Chemistry of Complex Compounds

Simple salts: When an acid reacts with an alkali, neutralisation takes place and a simple salt is produced.

e.g; $HCl + NaOH \longrightarrow NaCl + H_2O$

When dissolved in water, these salts ionise and produce ions in solution.

Molecular or addition compounds:

When solutions of two or more simple salts are mixed together in simple molecular proportion and the solution thus obtained is allowed to evaporate, crystals of a new comp. is obtained, this new compound is called molecular comp. or addition compound.

e.g; $K_2SO_4 + Al_2(SO_4)_3 + 24H_2O \longrightarrow K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$
(potash alum)

$FeSO_4 + (NH_4)_2SO_4 + 6H_2O \longrightarrow FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$
(Mohr's salt)

$CuSO_4 + 4NH_3 \longrightarrow CuSO_4 \cdot 4NH_3$
(tetrammine cupper sulphate)

$4KCN + Fe(CN)_2 \longrightarrow 4KCN \cdot Fe(CN)_2$
(potassium ferrocyanide)

Types of molecular or addition compounds:

Addition compounds are of two types. These are:

(i) double salt

(ii) complex salt or co-ordination compound.

(i) Double salt:

The molecular compound which is form crystallisation of a solution containing the simple salts is called double salt. They exist only in crystalline state. When dissolved in water, they dissociate into ions in the same way in which the individual components of the double salts do.

e.g; $FeSO_4, (NH_4)_2SO_4 \cdot 6H_2O \rightleftharpoons Fe^{2+} + 2NH_4^{\oplus} + 2SO_4^{2-} + 6H_2O.$

$K_2SO_4, Al_2(SO_4)_3 \cdot 24H_2O \rightleftharpoons 2K^{\oplus} + 4SO_4^{2-} + Al^{3+} + 24H_2O.$

In aqueous solution, they give the test of all their constituent ions i.e; the individual components of double salt do not loss their identity.

The other examples of double salts are chrome alum [$K_2SO_4 \cdot Cr_2(SO_4)_3 \cdot 24H_2O$] and ferric alum [$K_2SO_4 \cdot Fe_2(SO_4)_3 \cdot 24H_2O$]

Q. Between $FeSO_4$ & $Fe_2(SO_4)_3$ which one would you form a double salt with K_2SO_4? what is the common name of that compound?

Complex salt:

The molecular compound which is formed by a result of two normal salts in definite molar ratio dissociates in solution not to all the component ions but two component ions combine to form a new ion is called complex salt and the ion is called complex ion.

e.g.; When solution of $Fe(CN)_2$ and KCN are mixed together and evaporated potassium ferrocyanide is obtained which in aqueous solution does not give the test of Fe^{2+} and CN^- ions but gives test $K^\oplus$ and ferrocyanide ions.

$$\underbrace{Fe(CN)_2 + 4KCN}_{\text{soln}} \xrightarrow{\text{evap}} 4KCN \cdot Fe(CN)_2 \text{ (crystal)}$$

$$\Big\Vert$$

$$K_4[Fe(CN)_6] \cdot 3H_2O \text{ (crystal)}$$

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$$4K^\oplus + [Fe(CN)_6]^{4-}$$

Thus we see that in $K_4[Fe(CN)_6]$ the individual comp. loss their identity.

A complex salt contain a simple cation and a complex anion or a complex cation and a simple anion or a complex cation and complex anion as shown below;

(i) $K_3[Fe(CN)_6] \rightleftharpoons 3K^\oplus + [Fe(CN)_6]^{3-}$

(ii) $[Co(NH_3)_6]Cl_3 \rightleftharpoons [Co(NH_3)_6]^{3+} + 3Cl^-$

(iii) $[Pt(NH_3)_4][PtCl_4] \rightleftharpoons [Pt(NH_3)_4]^{2+} + [PtCl_4]^{2-}$