AP® Chemistry
Syllabus 4

Overview of AP® Chemistry

AP Program

Our school offers two sections of AP Chemistry, which meet five days a week for 55 minutes; two periods per week for laboratories. **[C7]**

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.** The class is not split into "those who are" and "those who are not" going to take the AP Exam; everyone is in the same boat. Since every student realizes that he or she is going to take the exam, each works hard to understand the material.
3. **Limit lectures to allow plenty of time for other learning activities.** I do not lecture a great deal. After students have read and outlined a chapter, I will spend a day or two lecturing on it, covering the high points of the theory, deriving any important equations, and presenting demonstrations that are relevant to the topic. I assign a few questions from the back of each chapter but use them only as an introduction to the material. 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.

C7—The course includes a laboratory component comparable to college-level chemistry laboratories. A minimum of one double-period per week or its equivalent is spent engaged in laboratory work. A hands-on laboratory component is required. Each student should complete a lab notebook or portfolio of lab reports. Note: Online course providers utilizing virtual labs (simulations rather than hands-on) should submit their laboratory materials for the audit. If these lab materials are determined to develop the skills and learning objectives of hands-on labs, then courses which use these labs may receive authorization to use the "AP" designation. Online science courses authorized to use the "AP" designation will be posted on the AP Central Web® site. (For information on the requirements for an AP Chemistry laboratory program, the Guide for the Recommended Laboratory Program is included in the *AP Chemistry Course Description*).

5. **Require each student to present the solution to a problem.** This technique is probably my trademark as a teacher. Each student receives 6 to 10 AP Released Exam questions/problems on the current chapter and is expected to complete them in two or three days. (The problems often do not contain all the parts of the original exam question; for example, I only assign those parts that pertain to the chapter we are covering.) In addition, each student is responsible for presenting two of the questions/problems on the overhead projector for the entire class. Many students receive the same question, but they do not know who will be asked to do the presentation. Students receive points based on the quality of their presentation. I post the detailed solution to each problem in the classroom so they can examine beforehand the problems they do not understand.

   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. This involves knowing when to step in and ask pertinent and probing questions such as, "Could you go over step three again? I don't understand how you got your answer." I will ask the presenter questions if I feel the class is getting lost. I can tell when this happens because the class usually grows very quiet, as if projecting the plea, "Don't call on me because I don't understand." There are also times when I ask questions because I honestly cannot follow what the presenter is doing.

   The seminar-like atmosphere these problem-presentation sessions create 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. These sessions are the very heart of how I teach AP Chemistry. **[C6]**

C6—The course emphasizes chemical calculations and the mathematical formulation of principles.

Preparing for the AP Chemistry Exam

Three weeks before the AP Exam I schedule six review sessions from 7:30 to 9:00 p.m. in my classroom to go over multiple-choice questions from the 1994 AP Exam. Two Saturdays before the exam we all meet in the school cafeteria in the morning to take the 1989 AP Exam for practice. The following Saturday the same procedure is followed with the 1994 AP Exam. The exams are identical in administration to the actual AP Exam. At the end of both exams I give the answers and a scoring sheet to the students, which they use to grade their own exams and figure their scores. They are shocked by their results on the first exam but are better able to see the areas in which they are weak. The second exam usually shows an improvement in scores since students know where to focus their preparation.

Laboratory

Students are required to submit a complete report for each lab experiment, including a hypothesis, procedure, observations/data, calculations, and a conclusion. All reports are kept in a lab notebook. Very often students are called upon to make a presentation to the class about their hypotheses, 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. **[C5, C7]**

C5—Laboratory (Physical manipulations; processes and procedures; observations and data manipulation; communication, group collaboration, and the laboratory report).

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Texts

McQuarrie, Donald A., and Peter A. Rock. *General Chemistry.* 3rd ed.

Zumdahl, Steven. *Chemistry*. 3rd ed.

Laboratory Manuals

We do not use a lab manual but rather a collection of labs from various sources. These include:

Hope College Lab Program. Hope College, Holland, Mich.

Masterson, William L., and Emil J. Slowinski. *Chemical Principles in the Laboratory.* 5th ed.

Ehrenkranz, David and John J. Mauch. *Chemistry in Microscale.*

Demonstration Resources

Shakhashiri, Bassam. *Chemical Demonstrations: A Handbook for Teachers of Chemistry.*

Summerlin, Lee R., and James L. Ealy, Jr. *Chemical Demonstrations: A Sourcebook for Teachers*

Course Outline

Note: An asterisk (*) indicates the most important labs.

Unit I: Calculations and Uncertainty ..... 1.0 weeks

Dimensional analysis, uncertainty, significant figures **[C6]**

C6—The course emphasizes chemical calculations and the mathematical formulation of principles.

Suggested Experiments

None

Unit 2: Atoms, Molecules, and Ions ..... 1.5 weeks

Review of formula writing, oxidation states, nomenclature, etc.

Suggested Experiments

- Safety in the lab
- How to use a balance
- How to use equipment **[C5]**

C5—Laboratory (Physical manipulations; processes and procedures; observations and data manipulation; communication, group collaboration, and the laboratory report).

Unit 3: Stoichiometry ..... 2.5 weeks

Mole, atomic weight, molecular formula, balancing equations, limiters, empirical formulas, percent composition, percent yield, and solution stoichiometry **[C3]**

C3—Reactions (Reaction types, Stoichiometry, Equilibrium, Kinetics, Thermodynamics).

