

## INTRODUCTION TO COORDINATION CHEMISTRY

Transition metals differ from main group metals in several key properties. One of the more interesting aspects of transition metals is their ability to form **coordination compounds**. Coordination compounds are formed between a metal atom or ion and a molecule with one or more unshared electron pairs, called a **ligand** this ligand act as Lewis bases, Metals ions have empty valance orbital; they act as Lewis acids. Ligands may be classified according to the number of donor atoms they contain. A **monodentate** ligand donatēs a single electron pair to the metal or metal ion. Common examples of monodentate ligands include  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{NO}_2^-$ , and  $\text{CN}^-$ . A **bidentate** ligand, as the name suggests, donates two electron pairs to the metal or metal ion. A good example is ethylenediamine,  $\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$ .

Anions as well as neutral molecules may act as ligands. If one or more neutral molecules coordinate to metal ion, the resulting species retains the charge of the transition metal ion and is called a **complex ion**. For example, most transition metal ions form complex ions with water molecules when in aqueous solution. Examples include  $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$  and  $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ . If one or more anions coordinate to a metal ion, a complex ion with an overall negative charge may result. Examples include  $[\text{Co}(\text{NO}_3)_6]^{3-}$  and  $[\text{Fe}(\text{CN})_6]^{4-}$ .

In writing formulas for complex ions and coordination compounds, the molecules inside the brackets represent ligands physically coordinated to the metal ion. Anything outside of the brackets is present for charge balance. Therefore the formulas  $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_3$  and  $[\text{Ni}(\text{H}_2\text{O})_6]\text{Cl}_3$  represent neutral compounds in which the chloride ions are present for