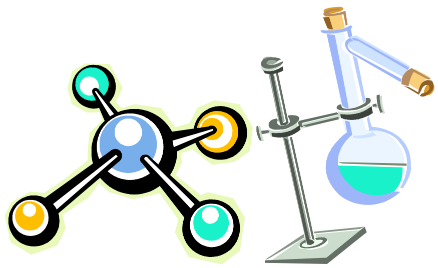
Fresno Unified School District

AP CHEMISTRY
COURSE OUTLINE



Adapted from The College Board Course Description for AP Biology, 2006

Introduction

The AP Chemistry course is designed to be the equivalent of the general chemistry course usually taken during the first college year. For some students, this course enables them to undertake, in their first year, second-year work in the chemistry sequence at their institution or to register in courses in other fields where general chemistry is a prerequisite. For other students, the AP Chemistry course fulfills the laboratory science requirement and frees time for other courses.

Course Description

AP Chemistry should meet the objectives of a good college general chemistry course. Students in such a course should attain a depth of understanding of fundamentals and a reasonable competence in dealing with chemical problems. The course should contribute to the development of the students' abilities to think clearly and to express their ideas, orally and in writing, with clarity and logic. The college course in general chemistry differs qualitatively from the usual first secondary school course in chemistry with respect to the kind of textbook used, the topics covered, the emphasis on chemical calculations and the mathematical formulation of principles, and the kind of laboratory work done by students. Quantitative differences appear in the number of topics treated, the time spent on the course by students, and the nature and the variety of experiments done in the laboratory. *Secondary schools that wish to offer an AP Chemistry course must be prepared to provide a laboratory experience equivalent to that of a typical college course.*

Prerequisites

The AP Chemistry course is an excellent option for any interested student who has completed two years of high school laboratory science: one year of Biology and one year of Chemistry. Due to the quantitative analysis that is required in the course, students should also have completed successfully *a second-year algebra course.* Because of the prerequisites, AP Chemistry will usually be taken in either the junior or senior year. Students are required to take the AP Chemistry exam at the end of the year. It aims to provide students with the conceptual framework, factual knowledge, and analytical skills necessary to deal critically with the rapidly changing science of Chemistry. The advanced work in chemistry should not displace any other part of the student's science curriculum. It is highly desirable that a student has a course in secondary school physics and a four-year college-preparatory program in mathematics.

Developing the requisite intellectual and laboratory skills required of an AP Chemistry student demands that adequate classroom and laboratory time be scheduled. Surveys of students taking the AP Chemistry Exam indicate that performance improved as both total instructional time and time devoted to laboratory work increased. At least six class periods or the equivalent per week should be scheduled for an AP Chemistry course. Of the total allocated time, a minimum of one double period per week or the equivalent, preferable in a single session, should be spent engaged in laboratory work. Time devoted to class and laboratory demonstrations should not be counted as part of the laboratory period. Students in AP chemistry course should spend at least five hours a week in individual study outside of the classroom.

Textbooks

Current college textbooks are probably the best indicators of the level of the college general chemistry course that AP Chemistry is designed to represent. A contemporary college chemistry text that stresses principles and concepts and their relation to the descriptive chemistry on which they are based should be selected. Even the more advanced secondary school texts cannot serve adequately as texts for an AP course that aims to achieve its objectives. A list of example textbooks appropriate for use in this course is available on the AP Chemistry Course Home Page at AP Central (apcentral.collegeboard.com/chemistry). The Teachers' Resources section of AP Central (apcentral.collegeboard.com) has a searchable database of chemistry resources. Many of these resources have been reviewed and rated by experienced AP Chemistry teachers.

Topic Outline

The importance of the theoretical aspects of chemistry has brought about an increasing emphasis on these aspects of the content of general chemistry courses. Topics such as the structure of matter, kinetic theory of gases, chemical equilibria, chemical kinetics, and the basic concepts of thermodynamics are now being presented in considerable depth.

If the objectives of a college-level general chemistry course are to be achieved, instruction should be done by a teacher who has completed an undergraduate major program in chemistry including at least a year's work in physical chemistry. Teachers with such training are best able to present a course with adequate breadth and depth and to develop students' abilities to use the fundamental facts of the science in their reasoning. Because of the nature of the AP course, the teacher needs time for extra *preparation for both class and laboratory and should have a teaching load that is adjusted accordingly.*

The following list of topics for an AP course is intended to be a guide to the level and breadth of treatment expected rather than to be a syllabus. The percentage after each major topic indicates the approximate proportion of multiple-choice questions on the exam that pertain to the topic.

I. Structure of Matter (20%)

A. Atomic theory and atomic structure
  1. Evidence for the atomic theory
  2. Atomic masses; determination by chemical and physical means
  3. Atomic number and mass number; isotopes
  4. Electron energy levels: atomic spectra, quantum numbers, atomic orbitals
  5. Periodic relationships including, for example, atomic radii, ionization energies, electron affinities, oxidation states

B. Chemical bonding
  1. Binding forces
    a) Types: ionic, covalent, metallic, hydrogen bonding, van der Waals (including London dispersion forces)
    b) Relationships to states, structure, and properties of matter
    c) Polarity of bonds, electronegativities
    d) Molecular models
      1. Lewis structures
      2. Valence bond: hybridization of orbitals, resonance, sigma and pi bonds
      3. VSEPR
  2. Geometry of molecules and ions, structural isomerism of simple organic molecules and coordination complexes; dipole moments of molecules; relation of properties to structure