Suggested Experiments

- Empirical formula of copper iodide (Hope College)*
- Synthesis of aspirin (Masterton)
- Net ionic reactions using microscale (Mauch)*

Unit 4: Gases ..... 2.0 weeks

Ideal gas law, van der Waal's equation, Avogadro's Law, STP, Dalton's Law, Graham's Law, kinetic theory of gases, etc. **[C2]**

C2—States of Matter (Gases, Liquids and Solids, Solutions).

Suggested Experiments

- Molecular mass of a volatile liquid (Masterton)*
  Isopropanol works best.

Unit 5: Thermochemistry ..... 2.0 weeks

Enthalpy, thermochemical equations, heats of formation, bond energies, heats of reactions, etc. **[C3]**

Suggested Experiment

- Calorimetry (Hope College)*
  This covers thermochemistry and solution stoichiometry.

Unit 6: Atomic Structure and Periodicity ..... 2.0 weeks

Atomic spectra, Bohr atom, quantum numbers, atomic orbitals, electronconfigurations, periodic table, trends in the periodic table in terms of physical and chemical properties **[C1, C4]**

C1—Structure of Matter (Atomic theory and atomic structure, Chemical bonding).

C4—Descriptive Chemistry (Relationships in the periodic table).

Suggested Experiments

- Flame test for metals using spectroscopes
  [Also, show discharge tubes and how they relate to wavelength. Mention bright line spectra and have students use diffraction gratings to view spectra.]

C1—Structure of Matter (Atomic theory and atomic structure, Chemical bonding).

Unit 7: Chemical Bonding ..... 3.0 weeks

Lewis structures, ionic bonding, character of bonds, covalent model, octet rule and exceptions, resonance, VSEPR model, and hybridization **[C1]**

Suggested Experiment

- VSEPR model building using styrofoam balls and pipe cleaners.*
  Students must first make five geometries and be able to distinguish between electron and molecular geometry. It is important that students know this material well for the AP Exam.

Unit 8: Liquids and Solids ..... 1.5 weeks

Dipole–dipole interactions, hydrogen bonding, London forces, liquid state, types of solids, metallic bonding, network solids, vapor pressure, change of state, phase diagrams, and specific heat **[C2]**

C2—States of Matter (Gases, Liquids and Solids, Solutions).

Suggested Experiment

- None
  There are many good demonstrations for this unit's material.

Unit 9: Properties of Solutions ..... 2.0 weeks

Electrolytes and nonelectrolytes, molarity, molality, mole fraction, colligative properties, Raoult's Law, Henry's law, freezing point depression, boiling point elevation, and osmotic pressure **[C2]**

Suggested Experiment

- Molecular mass determination by freezing point depression (Masterton)
  [There are also many good demonstrations for this unit.]

C3—Reactions (Reaction types, Stoichiometry, Equilibrium, Kinetics, Thermodynamics).

Unit 10: Chemical Thermodynamics ..... 2.5 weeks

Gibbs free energy equation, laws of thermodynamics, enthalpy, entropy, free energy, energy and work, exothermic and endothermic reactions, and state functions **[C3]**

Suggested Experiments

- None
  There are many good demonstrations from a variety of sources for this unit.

Unit 11: Chemical Kinetics..... 2.5 weeks

Reaction kinetics, rate law expressions, order of reactions, rate constant, half-life, activation energy, catalysts, and reaction mechanism **[C3]**

Suggested Experiment

- Kinetics of thiosulfate decomposition (Ehrenkranz)

C3—Reactions (Reaction types, Stoichiometry, Equilibrium, Kinetics, Thermodynamics).

Unit 12: Chemical Equilibria ..... 2.0 weeks

Laws of mass action, equilibrium expressions, calculations of K and equilibrium concentrations, Le Chatelier's principle, and how equilibrium is shifted by temperature, concentration, etc. **[C3]**

Suggested Experiment

- Determination of the equilibrium constant (Hope College) **[C5]**

C5—Laboratory (Physical manipulations; processes and procedures; observations and data manipulation; communication, group collaboration, and the laboratory report).

Unit 13: Acids and Bases ..... 2.5 weeks

pH, K_a and K_b expressions, titration, degree of ionization, K_w expressions, indicators, equivalence points, Arrhenius, Brønsted-Lowry and Lewis acid theories, and salt hydrolysis **[C3]**

Suggested Experiments

- Titration of a solid acid to find its molecular weight (Hope College)
- Titration of a diprotic acid (Hope College)* **[C5]**

Unit 14: Electrochemistry ..... 1.5 weeks

Oxidation and reduction half-cells and equations, **[C3]** electrochemical (voltaic) cells, standard voltages, standard voltages from a table, Nernst equation, Faraday's laws, writing redox equations, and balancing equations in acid/base solutions

Suggested Experiment

- Electrolysis of water, identifying electrodes, writing half reactions, etc.* This is a lab I created. It uses a nine-volt battery, two pencils sharpened on both ends, and universal solution in water and shows the evolution of hydrogen and oxygen and the ensuing color changes. Students must write the half reactions and the overall reaction and justify each step. **[C5]**

Unit 15: Nuclear Chemistry ..... 0.5 week

This unit takes only a few days and includes nuclear equations, half lives, nuclear particle emissions, fission and fusion, and a bit about nuclear reactors.

AP Exam Review..... 3.0 to 4.0 weeks

I emphasize writing net ionic equations, knowing the solubility rules, solving equilibrium problems, and reviewing AP Released Exams.