AP Chemistry Syllabus

Text:

Brady, J., and Senese, F. 2004. *Chemistry: Matter and Its Changes*. John Wiley and Sons, Inc. ISBN # 0-472-44892-5

Course Design

This course is designed to provide a solid, first-year college chemistry experience, both conceptually and in the laboratory. The labs serve to supplement the learning in the lecture section of the course. Problem-solving skills, both on paper and in the lab, are emphasized. As this is intended to be a second-year course, students should have a sound previous knowledge of:

- molar relationships
- atomic structure
- periodicity
- history of atomic theory
- intramolecular and intermolecular bonding
- molecular geometry
- gas laws
- solutions and colligative properties
- reaction Rate
- chemical Equilibrium
- acids and Bases
- nuclear chemistry

The course takes full advantage of students' Chemistry 1 course because although these topics are covered in detail in this course, we go over them quickly. Therefore, it is strongly recommended students take Chemistry 1 prior to AP Chemistry.

Learning Objectives:

By the completion of this course, the successful student will have:

- Thoroughly learned the topics and skills described in "Advanced Placement Course Description" written by the College Board.
- Mastered important laboratory skills including experimental design, detailed observation, accurate reading, data interpretation, statistical analysis, and operation of technical equipment.
- Learned how to read and outline a college-level textbook
- Systematically solve complex chemistry problems
- Gained an appreciation of the scientific process and how chemistry applies to everyday life.
- Worked effectively with their peers towards a common goal.

Teaching Strategies

I use the following strategies when teaching my AP Chemistry course. I believe they are the most important factors to having a successful course.

1. Create a group spirit and high *esprit de corps*, similar to that which develops among members of a sports team.

2. Encourage students to work together in order to learn.
Students think better in a group. Teaching another student is the best way to remember a concept. By learning together, students learn faster and easier.

3. Limit lectures to allow plenty of time for other learning activities.
I try not to lecture a great deal. After students have read and outlined a few sections of a chapter, I will spend 10-20 minutes lecturing on it, covering the high points of the theory, deriving any important equations, and presenting demonstrations that are relevant to the topic. After going over example problems, I assign a few questions from the back of each chapter. We go over these questions, and shortly thereafter I hand out a set of questions taken from AP Released Exams. These are the essay and problem type questions that students can expect to see on the exam in May.

4. Keep quizzes and tests short, sometimes even to just one or two questions, so that testing does not take up too much time during the class period.

5. Require each student to present the solution to a problem.
Each student receives AP Review Book questions/problems on the current chapter and is expected to complete them by the day of the quiz. Each student is responsible for presenting questions/problems for the entire class. Detailed solutions are given in the book, and students are encouraged to ask questions if these solutions don't make sense. Students often have stage fright when they are first asked to present the solution. They soon find, however, that the rest of the class wants them to succeed. The class is attentive during the explanation and even tries to help the presenter over the rough spots. My role as the teacher is to stand near the back of the room and oversee the process. The seminar-like atmosphere these problem-presentation sessions creates is not threatening and makes it easy for students to ask questions. Soon there is a lively give-and-take between the presenter and the class. Lights seem to go on and learning takes place.

Remember,
"The person in the class doing the most talking
is the one doing the most learning"

Learning Experiences:

In this course students will:

- Actively participate in class discussions, demonstrations, study-group sessions, and laboratories.
- Conduct independent and group laboratory investigations and keep records in a bound notebook.
- Study course topics in the text and other resources.
- Lead selected lessons and solve problems for their classmates.

Laboratory:

This course, when combined with Chemistry 1, completes all 22 recommended labs for the AP Chemistry Course. Labs take place 2-3 times per month over 2-5 class periods each. In addition, there are 4 'Saturday Labs' conducted at UMASS Boston. Lab handouts will be made available in advance, usually with an assigned set of Pre-Lab questions due the day of the lab. Students will not be allowed to begin the lab until all Pre-Lab questions are completed.

