3.6</td>
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<td>3. Molecules, Compounds, and Chemical Equations</td>
<td>BI 1 &amp; 3</td>
<td>LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO 1.14, LO 1.17, LO 1.18, LO 1.19, LO 3.1, LO 3.3, LO 3.4, LO 3.6</td>
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<td><strong>Unit 2:</strong> Chemical Quantities &amp; Reactions in Solution</td>
<td>4. Chemical Quantities and Aqueous Reactions</td>
<td>BI 1, 2, &amp; 3</td>
<td>LO 1.4, LO 1.18, LO 2.8, LO 2.9, LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 3.8, LO 3.9, LO 3.10</td>
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<tr>
<td><strong>Unit 3:</strong> Chemical Energy &amp; Thermochemistry</td>
<td>6. Thermochemistry</td>
<td>BI 3 &amp; 5</td>
<td>LO 3.11, LO 5.3, LO 5.4, LO 5.5, LO 5.7, LO 5.8</td>
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<tr>
<td>Unit 4: Atomic Structure &amp; Periodicity</td>
<td>7. The Quantum-Mechanical Model of the Atom</td>
<td>BI 1</td>
<td>LO 1.5, LO 1.6, LO 1.9, LO 1.10, LO 1.12, LO 1.13, LO 1.16, LO 1.15, LO 1.16</td>
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<td>8. Periodic Properties of the Elements</td>
<td>BI 1</td>
<td>LO 1.6, LO 1.7, LO 1.8, LO 1.9, LO 1.10, LO 1.12, LO 1.13</td>
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<tr>
<td>Unit 5: Bonding &amp; Molecular Structure</td>
<td>9. Chemical Bonding I: The Lewis Model</td>
<td>BI 1, 2, &amp; 5</td>
<td>LO 1.7, LO 1.8, LO 1.15, LO 2.1, LO 2.17, LO 2.18, LO 2.21, LO 2.23, LO 2.24, LO 5.8</td>
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<td>10. Chemical Bonding II: Molecular Shapes, Valence Bond Theory, and Molecular Orbital Theory</td>
<td>BI 1 &amp; 2</td>
<td>LO 1.7, LO 1.15, LO 2.21</td>
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<tr>
<td>Unit 6: States of Matter &amp; Interparticle Forces</td>
<td>5. Gases</td>
<td>BI 1, 2, 3, &amp; 5</td>
<td>LO 1.3, LO 1.4, LO 2.4, LO 2.5, LO 2.6, LO 2.12, LO 2.15, LO 3.4, LO 5.2</td>
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<td>11. Liquids, Solids, and Intermolecular Forces</td>
<td>BI 1, 2, &amp; 5</td>
<td>LO 1.11, LO 2.1, LO 2.3, LO 2.11, LO 2.13, LO 2.16, LO 2.19, LO 2.20, LO 2.22, LO 2.23, LO 2.24, LO 2.25, LO 2.26, LO 2.27, LO 2.28, LO 2.29, LO 2.30, LO 2.31, LO 2.32, LO 5.6, LO 5.9, LO 5.10, LO 5.11</td>
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<td></td>
<td>12. Solutions</td>
<td>BI 2 &amp; 5</td>
<td>LO 2.8, LO 2.9, LO 2.14, LO 2.15, LO 5.10</td>
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Course Work:

Chapter 1: Matter, Measurement, and Problem Solving

Labs: Safety/Lab Skills/Lab Preparation/Lab Write-ups
Kool Aid Chromatography (SP 1.4, 6.4; LO 2.13) [CR5b] & [CR6]
Ion Chromatography (SP 6.1; LO 2.18) [CR5b] & [CR6]

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

Chapter 2: Atoms and Elements

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

Chapter 3: Molecules, Compounds, and Chemical Equations

Labs: Guided Inquiry: Determination of the Formula of a Compound (SP 4.2, 5.1, 6.4; LO 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 of mass. [CR3c]

Chapter 4: Chemical Quantities and Aqueous Reactions

Labs: 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]
Reduction of Permanganate (SP 4.2, 5.1, 6.4; LO 1.20, 3.3) [CR5b] & [CR6]
Guided Inquiry: Progressive Precipitation (SP 1.5, 5.1, 6.4; LO 1.20, 3.3) [CR5b] & [CR6]

Chapter 6: Thermochemistry

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 motion 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.

Chapter 7: The Quantum-Mechanical Model of the Atom

Labs:  
Guided Inquiry: Relationship Between the Spectrum and Absorbance of Light (SP 4.1; LO 1.15) [CR5b] & [CR6]  
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]  
Beer’s Law (SP 4.2, 5.1; LO 3.4) [CR5b] & [CR6]

Chapter 8: Periodic Properties of the Elements

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]

Chapter 9: Chemical Bonding I: The Lewis Model

Labs:  
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]

Chapter 10: Chemical Bonding II: Molecular Shapes, Valence Bond Theory, and Molecular Orbital Theory

Lab:  
Determination of the Formula of a Hydrate (SP 2.1, 4.2, 6.4; LO 3.5) [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]
Chapter 5:  Gases

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]

Chapter 11:  Liquids, Solids and Intermolecular Forces

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

Chapter 12:  Solutions

Labs: 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/FPofWine.html

Chapter 13:  Chemical Kinetics

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

Chapter 14:  Chemical Equilibrium

Lab: Guided Inquiry: Equilibrium Position (SP 4.2; LO 6.9) [CR5b] & [CR6]
Equilibrium Constant Position (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, student is able to construct an explanation that connects the observations to the reversibility of the underlying chemical reactions or processes.

Students view the NO₂/N₂O₄ 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]

Chapter 15: Acids and Bases

Labs:
- \( K_a \) Pre-lab
  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]
  Acid-Base Titration (SP 4.2, 5.1, 6.4; LO 1.20) [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]

Chapter 16: Aqueous Ionic Equilibrium

Labs:
- Buffered Solutions (SP 2.3, 4.2, 6.4; LO 1.4, 6.18, 6.20) [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]

Chapter 17: Free Energy and Thermodynamics

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]

Chapter 18: Electrochemistry

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]