

**CHEM 362**  
**Goals for Chapters 4, 5 and 6**

*Chapter 4*

1. Be able to sketch simple crystal structures: NaCl (rock salt), CsCl (cesium chloride), CaF<sub>2</sub> (fluorite), TiO<sub>2</sub> (rutile).
2. Understand the **radius ratio** concept for **ionic compounds**. Know how to apply the radius ratio rule for the different lattice types.
3. Understand that by assuming ions are charged, hard spheres, packed in a repetitive arrangement, *i.e.*, an ionic compound, we can calculate lattice enthalpies. Know that the lattice enthalpy is the principal **driving force** of the reactions that produce ionic compounds.
4. Know the meaning of **unit cell** and **coordination number**. Given a unit cell, be able to determine the formula from the contributions of each atom to the contents of the unit cell. Be able to identify the **coordination number** for each type of atom.
5. Know that the **Madelung Lattice Energy**,  $U$ , is the enthalpy change for the reaction:  $M^+_{(g)} + X^-_{(g)} \rightarrow MX_{(s)}$ . Given appropriate thermochemical data, be able to calculate lattice enthalpies from a Born-Haber cycle.
6. Understand and be able to sketch **hexagonal closest packing** (..ABAB..) and **cubic closest packing** (..ABCABC..) and understand the differences between the two.
7. Understand that numerous structures result through modification of closest-packing. This mainly involves different fillings of the **tetrahedral and octahedral holes** in the two types of closest-packed structures: CdI<sub>2</sub>, CaTiO<sub>3</sub>, BI<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub>, etc., (Table 4-4, p.140).

*Chapter 5*

1. Know that a **Ligand** is an atom or molecule that is coordinated to a metal ion.
2. Know that **Anions are very important Ligands** in molecules as well as solids. There are two main classes of compounds that use anions as ligands, namely **Coordination Compounds** and **Solid-State or Ionic Compounds**.
3. Know the **General Anion types**:  
“Simple”, Oxo anions (discrete and polymeric), Complex Anions.

4. Know the **Specific Categories of Anions** and their Reactivity Patterns:  
Oxides (Acidic versus Basic), Hydroxide, Alkoxides  
Polymeric Oxides  
Halogen-Containing Anions (Halides and Pseudohalides)  
Sulfide and Hydrosulfide Anions
5. Know the **Different Binding Modes for various oxo anions**, for example:  $\text{NO}_2^-$ ,  $\text{NO}_3^-$ ,  $\text{SO}_3^{2-}$ ,  $\text{SO}_4^{2-}$ ,  $\text{CO}_3^{2-}$  etc.
6. Know the basic building blocks of **Silicates** and **Phosphates** and that they form very important industrial materials (silicates can form zeolites and phosphates have been used as water softeners).

### Chapter 6

1. Know the significance of the work of the “Father of Modern Coordination Chemistry”, **Alfred Werner**, in terms of its impact on inorganic chemistry.
2. Understand the terms: **coordination complex, monodentate bidentate, tridentate, tetradentate etc., ligands, chelating versus bridging binding mode, linkage isomerism** ( $\text{NO}_2^-$  vs.  $\text{ONO}^-$ ), **bite angle, macrocycles**.
3. Know the differences between ionization, optical, coordination, linkage, geometric and hydrate isomers. Know how to sketch all the possible geometric isomers of a coordination complex.
4. Be able to name Coordination Complexes according to the IUPAC rules.
5. Know the **Basic Coordination Geometries** for the common coordination geometries 2, 3, 4, 5, 6 and  $> 6$ .
6. Know the **Names of Common Ligands** and the number of binding sites they have. Example: 2,2'-bipyridine (bpy), acetylacetonate (acac) and ethylenediamine (en) have two binding sites and Triethylenetetramine has four sites, etc.
7. Know the basic geometries of **octahedral** and **square planar** which are the most important basic shapes for transition metal complexes. Know the distortions of an octahedron (axial, rhombic, trigonal pyramid). Also know the shapes that result from adding an extra ligand to octahedral and square planar geometries.
8. Know the meaning of the terms *cis*, *trans* and *fac*, *mer*.
9. Understand that the **Stepwise Formation** of metal complexes involve equilibria and that the overall formation constant is the product of the equilibrium constants for all of the individual steps.

11. Understand that the “**Chelate Effect**” is an entropic effect and that it greatly affects the thermodynamic stability of complexes.
12. Understand the three basic reactivity patterns for octahedral and square planar molecules, namely **Substitution**, **Electron-Transfer** and **Isomerization** and that the correlation of these reactions with electronic and molecular structure is the essence of inorganic chemistry.
13. Know that substitution reactions occur by two main pathways, **Associative (A)** and **Dissociative (D)**, but that less extreme cases of these, namely **Interchange-Associative (I<sub>A</sub>)** and **Interchange-Dissociative (I<sub>D</sub>)** are closer to the real cases. Know how to draw and label the Free Energy Reaction Profiles for A, D, I<sub>A</sub> and I<sub>D</sub> processes.
14. Know the basic types of substitution reactions that were discussed in the notes. Know that octahedral molecules can react by either dissociative or associative mechanisms, but that square planar molecules undergo associative substitution reactions.
15. Know the factors that influence the rates of substitution in molecules: **Charge, sterics, ligand types, stereochemistry**.
16. Know the two different types of **Electron Transfer** Reactions: **Inner-sphere** and **Outer-sphere**.
17. Know the meaning of **Stereochemical Non-rigidity** and how five coordinate and six coordinate molecules interchange ligands without having to undergo dissociation.