CHE 116/117 General Chemistry II

CHE 116

General Chemistry Lecture II
(3 credits)

CHE117
Laboratory (1 credit)
Class Size: 20-24

Faculty: James Spencer, Ph.D., Professor, Department of Chemistry
Administrative Contact: David Tate, Associate Director, Project Advance

Course Catalog Description

CHE 116: Builds upon the fundamental chemical principles learned in CHE 106 and introduces chemical kinetics and thermodynamics, intermolecular forces, advanced chemical equilibria, oxidation/reduction, and modern materials.

CHE 117: Experimental study of basic principles and techniques of chemistry. States of matter, determination of formulas and molecular weights, simple volumetric and gravimetric analysis, heats of reaction. Equilibrium, rates of reactions, and qualitative analysis.

Course Overview

Chemistry 116 and 117 are the lecture and laboratory courses, respectively, of the four-credit continuation course sequence

in general chemistry taught at Syracuse University.

Chemical Kinetics: Reaction rates, average and instantaneous rates, reaction rates and stoichiometry, rate law, rate constant (units), reaction order.

Effect of Concentration on Rate: Determining rate law from initial rates, first-order, second-order reactions, half-life, dependency of half-life on time.

Effect of Temperature on Rate: Collision model of chemical reactions, activation energy, activated complex, the Arrhenius equation, frequency factor, determination of rate constants at different temperatures.

Reaction Mechanisms: Reaction steps, rate determining step, reaction intermediates, reaction rate profiles, determination of rate law from reaction mechanism, homogeneous and heterogeneous catalysis, enzymes.

Chemical Equilibrium (Introduction): Dynamic equilibrium; criteria for establishing equilibrium; the equilibrium expression and concentration equilibrium constant; Kc. effect of pressure on the equilibrium constant, Kp; predicting where equilibrium lies from the magnitude of K; homogeneous vs. heterogeneous equilibria; calculation of equilibrium concentrations; Le Chatelier’s Principle; effect of catalysts.

Acid-Base Equilibria: The dissociation of water, ion-product constant for water, Bronsted-Lowry acids and bases, proton transfer reactions, conjugate acid-base pairs, acid-base strengths, pH, measurement of pH, strong acids and bases, weak acids and bases, calculation of pH for solutions of weak acids and bases, percent ionization, acid- and base-dissociation constants,polyprotic acids and bases, acid-base properties of salt solutions, hydrolysis, Lewis acids and bases.

Aqueous Equilibria (Additional Aspects): Common-ion effect, acid-base titrations, titration curves, end point, equivalence

point, buffers and buffered solutions, buffer capacity, buffer level.

Solubility equilibria: Solubility-product constant, Ksp, calculation of solubility from Ksp values, effect of a common ion, criteria for precipitation or dissolution, selective precipitation of ions, complex formation and solubility, chemical separations and qualitative analysis.

Thermochemistry and Thermodynamics: First Law of Thermodynamics; energy, heat, and work; constant volume processes; constant pressure processes; enthalpy; state functions; Hess's Law; enthalpy of formation; standard states; Second Law of Thermodynamics; spontaneous processes; calculation of entropy changes; Gibbs free energy; free energy and temperature; using free energy changes to determine reaction spontaneity; free energy and the equilibrium constant.

Electrochemistry: Oxidation states, redox reactions, oxidizing agent, reducing agent, balancing oxidation-reduction equations, redox reactions in acidic and basic solution.

Voltaic Cells: Anode, cathode, salt bridge, cell electromotive force, standard electrode potentials, spontaneity of redox reactions, emf and free-energy change.

Effect of Concentration on Cell emf: The Nernst Equation, calculation of cell voltages at concentrations other than standard, determination of equilibrium constants from redox data, electrolysis, Faraday's Laws, quantitative aspects of electrolysis.

Nuclear Chemistry: Radioactivity; radionuclides; radioisotopes; nuclear equations; types of radioactive decay; alpha, beta, and gamma rays; half-life; stability of nuclei; radioactive series; nuclear transmutations; transuranium elements; radiochemical dating; detection of radioactivity; nuclear reactions: energy changes, fission, and fusion;

biological effects of radiation.

Organic Chemistry: Hydrocarbons, alkanes, alkenes, alkynes, structural formulas, isomers, nomenclature, reactions of hydrocarbons, addition reactions, aromatic hydrocarbons, benzene, functional groups, alcohols, ethers, aldehydes, ketones, carboxylic acids, amines, amides, amino acids, optical isomerism, chiral molecules, carbohydrates, sugars, nucleic acids, DNA, double helix.

Polymers: Monomer, dimer, polymer, addition polymerization, free radicals, chain initiation, chain termination, examples of addition polymers, condensation polymerization, examples.

Pre- / Co-requisites

CHE 116 PREREQ: CHE 106 OR CHE 109 OR AP CHEM EXAM SCORE MIN 5

CHE 116 COREQ: CHE 117

Course Objectives

This course is intended to provide an introduction to understanding on a deeper level the role of chemistry in our world. This will be accomplished by providing a rational basis for interpreting and predicting chemical phenomena through examples of chemical behavior observed in nature. Thus, it is anticipated that students will be able to understand fundamental chemical processes and to be able to apply this understanding to solve new problems in chemical behavior.

Laboratory

The CHE 117 laboratory in the second semester follows the same procedure as that in the first. Some qualitative analysis procedures are carried out, since the lecture part of the

course covers many of the chemical concepts necessary to understand their chemical basis e.g., equilibrium, pH, and solubility.

Required Materials

CHEMISTRY: The Central Science by T.L. Brown, E. LeMay Jr., and B.E. Bursten, Prentice-Hall Publishing Co., Inc.

Loose Leaf with online component – ISBN: 9780134809663 (Pearson, 800-848-9500)

Other Texts (related books for this course which may be helpful):

Student's Guide to CHEMISTRY, J.C. Hill, Prentice-Hall Publishing Co., Inc.

Solutions to Exercises in CHEMISTRY, R. Wilson, Prentice-Hall Publishing Co., Inc.

Instructor Recommendations

No specific laboratory manual is recommended for use in this course; however, many Project Advance instructors use the companion lab manual Laboratory Experiments by J. Nelson and K. Kemp. In some cases, individual experiments are adapted from Chemical Separates, a collection of chemistry laboratory experiments prepared by a team of expert teachers under the aegis of the American Chemical Society (available from Chemical Education Resources, Inc., P.O. Box 357, 220 S. Railroad, Palmyra, PA 17078)