

Stability of a chelate increases with increase in the no. of such rings. Chelate containing alternate single and double bond are even most stable. In such cases the π -electron density is delocalised and spread over the rings which are stabilised by resonance as in $[\text{Be}(\text{acac})_2]^0$.

Applications of the formation of chelated complexes

Some applications of the formation of chelated complexes are given below;

- (1) Formation of chelates in analytical chemistry. examples are;
 - (a) Gravimetric estimation and identification of Ni^{2+} ions by di-methyl gly-oxime.
 - (b) Estimation of Mg^{2+} and Ca^{2+} ion by EDTA.
- (2) Formation of chelates in softening water and estimation of hardness of water.
- (3) Formation of chelates for removing poisonous metals from the body. e.g; poisonous lead can be removed from the body by this process.

Injection of $\text{Ca}[\text{Na}_2(\text{EDTA})]$ is given to the patient. This complex reacts with lead in the body and forms $\text{Pb}[\text{Na}_2(\text{EDTA})]$ chelate which is more stable than $\text{Ca}[\text{Na}_2(\text{EDTA})]$ and goes out from the body ^{through} urine.

- (4) Separation of ions by solvent extraction method: e.g; Cu^{2+} and Fe^{3+} ion can be separated from other ions by this method. When Cu^{2+} ion is treated with $\text{HAc}-\text{H}$, Cu^{2+} chelate is formed. $[\text{Cu}(\text{acac})_2]^0$, these chelate is extracted with some suitable organic solvent.



and thus Cu^{2+} ion can be separated from other ions.

(5) Role of metal chelates in living systems:

- (A) Role of hemoglobin, role of chlorophyll in plants.
- (B) Estimation of trace amount of transition metal ion. e.g; trace amount of Fe^{3+} can be estimated by forming the intensely coloured chelate $[\text{Fe}(\text{O-phen})_3]^{3+}$.

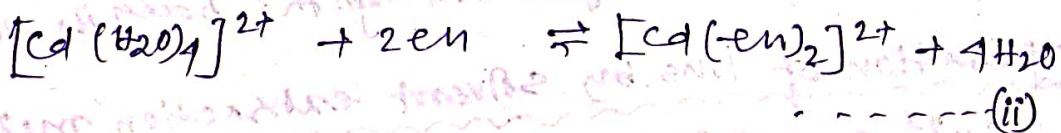
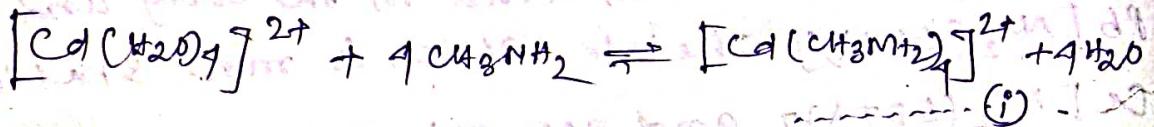
Chelate Effect:

The chelated complexes are known to be more stable than the non-chelated complexes. This effect is known as chelate effect.

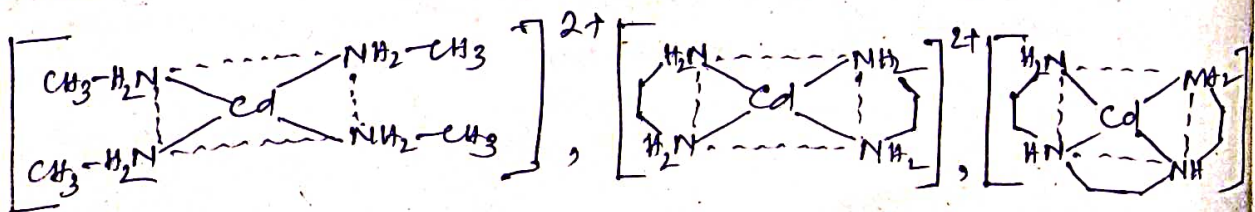
Explanation of chelate effect:

Chelate effect can be explained by considering the formation of some non-chelated and chelated complex ions of the same metal.

$[\text{Cd}(\text{H}_2\text{O})_4]^{2+}$ forms four co-ordinated complex ions with CH_3NH_2 , en and trien which are formulated as $[\text{Cd}(\text{NH}_2)_4]^{2+}$, $[\text{Cd}(\text{en})_2]^{2+}$ and $[\text{Cd}(\text{trien})]^{2+}$.

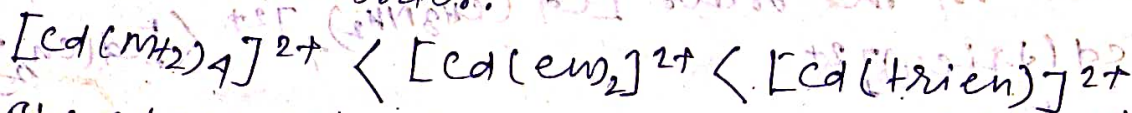


The structure of the complex ion formed in the above rxn are shown in figure below;



The above structures show that $[Cd(CH_3NH_2)_4]^{2+}$ has no rings while $[Cd(en)_2]^{2+}$ and $[Cd(trien)]^{2+}$ ions have two and three five membered rings including Cd²⁺ ions.

In each complex ion the co-ordination no. of Cd²⁺ ion is equal to four, since, CH_3NH_2 , en and trien are the monodentate, bi-dentate and tetradentate ligand respectively. Since $[Cd(en)_2]^{2+}$ and $[Cd(trien)]^{2+}$ ions are chelated ions each of these is more stable than $[Cd(CH_3NH_2)_4]^{2+}$ ion which is a non-chelated ion. It has been observed that the stability of these ions is in the order.



The above order can be explained on the basis of ΔG° value of rxns (i), (ii) and (iii).

The value ΔG° for a rxn is given by the relation

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

The value of ΔG° for all the three rxns has been found to be negative. It has been found that larger is the negative value of ΔG° , greater is the stability of the complex ion.

In rxn (i),

Since the no. of molecules on R.H.S is the same as that of L.H.S, there is no change in the entropy in going from reactants to products.

$$\Delta G^\circ = \Delta H^\circ = -ve$$

In rxn (ii),

Since four molecules of H_2O are replaced by two molecules of en, there is an increase of two molecules on going from reactants to products and hence there is an increase in the value of ΔS° in the same direction. Thus ΔS° would have a larger (+ve) value. This implies that ΔG° would be a larger (-ve) quantity than that of rxn (i).