Intermediate Inorganic Chemistry (CHMC31Y3)

Welcome to CHMC31 course, a course that brings to you the exciting, rich and colourful world of transition elements. Below you will find a more detailed course scope and outline which will, I hope, give you a bit more information about what is in front of us and what is expected from us all this semester.

Course Scope

Intermediate Inorganic Chemistry (CHMC31) builds up on the material covered in Introduction to Inorganic Chemistry (CHMB31) and will cover topics from the general and special chemistry of transition elements. Thus, the main goal of this course is to provide you with knowledge and understanding of transition elements, their compounds and coordination chemistry. General topics will include: overview of transition metal properties (their position in the Periodic Table of Elements, relationships to the main group elements, etc.) main classes of compounds, coordination compounds (structure and bonding, general reactivity, magnetic properties), spectroscopic methods in inorganic chemistry (UV, IR, NMR), and basic organometallic chemistry of transition elements. Special topics will include reactivity of some transition metal complexes (through important examples), and introduction to organometallic chemistry. Thus, the course is oriented more towards the physical rather than descriptive inorganic chemistry.

Detailed Course Outline

These are some of the topics that will be covered in the course. We will not cover them necessarily in this order.

1. INTRODUCTION
    a. General introduction to transition and inner transition elements:
        i. Brief history, their position in Periodic Table of Elements, relationship to main group (*s*- and *p*- block) elements, electronic configurations;
        ii. Accessible oxidation states, main classes of compounds (binary, salts, complex, organometallic).

2. COORDINATION COMPOUNDS (OR COMPLEXES):
    a. Definition and brief history;
    b. Ligand Classes;
    c. Coordination numbers and geometries;

d. Isomers;

3. LIGANDS, STABILITY AND SYMMETRY
    a. Relationships between ligand structure and complex geometry
    b. Complex stability:
        i. Thermodynamic stability of complexes
        ii. Chelating and macrocyclic effects
    c. Introduction to symmetry:
        i. The concept of symmetry
        ii. Symmetry elements and symmetry operations
        iii. Point groups

4. BONDING IN COORDINATION COMPOUNDS:
    a. Ligand Field Theory;
    b. Crystal Field Theory;
    c. Molecular Orbital Approach.

5. CHARACTERIZATION OF COORDINATION COMPOUNDS I: UV-VIS SPECTROSCOPY
    a. Colour of transition metal complexes;
    b. Spectral terms and selection rules;
    c. Correlation diagrams;
    d. Charge transfer: metal-to-ligand and ligand-to-metal.

6. CHARACTERIZATION OF COORDINATION COMPOUNDS II: INFRARED SPECTROSCOPY (THEORY AND APPLICATIONS);

7. SPECTROSCOPY III: NMR SPECTROSCOPY IN INORGANIC AND ORGANOMETALLIC CHEMISTRY:
    a. General introduction to NMR spectroscopy;
    b. NMR active nuclei;
    c. Chemical 0M

c. Izomerization;
d. Electron-transfer pathways.

9. ORGANOMETALLIC COMPOUNDS:
    a. Ligands in organometallic chemistry;
    b. 18-electron rule and structure of organometallic compounds.
    c. Basic classes of organometallic compounds:
        i. σ- bonded alkyl and aryl complexes
        ii. π-bonded systems (alkenes, alkynes, cyclopentadienyl and other aromatic systems)
        iii. Other common ligands in organometallic chemistry: hydride, dihydrogen, and phosphines

10. SPECIAL TOPICS II: CATALYSIS - CHEMISTRY AND INDUSTRY IN ACTION TOGETHER:
    a. Energy considerations, "green chemistry" and "atom economy" principles (i.e. "Why bother with catalysis);
    b. Heterogeneous catalysis;
        i. Principles;
        ii. Mechanisms;
        iii. Examples;
    c. Homogeneous catalysis;
        i. Principles;
        ii. Mechanisms;
        iii. Examples;
    d. Homogeneous *vs*. heterogeneous catalysis: which way to go?
    e. Industry.

11. SPECIAL TOPICS III: BIOINORGANIC COORDINATION CHEMISTRY
    a. The elements of life: s-, p- and d-block elements in living systems
    b. Criteria for element selection: abundance, availability and usefulness
    c. Most important biological ligands: amino acids, corrins and small inorganic molecules
    d. Metal – protein symbiosis in living systems

Suggested reading materials

Your lecture notes, which will be available on the CHMC31 intranet site, should be your major guides to mastering the material for this course. **However, the knowledge of both textbook and lecture materials is required**.

Our textbook is still:

Atkins, Overtone, Rouke, Weller, Armstrong and Hagerman. **Shriver and Atkins' Inorganic chemistry**. 5th edition. New York: W.H. Freeman and Company, 2010