Subject: Inorganic chemistry and qualitative inorganic analysis

Department: University of Debrecen, Department of Inorganic and Analytical Chemistry
Students: 1st grade pharmacist, 2nd semester
Lessons: 45 hours/semester
Exam: written test

Topics
There are four subunits:
A: Chemistry of p-block elements
B: Chemistry of s-, d- and f -block elements
C: Introduction to bio-inorganic chemistry
D: Qualitative inorganic analysis of cations and anions

Taking into account the requirements of the laboratory practice in the same subject, the “A” subunit (5x3 hours) will be followed by the qualitative inorganic analysis, “D” (2x3 hours lecture + 3x1 hours seminar), than “B” (5x3 hours lecture) and “C” (2x3 hours lecture) will be hold.

Detailed schedule of the lectures see page 2!

Recommended readings:

1. G. Svehla (reviser)
   Vogel’s Qualitative Inorganic Analysis
   Sixth edition
   Longman Scientific & Technical
   Copublished in the United States with John Wiley & Sons, Inc.,
   New York, 1994
   ISBN 0-582-45090-X
   ISBN 0-470-20710-8 (USA only)

2. N. N. Greenwood and A. Earnshaw
   Chemistry of the Elements
   Reed Educational and Professional Publishing Ltd, 2 ed, 1997
   ISBN 0 7506 3365 4

3. H. F. Holtzlaw, Jr., W. R. Robinson
   College Chemistry with Qualitative Analysis
   Eighth edition
   D. O. Heath and Company,
   Lexington, Massachusetts, Toronto, 1988
   ISBN 0-669-12862-7

4. Lecture notes by I. Tóth and K. Várnagy: Inorganic chemistry and qualitative inorganic analysis
   hard copy in the Copy shop (at the Chemistry Building) and on the INTERNET, see
   http://www.klte.hu/~wwwinorg/szervtln.html at the home pages of Dr. Imre Tóth and Dr. Katalin Várnagy
Schedule of the lectures: 2008/2009. 2nd semester

Subject: Inorganic chemistry and qualitative inorganic analysis

1st grade pharmacist student

<table>
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<tr>
<th>Lecture</th>
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*3x1 hour will be given by Dr. Gyula Tircső as “seminar” related to the laboratory practice, counting together the 45 lessons/semester
Detailed topics

Week 1.

*Hydrogen.* Atomic and physical properties, abundance, chemical properties. Deuterium and tritium. Production and uses.

*The Noble gases.* (Group 18). Atomic and physical properties, distribution, chemical properties. Clatrates, ionic and covalent compounds. Production and uses.

Week 2.


Week 3.

Week 4.

Week 5.
*Boron, aluminium, gallium, indium and thallium* (Group 13) Atomic and physical properties, distribution, chemical properties of the elements. Structure and chemical properties of EX₃ compounds. 3-centre bonding. Boron hydrides, binary and ternary hydrides of aluminium. Oxides and related compounds. Production and uses of the elements.

Week 6.
*Introduction to qualitative analysis.* (This topic is partially worked up during the seminars.) Sort history of the analytical chemistry. Basic experimental methods in analytical chemistry. Classification of chemical reactions in analytical chemistry: acid-base, redox and complexation reactions, reactions with colour changes and precipitation. Specific, and selective reactions. Sensitivity. Preparation and homogeneity of the samples. Dissolution of solid samples. Classifications of the cations and anions based on inorganic chemical considerations. Types of sulphides. Thioacids, thiobasics and thiosalts.


*Anions.* Group 1 and 2: carbonate, bicarbonate, silicate, sulphide, polysulphide, sulphite, tiosulphate, hypochlorite; and borate, phosphate, sulphate, fluoride, bromate, iodate. Groups 3 and 4: chloride, bromide, iodide, cyanide, thiocyanide; and nitrite, nitrate, acetate, chloride, perchlorate, peroxide.

Week 7.
*Systematic analysis of cations. The Fresenius system.* Reactions and separation of Group 1 cations: Ag(I), Pb(II), Hg(I), Cu(II), Hg(II), Bi(III), Cd(II). Reactions and separation of Group 2 cations (anions of semimetals): As(III), As(V), Sb(III) and Sb(V), Sn(II) and Sn(IV). Reactions and separation of Group 3 cations: Ni(II), Co(II), Fe(II), Fe(III), Mn(II), Cr(III), Al(III) and Zn(II). Reactions and separation of Group 4 cations: Ca(II), Sr(II) and Ba(II). Reactions of Group 5 cations: Na⁺, K⁺, Li⁺, Mg(II) and NH₄⁺. Complete analysis of cations. Separation methods in the qualitative analysis.

Week 8.
*s-block elements* (Group 1 and 2.): Atomic and physical properties, distribution, chemical properties and uses of the alkali and alkaline earth metals. Dissolution of Na in liquid ammonia. Covalent and coordination

Week 9.  

Week 10-11.  
Titanium, Zirconium and Hafnium. Atomic and physical properties, distribution, chemical properties and uses of the elements. Halogenides and oxides. TiCl₄, TiO₂, ZrO₂. Vanadium, Niobium and Tantalum. Atomic and physical properties, distribution, chemical properties and uses of the elements. Halogenides as cluster compounds. Oxides and related compounds.  
Chromium, Molybdenum and Tungsten. Atomic and physical properties, distribution, chemical properties and uses of the elements. Halogenides and oxides. Iso and heteropolyacids. Some Cr(III) compounds.  
Manganese, Technetium and Rhenium. Atomic and physical properties, distribution, chemical properties and uses of the elements. Important compounds of manganese.  
Iron, Cobalt and Nickel. Atomic and physical properties, distribution, chemical properties and uses of the elements. Production of iron and steel. Important inorganic and coordination compounds of the elements.  
Platinum metals (Ru, Rh, Pd, Os, Ir, Pt). Atomic and physical properties, distribution, chemical properties, production and uses of the elements. Important inorganic and coordination compounds of the elements. Chemistry of photography.  
Copper, Silver and Gold. Atomic and physical properties, distribution, chemical properties and uses of the elements.  
Zinc, Cadmium and Mercury. Atomic and physical properties, distribution, chemical properties, production and uses of the elements. Halogenides, oxides, sulphides and coordination compounds.

Week 12.  
f-block elements. Electronic structure, the lanthanide contraction. Some important complexes of Gd. Important uranium compound related to the atomic energy industry.

Week 13.  
Introduction to the bioinorganic chemistry. Essential and toxic elements in biological systems. Classification of the biological functions of the essential elements. Complex forming properties of the biologically important ligands. Experimental methods for chemical and biological studies. Biological functions of the essential elements. Transport and activation of the small biomolecules. Metalloenzymes, metalloproteins, important examples, enzyme models. Distribution of cations, transport processes, ion uptake through the membrane.

Week 14.  
Biological functions of alkali metal ions. The role of Na⁺ and K⁺ in controlling the membrane potential and in activation of enzymes.  
Biological functions of alkaline earth metal ions. The role of Ca²⁺ in contraction of muscles and enzymes. Ca²⁺ and mineralization in the body. The role of Mg²⁺ in enzymes and in the photosynthesis.  
Transition metals and other elements. Transport, storage and activation of O₂. The role and metabolism of iron. Copper containing proteins and metabolism of copper. Biological role of zinc in activation of enzymes. Importance of Mo, Se and Si.  
Medical applications. Toxicity of heavy metals. Complexes and ligands as pharmaceuticals.

Debrecen, 3 February 2009

Dr. Gyula Tircsó, Dr. Imre Tóth and Dr. Katalin Várnagy