Students are required to submit a complete report for each lab experiment, including pre-lab questions, materials & methods, results, discussion and post-lab questions. All reports are kept in a lab notebook. After labs reports are collected, corrected and returned, students are called upon to make a presentation to the class about their calculations and conclusions in a similar manner to the questions/problems-solving method described above. In this way, students are able to collaborate on the objectives and design of an experiment, to assist each other in reaching conclusions, and to gain insights into variance and sources of error.

The Table below correlates lab experiments to the relevant unit and chapter of the text (see below for Course Outline details). Where possible, experiments will precede lectures in order to follow the inquiry method of learning. Students will thus be motivated to read and complete problem sets in order to complete calculations and connect to conclusions.

Unit	***CMAIC*** **Chapter Reference**	**AP Chemistry Lab (#, Name)**
1	1	1. Determination of the formula of a compound (done at UMB Bridge in June)
1	4	2. Determination of the percentage of water in a hydrate
1	4	9 Determination of mass and mole relationship in a chemical reaction.
2	5	6. Standardization of a solution using a primary standard
2	5	14. Separation and qualitative analysis of cations and anions (done at UMB Bridge in August)
2	5	16. Analytical gravimetric determination
2	6	8. Determination of concentration by oxidation-reduction titration

3	7	13. Determination of enthalpy change associated with a reaction (Hess' Law)
3	8	17. Colorimetric or spectrophotometric analysis
4	21	20. Determination of electrochemical series
4	21	21. Measurements using electrochemical cells and electroplating
5	9	15. Synthesis of a coordination compound and its chemical analysis
6	11	5. Determination of the molar volume of a gas (done at UMB in August)
6	11	3. Determination of molar mass by vapor density
7	12	4. Determination of molar mass by freezing-point depression
7	13	18. Separation by chromatography
8	15	12. Determination of the rate of a reaction and its order
8	16	10. Determination of the equilibrium constant for a chemical reaction
9	18	7. Determination of concentration by acid-base titration, including a weak acid or a weak base
9	18	11. Determination of appropriate indicators for various acid-base titrations; pH determination
9	18	19. Preparation and properties of buffer solutions
10	25	22. Synthesis, purification, and analysis of an organic compound

Preparing for the AP Chemistry Exam

In April we will begin in-class review and practice of key topics on the AP Exam. The major review activity is the UMass Boston Practice Test. Because all review stems from the results of this test, taking the test counts for a Test grade and the score itself counts as part of your final exam. Once the practice test results are returned to USA, students will practice answering key multiple-choice and open response questions, and present solutions to the class. Additional review material will be taken from released AP exams and supplemental texts (Barron's, Princeton Review). **The AP Exam is scheduled for May and is a required aspect of the class**.

Grading:

60% Quizzes and Tests
Reading & Chapter Quizzes, Unit Tests, Chapter Outlines

20% Labs
Lab Reports, Participation in UMB Saturday Labs

20% Binder, Homework & Participation
Binder, Problem Sets, Presentation of Problems

Course Outline:

All reading selections from, Brady, J., and Senese, F. 2004. *Chemistry: Matter and Its Changes*. (*CMAIC*)

Unit 1 **Atoms, Compounds, measurement and moles (Approx 2 wks)**
Chaps 1-4 in *CMAIC, (Primarily done over summer)*

Atoms and elements
Scientific Method
History of the atomic model
Elements and atomic structure
The periodic table
Metals, nonmetals and metalloids

Compounds and chemical reactions
Chemical equations
Energy and chemical change
Molecules and molecular compounds
Naming molecular and ionic compounds
Properties of molecular and ionic compounds

Measurement
Units of measurement
Significant figures
Unit conversions
Density and specific gravity

The mole
Molar mass and Avogadro's number
Percent composition
Balanced equations
Ideal and limiting reactant stoichiometry
Percentage yields

