General Chemistry lecture

(pharmaceutics, chemistry, chemical engineering, biology, electrical engineering, physics majors)

Course time: 45 hours/semester, 10 Sept. 2014 – 18 Dec. 2014

Wednesday, 12pm – 2pm Room D404 (Chemistry Building)
Thursday, 12pm – 1pm Room D404 (Chemistry Building)

Instructor: ***Dr. Gábor Lente***, associate professor
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Exam: test after the completion of the semester, no midterm tests, sample test questions provided on the website in the beginning of December

Website: http://www.inorg.unideb.hu/
all lecture materials are posted at least one day before the lecture

Recommended textbook:
John McMurry – Robert C. Fay: Chemistry
6th ed., Prentice Hall ISBN: 0321704959. Available in the MEDICINA bookstore in the theoretical building on the medical campus. Price: HUF 22,000.

Weekly syllabus

Week 1 *Sciences and chemistry, Quantitative laws in chemistry, basic concepts of stoichiometry*
Classification of natural sciences, history and development of chemistry. The concept of chemical change.
The SI system of units, the most important physical quantities and units. Conservation of mass and energy. Einstein's equation on mass-energy equivalence. The law of definite proportions, the law of multiple proportions, law of combining gas volumes, Avogadro's law. Development of Dalton's atomic theory and its influence on chemistry. Relative atomic and molecular weights. Amount of substance and the definition of mole. Notations for elements and compounds, symbol, empirical formula, molecular formula, structure, isomerism. Valency and oxidation number. Oxidation number in inorganic compounds. Types of chemical reactions. Latin names of compounds.

Week 2 *Characterization of macroscopic chemical systems, states of matter*
Classification and structure of chemical systems. General characterization of different states of matter. The kinetic molecular theory of gases, ideal and real gases. Gas laws: Boyle's law, Charles's law, the ideal gas law. Gas mixtures, partial pressure. General characterization of liquids, surface tension, viscosity. General characterization and classification of solids. Changes of state: melting, freezing, evaporation, condensation, sublimation. Phase diagrams, critical temperature and pressure. Phase diagrams of water, sulfur and carbon dioxide. Thermodynamic temperature.

Week 3 *Solutions*
Classification of multicomponent systems, properties of solutions and mixtures. Solubility and units of concentration. Vapor pressure, freezing and boiling point of solutions. Osmosis pressure. Determination of molecular weight.

Week 4 *Thermochemistry*
Thermochemical equation, heat of reaction, Hess's law. The importance of heat of formation. Heat changes characteristic of changes of state. Heat of reaction and bond energies. The direction of spontaneous chemical reactions: internal energy, enthalpy, free energy and entropy.

Week 5 *Reaction rates*
Dependence of reaction rates on concentrations and the temperature. Order of reactions. Activation energy. Catalysts, homogeneous and heterogeneous catalytic reactions. Enzymes. Photochemical processes.

Week 6 *Equilibrium*
The equilibrium condition and the equilibrium constant. Possibilities to shift the composition of equilibria. Dependence of the equilibrium constant on temperature and pressure. Le Chatelier's principle.

Week 7 *Acid-base equilibria, Heterogeneous equilibria*
Different theories of acid-base reactions (Arrhenius, Brønsted, Lewis). Characterization of aqueous solutions, electrolytic dissociation. Strength of acids and bases. Amphoteric substances. The definition and calculation of pH. Buffer solutions and acid-base indicators. Acid-base properties of salts. Complex ion equilibria. Pearson's hard-soft theory. Solubility equilibria, solubility product. Temperature dependence of solubility. Gas-liquid and liquid-liquid equilibria. Extraction.

Week 8 *Redox reactions*
Galvanic cells and the concept of electrode potential. Standard electrode potentials, oxidizing and reducing agents. Water as a redox system. Electrolysis, voltage needed in electrolytic cells, overvoltage. Quantitative laws of electrolysis. Galvanic cells and batteries.

Week 9 *The structure of atoms*
Experimental background of the atomic theory, discovery of the nucleus. Quantized changes in the energy states of atoms. The photon hypothesis. The Bohr model of the atom. Characteristics of electromagnetic radiation, atomic line spectra, X-ray radiation.

Week 10 *The structure of the nucleus*
Discovery and basic properties of subatomic particles (electron, proton, neutron). The mass defect. Isotopes. Types and properties of radioactive radiation. Laws of radioactive decay, decay series. Medical and other practical importance of radioactive isotopes. Nuclear energy, nuclear fission and fusion.

Week 11 *Quantum mechanical model of the atom*
The dual nature of matter. Heisenberg's uncertainty principle. Schrödinger's equation and its application for the hydrogen atom. Quantum numbers and their importance. The shape of atomic orbitals. Characterization of polyelectronic atoms. Principles of the periodic table. Electronegativity, ionization energy, electronaffinity, atomic and ionic radii and their change across the periodic table.

Week 12 *The chemical bond*
The ionic bond. Calculation of the lattice energy. The covalent bond. Basic characteristics of the molecular orbital theory and its application for diatomic molecules. The valence shell electron pair repulsion model. The shape of molecules, bond angles, bond orders, hybridization. Polarity of covalent bonds, polar and nonpolar molecules. Metallic bonding.

Week 13 *Structure and bonding in chemical systems*
Intermolecular forces. Hydrogen bond and its importance in inorganic and organic chemistry. General characterization of molecular, ionic, metallic, and network atomic solids. The band theory of solids. Characteristics of insulators, semiconductors and conductors. Dielectric and magnetic properties: dia-, para- and ferromagnetic materials.

Weeks 14 *Principles of chemical structure determination*
Principles and application of mass spectrometry. Electromagnetic spectra, atomic and molecular spectroscopies. Principles and application of infrared spectroscopy. The chemical importance of NMR and ESR spectroscopies. Diffraction methods.

Weeks 15 *Metals and metallurgy*
Theoretical models of solid materials: band theory and its applications to metals. Superconductivity and its applications. Commercial methods of metal production.