Chemical Reactions: Complexation Reactions: Student Review Notes

Coordinate Covalent Bonds: one species donates both electrons to the bond

Transition metals can behave like Lewis Acids (electron pair acceptors) in the formation of what are called **complex ions**. A **coordination compound** typically consists of a complex ion and counter ion.

The molecules or ions that surround the metal in a complex ion are called **ligands**. The ligands act like a Lewis Base in that they donate a pair of electrons. A ligand must therefore have at least one unshared pair of electrons. The type of bond between the metal and the ligand is a **coordinate covalent bond**. In a coordinate covalent bond, one of the bonding atoms supplies both of the electrons.

The atomic in a ligand that is bound to the metal is called the donor atom. The coordination number is defined as the number of donor atoms surrounding a metal in a complex ion.

Here are some molecules that commonly act as ligands:

Here are some common examples of complexation reactions (not balanced):

A. Ammine Complexes--concentrated or excess ammonia added to:

Silver Chloride: $AgCl_{(s)} + 2NH_3 \rightarrow Ag(NH_3)_2^+{}_{(aq)} + 2Cl^-_{(aq)}$

Silver Cation: $Ag^{2+}_{(aq)} + 2NH_3 \rightarrow Ag(NH_3)_2^+{}_{(aq)}$

Zinc Hydroxide: $Zn(OH)_{2(s)} + 4NH_3 \rightarrow Zn(NH_3)_4^{2+}{}_{(aq)} + 2OH^-_{(aq)}$

Zinc Cation: $Zn^{2+}_{(aq)} + 4NH_3 \rightarrow Zn(NH_3)_4^{2+}{}_{(aq)}$

Copper (II) Hydroxide: $Cu(OH)_{2(s)} + 4NH_3 \rightarrow Cu(NH_3)_4^{2+}{}_{(aq)} + 2OH^-_{(aq)}$

Copper Cation: $Cu^{2+}_{(aq)} + 4NH_3 \rightarrow Cu(NH_3)_4^{2+}{}_{(aq)}$

B. Cyanide and thiocyanide Complexes--excess cyanide or thiocyanide anion added to:

Silver Chloride: $AgCN_{(s)} + CN^-_{(aq)} \rightarrow Ag(CN)_2^-{}_{(aq)}$

Silver Cation: $Ag^{2+}_{(aq)} + CN^-_{(aq)} \rightarrow Ag(CN)_2^-{}_{(aq)}$

Iron (III) Hydroxide: $Fe(OH)_{3(s)} + SCN^-_{(aq)} \rightarrow Fe(SCN)_6^{3-}{}_{(aq)} + 2OH^-_{(aq)}$

Silver Cation: $Fe^{3+}_{(aq)} + SCN^-_{(aq)} \rightarrow Fe(SCN)_6^{3-}{}_{(aq)}$

C. Hydroxide Complexes--a concentrated/excess strong base added to:

Aluminum Hydroxide: $Al(OH)_{3(s)} + OH^-_{(aq)} \rightarrow Al(OH)_4^-{}_{(aq)}$

Aluminum Cation: $Al^{3+}_{(aq)} + OH^-_{(aq)} \rightarrow Al(OH)_4^-{}_{(aq)}$

Aluminum oxide: $Al_2O_{3(s)} + OH^-_{(aq)} \rightarrow Al(OH)_4^-{}_{(aq)}$

Zinc Hydroxide: $Zn(OH)_{2(s)} + 2OH^-_{(aq)} \rightarrow Zn(OH)_4^{2-}{}_{(aq)}$

Zinc Cation: $Zn^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Zn(OH)_4^{2-}{}_{(aq)}$