General and inorganic chemistry II: Required knowledge

This document describes the scope of knowledge that students are expected to know from their previous studies before enrolling into the GIC II course. The areas indicated below will not be further addressed in the course.

Inorganic nomenclature

Symbols and names of all elements

Oxidation state and charge of an ion – the difference in notation and meaning (*e.g.* Ti^{IV} vs Ti^{4+}, S^{-II} vs S^{2-})

Common oxidation states of s-, p- and d-block elements (*e.g.* determine oxidation state of all atoms in KOH, BaO_2, H_2O, SO_5^{2-}, TiO^{2+}, H_6TiO_6)

Names and formulae of the following groups of ions and compounds:

- monoatomic cations and oxycations (*e.g.* Cu^{2+}, K^+, CO^{2+}, SO_2^{2+})
- monoatomic and simple polyatomic anions (*e.g.* O^{2-}, O_2^{2-}, S^{2-}, H^-, Cl^-, NH_2^-, NH^{2-}, N^{3-}, N_3^-, OH^-)
- oxyanions (*e.g.* SO_4^{2-}, SO_3^{2-}, BrO_4^-, $H_2PO_4^-$, TeO_6^{6-})
- binary hydrides and their derivatives (*e.g.* , P_2H_4, H_2Te, H_2I^+, SCl_2, SCl_3^+, $SiHCl_3$)
- binary and mixed salts, oxides, hydroxides and other common inorganic compounds (*e.g.* H_2O, NH_3, NaOH, $CuSO_4.5H_2O$, Ag_2S, Li_3PO_4, CaO, BaO_2, Pb_3O_4, $KAl(SO_4)_2$, Cu(OH)Cl)
- acids and their derivatives (*e.g.* HCl, H_2S, H_2SO_4, H_6TiO_6, H_2SO_3S, H_2SO_5, HSO_3Cl, HSO_3NH_2)
- coordination compounds (*e.g.* $[Cu(H_2O)_6]^{2+}$, $H[BF_4]$, $[Al(OH)_4]^-$, $[Cu(edta)]^{2-}$)

Operations with chemical equations

Balancing reactions without redox processes

examples: $BF_3 + H_2O \rightarrow H[BF_4] + H_3BO_3$
$Ca_3P_2 + H_2O \rightarrow Ca(OH)_2 + PH_3$

Balancing reactions with one or more oxidation and reduction processes, disproportionation and synproportionation, conversion of molecular equation into an ionic form, determination of a pH range for a reaction to proceed.

examples: $MnO_4^- + NO_2^- + H_3O^+ \rightarrow Mn^{2+} + NO_3^- + H_2O$
$I_2 + HNO_3 \rightarrow HIO_3 + NO + H_2O$

Periodic Table (PT)

Positions of all s-, p- and d- elements in the table (period and group)

Trends in electronegativity, ionization energy, electron affinity, atomic and ionic radii across the PT

Structure of atoms and molecules

Quantum numbers, their allowed values and significance

Electron configuration of atoms and ions

Ionic, covalent and metallic bond – their basic differences and implications for the compound

Theory of valence bond, Lewis structures

Molecular orbitals for diatomic molecules (homo- and hetero-nuclear, s-p mixing)

Chemical reactions

Enthalpy, entropy, Gibbs energy: their relation and significance

Chemical equilibrium and Le Chatelier's principle

Reaction mechanisms of Lewis acids and bases

Properties of ions, molecules, acids and bases

Polarizing power of cations, polarizability of anions, acidobasic predominance diagrams, hydrolysis of ions

Strength of acids (Brønsted theory) and bases

VSEPR theory, shape of molecules, dipole moment

Systematic inorganic chemistry

Laboratory synthesis vs industrial production of common inorganic compounds

Physical properties and structure of basic non-metals (H_2, O_2, N_2, halogens, S, allotropes of carbon and phosphorus, B)

Non-metals: means of preparation, basic reactivity (with acids and hydroxides), trends in reactivity of halogens

Oxides: acid-base behaviour, means of preparation

Hydrolyses of halides, oxide-halides, nitrides, phosphides, carbides, borides, hydrides (covalent vs ionic)

Reactivity of metals towards acids, bases and water (noble vs base metals)