Unit 2 **Solutions** **(Approx 3 weeks)**
Chaps 5 & 6 in *CMAIC*

Ionic reactions in aqueous solutions
Qualities of solutions
Molar concentration and dilution
Metathesis reactions
Strong acid and base neutralization
Activity series and solubility rules
Solution Stoichiometry

Oxidation-reduction reactions

Half reactions
Metal-acid reactions
Metal displacement reactions
Oxidation by molecular oxygen
Redox titrations

Unit 3 **Bond Energy and Thermodynamics** **(Approx 3 weeks)**
Chaps 7 and 20 in *CMAIC*

Energy and chemical change
Potential, kinetic, and internal energies
Heat vs. temperature
Endothermic and exothermic reactions
Enthalpy and the first law of thermodynamics
Hess's law and thermochemical equations

Thermodynamics
First and second laws of thermodynamics
Spontaneity and Gibbs free energy
Standard free energy changes

Unit 4 **Electrochemistry** **(Approx 2 weeks)**
Chapter 21 in *CMAIC*

Electrochemistry
Galvanic cells
Electrolysis and electroplating
Quantitative aspects of electrochemical reactions

Unit 5 **Quantum mechanics, bonding, and structure** **(Approx 3 weeks)**
Chaps 8-10 in *CMAIC*

The quantum mechanical atom
Electromagnetic radiation
Atomic spectra
Particles of light and matter waves
Electron configurations
Orbital theory
Atomic properties

General concepts of chemical bonding
Ionic bonding
Covalent bonding and organic compounds
Electronegativity: reactivity and polarity
Lewis symbols
Formal charges

Resonance

Chemical bonding and molecular structure
VSEPR theory
Polarity
Brief hybrid orbitals and MO theory

Unit 6 Gases (Approx 2 weeks)
Chapter 11 in *CMAIC*

Gases
Pressure
Gas laws
Kinetic molecular theory of gases
Real gases
Gas stoichiometry

Unit 7 Liquids, Solids, and more Solutions (Approx 2 weeks)
Chaps 12 & 14 in *CMAIC*

Intermolecular attractions and properties of liquids and solids
Intermolecular attractions
Changes of state
Vapor pressure
Changes of state and phase diagrams
Crystalline solids: structures of carbon

Solutions
Heats of solution
Osmotic pressure and gas solubility
Concentration expressions
Colligative properties

Unit 8 Kinetics and Equilibrium (Approx 4 weeks)
Chaps 15 & 16 in *CMAIC*

Chemical kinetics
Reaction rates
Rate laws and their determination
Integrated rate laws
Reaction mechanisms
Catalysts

Equilibrium
Equilibrium conditions
Equilibrium constant
K_{eq}, K_c, K_p

Heterogeneous equilibria
Le Chatelier's Principle
Solving equilibrium problems
Free energy and thermodynamic equilibrium constants
Thermodynamic and cell potentials
The Nernst equation

Unit 9 **Acids, Bases and Solubility** **(Approx 4 weeks)**
Chaps 17, 18 and 19 in *CMAIC*

Strong acids and bases
Bronsted-Lowry
Lewis
Periodic trends
pH, pOH, and K_w

Weak acids and bases
K_a and K_b
Equilibrium calculations
Polyprotic acids
Buffers
Titrations and indicators

Solubility and simultaneous equilibria
Molar solubility and K_{sp}
Selective precipitation
Complex ions of metals and stability

Unit 10 **Nuclear and Organic Chemistry** **(Approx 2 weeks)**
Chapters 22 and 25 in *CMAIC*

Nuclear reactions
$E = mc^2$
Nuclear binding energy and stability
Radioactivity
Radiological dating
Fusion and fission, reactions and products

Organic compounds and biochemistry
Organic compound nomenclature
Common organic functional groups
Macromolecules

Unit 11 **Review** **(Approx 4 weeks)**
***Chapters 1-25 in CMAIC*, Review Guides & Released AP test material**