C. Nuclear chemistry: nuclear equations, half-lives, and radioactivity; chemical applications

II. States of Matter (20%)

A. Gases
  1. Laws of ideal gases
    a) Equation of state for an ideal gas
    b) Partial pressures
  2. Kinetic molecular theory
    a) Interpretation of ideal gas laws on the basis of this theory
    b) Avogadro's hypothesis and the mole concept
    c) Dependence of kinetic energy of molecules on temperature

d) Deviations from ideal gas laws

B. Liquids and solids
   1. Liquids and solids from the kinetic-molecular viewpoint
   2. Phase diagrams of one-component systems
   3. Changes of state, including critical points and triple points
   4. Structure of solids; lattice energies

C. Solutions
   1. Types of solutions and factors affecting solubility
   2. Methods of expressing concentration (use of normalities is not tested)
   3. Raoult's law and colligative properties (nonvolatile solutes); osmosis
   4. Nonideal behavior (qualitative aspects)

III. Reactions (35-40%)

A. Reaction types
   1. Acid-base reactions; concepts of Arrhenius, Bronsted-Lowry, and Lewis; coordination complexes; amphoterism
   2. Precipitation reactions
   3. Oxidation-reduction reactions
      a. Oxidation reactions
      b. The role of the electron in oxidation-reduction
      c. Electrochemistry: electrolytic and galvanic cells; Faraday's laws; standard half-cell potentials; Nernst equation; prediction of the direction of redox reactions

B. Stoichiometry
   1. Ionic and molecular species present in chemical systems; net ionic equations
   2. Balancing of equations including those for redox reactions
   3. Mass and volume relations with emphasis on the mole concept, including empirical formulas and limiting reactants

C. Equilibrium
   1. Concept of dynamic equilibrium, physical and chemical; LeChatelier's principle; equilibrium constants
   2. Quantitative treatment
      a. Equilibrium constants for gaseous reactions: $K_{p,}$ K_c
      b. Equilibrium constants for reactions in solution
         (1) Constants for acids and bases; pK; pH
         (2) Solubility product constants and their application to precipitation and the dissolution of slightly soluble compounds
         (3) Common ion effect; butter; hydrolysis

D. Kinetics
   1. Concept of rate of reaction

2. Use of experimental data and graphical analysis to determine reactant order, rate constants, and reaction rate laws
3. Effect of temperature change on rates
4. Energy of activation; the role of catalysts
5. The relationship between the rate-determining step and a mechanism

E. Thermodynamics
1. State functions
2. First law: change in enthalpy; heat of formation; heat of reactions; Hess's law; heats of vaporization and fusion; calorimetry
3. Second law: entropy; free energy of formation; free energy of reaction; dependence of change in free energy on enthalpy and entropy changes
4. Relationship of change in free energy to equilibrium constants and electrode potentials

IV. Descriptive Chemistry (10-15%)

Knowledge of specific facts of chemistry is essential for an understanding of principles and concepts. These descriptive facts, including the chemistry involved in environmental and societal issues, should not be isolated from the principles being studied but should be taught throughout the course to illustrate and illuminate the principles. The following areas should be covered:

1. Chemical reactivity and products of chemical reactions
2. Relationships in the periodic table: horizontal, vertical, and diagonal with examples from alkali metals, alkaline earth metals, halogens, and the first series of transition elements
3. Introduction to organic chemistry: hydrocarbons and functional groups (structure, nomenclature, chemical properties)

V. Laboratory (5-10%)

School administrators should be aware that an AP college-level laboratory is significantly more expensive to operate than a typical high school chemistry laboratory and requires more time than non-laboratory courses. The first-level college course consists of approximately 40 to 50 hours of lecture and 30 to 40 hours of laboratory work per quarter or semester. Proportional allocations of time for laboratory work should be accorded an AP Chemistry course. School administrators should provide the equivalent of two double periods a week for laboratory work.

Some of the laboratories will require equipment schools may not have; alternative ways of conducting the laboratories are therefore offered. Schools should try to purchase college-level laboratory equipment eventually. Many teachers have indicated that their administrations do not fully realize the implications, in both cost and time, of incorporating serious laboratories into their programs. *An AP course is a college course, and the equipment and time allotted to laboratories should be similar to that in a college course.* The differences between college chemistry and the usual secondary school chemistry course are especially evident in the laboratory work. The AP Chemistry Exam includes some questions based on experiences and skills students acquire in the laboratory:

- Making observations of chemical reactions and substances
- Recording data
- Calculating and interpreting results based on the quantitative data obtained
- Communicating effectively the results of experimental work

Colleges have reported that some AP students, while doing well on the exam, have been at a serious disadvantage because of inadequate laboratory experience. Meaningful laboratory work is important in fulfilling the requirements of a college-level course of laboratory science and in preparing a student for sophomore-level chemistry courses in college. *Because chemistry professors at some institutions ask to see a record of the laboratory work done by an AP student before making a decision about granting credit, placement, or both, in the chemistry program, students should keep a laboratory notebook that includes reports of their laboratory work in such a fashion that the reports can be readily reviewed.*

Chemical Calculations

The following list summarizes types of problems either explicitly or implicitly included in the preceding material. Attention should be given to significant figures, precision of measured values, and the use of logarithmic and exponential relationships. Critical analysis of the reasonableness of results is to be encouraged.

1. Percentage composition
2. Empirical and molecular formulas from experimental data
3. Molar masses from gas density, freezing-point, and boiling-point measurements
4. Gas laws, including the ideal gas law, Dalton's law, and Graham's law
5. Stoichiometric relations using the concept of the mole; titration calculations
6. Mole fractions; molar and molal solutions
7. Faraday's laws of electrolysis
8. Equilibrium constants and their applications, including their use for simultaneous equilibria
9. Standard electrode potentials and their use; Nernst equation
10. Thermodynamic and thermochemical calculations
11. Kinetics calculations