Sem-1
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Unit-III

Metal-Ligand equilibrium in Solution:

When Ammonia is added to an aqueous Solution of Nickel Sulphate ($NiSO_4$) then Colour changed because some of the $[Ni(H_2O)_6]^{2+}$ ions are converted into $[Ni(NH_3)_6]^{2+}$ ions.

The reaction involved is Ligands replacement reaction:-

$$[Ni(H_2O)_6]^{2+} + 6NH_3 \rightleftharpoons [Ni(NH_3)_6]^{2+} + 6H_2O$$

Equilibrium Constant K for this reaction is as

$$K = \frac{[Ni(NH_3)_6]^{2+}\,[H_2O]^6}{[Ni(H_2O)_6]^{2+}\,[NH_3]^6}$$

A High value of Equilibrium Constant means that the $[Ni(NH_3)_6]^{2+}$ is more stable.

In Aqueous Solution the Concentration of Water is Constant, So, the Value of Equilibrium Constant K is given as

$$K = \frac{[Ni(NH_3)_6]^{2+}}{[Ni(H_2O)_6]^{2+}\,[NH_3]^6}$$

Where K is Constant Known as the "Stability Constant" for $[Ni(NH_3)_6]^{2+}$ ion.

Higher the Value of Stability Constant for a Complex ion, the greater is its Stability.

And the value of $\frac{1}{K}$ is Known as "Instability Constant".
High value of Instability Constant posses Unstable Complex ion.

Generally Stability Constant are quoted as $\log_{10} K$ and Some typical values are shown below:-

$[Co(NH_3)_6]^{2+}$ → 5.11

$[Ni(NH_3)_6]^{2+}$ → 7.99

$[Zn(NH_3)_4]^{2+}$ → 9.11

$[Cu(NH_3)_6]^{2+}$ → 12.6

$[Fe(CN)_6]^{4-}$ → 8.3

$[Fe(CN)_6]^{3-}$ → 100