SYRACUSE UNIVERSITY

CHE 116 General Chemistry Lecture (*3 credits*)
CHE 117 Laboratory (*1 credit*)
2017-2018

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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. As with CHE 106, the grade for the lecture part of the course is based on the four exams and a final exam which covers all the material addressed during the semester. Laboratory grades are based on students' performance on individual laboratory exercises and a comprehensive laboratory final examination.

Course Outline

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 and 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, K_c. Effect of pressure on the equilibrium constant, K_p. 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, K_{sp}, calculation of solubility from K_{sp} 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' 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, 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.

Laboratory

The laboratory in the second semester follows the same procedure as that in the first semester. 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.

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